Remote Sensing for Fisheries Science

Spatio-Temporal Variability of the Habitat Suitability Index for Chub Mackerel (*Scomber japonicus*) in the East/Japan Sea and the South Sea of South Korea

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Long-term changes of fishery resources in Korea



National Institute of Fisheries Science



- In recent years, fishery resources in Korea are largely changed
- Several major commercial species showed **decreasing trends** in **recent 20 years**
- Mackerel mostly decreased in the period



Korea Statistical Information Service (2018)

Environmental factors affecting the population dynamics



- The **population dynamics** of marine fishes are a result of interactions within **complexly entangled several environmental factors**
- The habitat suitability index (HSI) has been used to investigate marine fish population dynamics
 ; need to find the key environmental parameters to marine fish species to establish HSI model
- The derivation of HSI model will help us to **understand recent changes** in fishery resources
- Three environmental factors were chosen to derive simple HSI model with a few parameters

Environmental factors chosen for the HSI derivation



- The satellite ocean color data from the **Moderate Resolution Imaging Spectroradiometer (MODIS)** onboard the satellite Aqua platform provided by Ocean Biology Processing Group at NASA Goddard Space Flight Center (https://oceandata.sci.gsfc.nasa.gov/) were used
- MODIS 8-day composite data from July 2002 to December 2016 at 4-km of spatial resolution
- **Primary production (PP)** was derived with a **K&I algorithm** based on the Vertically Generalized Productivity Model (VGPM) (Behrenfeld and Falkowski, 1997; Kameda and Ishizaka, 2005; Yamada *et al.*, 2005; Joo *et al.*, 2016)
- Mean values in 3x3 pixels for each environmental parameter on every catch point were extracted from the satellite dataset



Commercial catch data for the chub mackerel



Year	Reported catches	No. of Matchable catches
2010	991	457
2012	789	336
2013	609	246
2014	809	277
2015	1715	586
2016	1144	407
Total	6057	2309

- The **commercial catch** data for the chub mackerel **in the South Sea** from **2010 to 2016** were obtained from the Large Purse Seine Fishery Cooperatives of South Korea
- These data include fishing locations and dates as well as the amount of catch (M/T)



Favored environmental conditions of chub mackerel around Korean Peninsula



- The chub mackerels were distributed in SST ranging from 11.48 to 31.94 °C, Chl-*a* from 0.15 to 25.43 mg m⁻³, and PP from 279.37 to 1239.92 mg C m⁻² d⁻¹
- The optimum ranges were defined as the **10th quartile and 90th quartile** (Kaschner *et al.*, 2016)
- In the optimum conditions of SST, Chl-a and PP, the accounted amounts of total catches were 81%, 86% and 82%, respectively.

HSI model derivation



- To derive the HSI values for the chub mackerel, three empirical models were used (Chen *et al.*, 2009)
- The constants of the models were obtained from the least squares fitting to derive optimized models for the study area

 $HSI = (SI_{SST} + SI_{Chl-a} + SI_{PP}) / 3$

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Spatial distribution of HSI and fishing records



- **Spatial distributions** between the HSI and the fish catches for the chub mackerel appeared **well matched**
- High catches in high HSI region, low catches in low HSI region

Relationship between the HSI and the fishery landings



- To validate our HSI model, the HSI values from our model were compared with fishery catches
- The HSIs were divided into 10 classes with an equal interval of 0.1
- The landed fisheries from the region with the HSI values corresponding to each class were summed.
- A strong positive linear relationship ($\mathbf{R}^2 = 0.6964$) was observed between the HSI and the fishery landings



Spatio-temporal variation of the HSI



- The general migration routes of the chub mackerel was well reflected in the HSI
- Spawning / wintering ground in the South Sea; autumn to winter
- Feeding ground in the East/Japan Sea; spring to summer

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• The seasonal northward and southward movements of a high HSI region

Summary

- In this study, the **HSI model for the chub mackerel** (*Scomber japonicus*) was derived by using **commercial catch data** and **MODIS-Aqua satellite datasets** between 2010 and 2016.
- The **optimum ranges** were 14.72 25.72 °C, 0.30 0.92 mg m⁻³, and 523.69 806.46 mg C m⁻² d⁻¹ for SST, Chl-*a*, and PP, respectively. **More than 80% of the total catch** was obtained from the region within the optimum ranges.
- Based on the results from the HSI model, we found a strong positive relationship ($\mathbf{R}^2 = 0.6964$) between the HSI and the fishery landings and a good match for the spatial distributions of the chub mackerel.
- The **seasonal northward and southward** movements of a high HSI region were observed in climatological monthly distribution of the HSI.
- Consequently, the **seasonal and spatial variations of the HSI agreed well** with the migration patterns of the chub mackerel reported previously in the South Sea and the East/Japan Sea.



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Thank you!



