

Modelling of Essential Fish Habitat for *Acanthopagrus latus* Based on Remote Sensing, Spatial Analysis and GIS in the Coastal Waters off Western Taiwan

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ABSTRACT

Black Seabream (*Acanthopagrus latus*) is one of the most important commercial species in the coastal fisheries of Taiwan. This aims to understand for fishing activity of gillnet fishery and community structure of fishery resources in coastal waters off western Taiwan. In this study, we collected logbook of sampling gillnet vessel, environmental data (i.e. Sea Surface Temperature, chlorophyll-a, sediment and depth) and data of voyage data recorder. We also investigated abundance and spatial distribution of hot spot for species that regularly released in recent years, and analyzed annual variation on community structure of fishery resources for species. Through ArcGIS software, spatial distribution of black seabream showed widespread in each season. However, the range of CPUE is 1.58-2.16 kg/vessel/day in each season. For black seabream, mainly distributed in coastal waters of Chianan but high CPUE concentrated in the coastal waters of Nanliao Fishing Port to Yuanli Fishing Port in first and second quarter. In addition, Habitat Suitability Index (HSI) model showed that black seabream have high sensitivity to the habitat changes in its ocean environment. For the second quarter, distribution of HSI value is widespread and concentrate in the coastal waters of Yunlin and Chiayi in third and fourth quarter. For the future, results from this study could be used to understand the impacts on the environment, habitat and community structure of fishery resources, and provide suggestions for planning management strategy.

I. INTRODUCTION

FAO estimated that approximately 180 fish species were released in 64 countries (Abraham et al. 2004). Several countries have documented their stocking programs in the scientific literatures but didn't give the report to FAO. Later, Cowx (2005) reported that approximately 180 fish species were released in 70 countries. Japan is the world leader in marine fish stocking, although many of the stocking programs are at experimental or pilot scale. Many believe that stocking will increasingly become an important fishery management tool in the future. However, the practice must be evaluated and monitored accurately (Abraham et al. 2004). More than ten different marine and coastal fish species are stocked in the United States, Republic of Korea, Australia, Japan, Spain and Poland, but the numbers are lower in some other countries. For example, in Japan over 80 species were reared for stock enhancement (Masuda and Tsukamoto 1998) and various species were stocked in Canada despite the absence of hatchery production data (Abraham et al. 2004). Taiwan also is one of countries that produce fingerlings of fish to be released into the natural waters. The objective of study was assess of stock enhancement for major fingerling released species and understand for fishing activity of gillnet fishery and community structure of fishery resources in coastal waters off western Taiwan.

II. DATA AND METHOD

A. Hydrological conditions

Satellite-derived decadal SST data measured by advanced very-high-resolution radiometer (AVHRR) sensors over a 15-month period from Jan.2015 to Mar.2016 were collected from the National Oceanic and Atmospheric Administration Satellite Active Archive (<http://www.class.ngdc.noaa.gov>) and the regional AVHRR data library at National Taiwan Ocean University, Keelung, Taiwan (Lee et al., 2005). The Multichannel Sea Surface Temperature algorithm produced SST images at a spatial resolution of 1.1 km (McClain et al., 1985).

B. Fishery and Biodiversity data

Annual fishing data concerning the coastal gillnet fishery of western Taiwan from Jan.2015 to Mar.2016 were obtained from logbook. They included date, catch species, weight, number, CT numbers and fishing location (longitude and latitude). Marine biodiversity (H') has been defined as the complex of individuals belonging to different species in a biotic community (Jerry, 1967). To determine it, Shannon's formula were used in this study:

$$H' = - \sum_1^S (Wt/W) \ln(Wt/W) \quad (1)$$

Species evenness (J') refers to how close in numbers the species in an environment are. The evenness of a community can be represented by Pielou's evenness index:

$$J' = H' / \ln S \quad (2)$$

The Jaccard index (J_a), also known as the Jaccard similarity coefficient, is a statistic used for comparing the similarity and diversity of sample sets. The Jaccard coefficient measures the similarity between finite sample sets and is defined as the size of the intersection divided by the size of the union of the sample sets:

$$J_a = \frac{ab}{(a+b-ab)} \quad (3)$$

a : number of catch species in area1, b : number of catch species in area2, ab : number of the same catch species between two area.

C. Voyage Data Recorder (VDR) data

A total of 40121104 records of VDR data (1km spatial grid) including fishing longitude and fishing latitude, year(2008-2011), month, day, CT numbers and fishing methods. It can record real position of vessel.

D. Habitat Suitability Index

HSI modeling is a valuable tool in ecology (Chen et al., 2009) that may be combined with the Geographic Information System (GIS) technology to create maps. The HSI models use suitability indices (SI) as a function of one or more environmental variables to determine the quality and suitability of habitats:

$$SI = (Y_{fit} - \min Y_{fit}) / (Max Y_{fit} - \min Y_{fit}) \quad (4)$$

III. RESULTS AND DISCUSSION

Results based 135 sampled fishing vessels showed that 193 species were recorded during January and November 2015. Regularly released species accounts for 17.64% of the catch, in which the mullet (*Mugil cephalus*) has the highest proportion of the catch composition. For the result, spatial distribution of *Epinephelus coioides* showed most widespread in regularly released species, but CPUE of groupers wasn't high (2.21-3.8 kg/vessel/day) in four seasons. The results demonstrated *Eleutheronema tetradactylum* and *Acanthopagrus latus* also widespread. However, the CPUE of *Eleutheronema tetradactylum* (4.24-7.69 kg/vessel/day) were higher than *A. latus* (1.58-2.16 kg/vessel/day) in four seasons. In first quarter to third quarter, the spatial distribution of high CPUE in *E. tetradactylum* were mainly focus on the offshore waters of Hsinchu. For *A. latus*, mainly distributed in coastal waters of Chianan but high CPUE concentrated in the coastal waters of Nanliao Fishing Port to Yuanli Fishing Port in first quarter and second quarter.

Furthermore, results from CTD showed that there is no clear pattern in the temperature and salinity with the depth of fishing operation in the study area. The index of relative importance (IRI) was used to evaluate the dominant species in

this area, which showed that the highest value was *A. schlegelii* for the first season (88.19) and second season (130.75). Furthermore, *Trichiurus lepturus* was the highest value in third season (139.83) and last season (93.06). The results suggested that release of fingerling fish could contribute to the resources and thus the catch in coastal waters of Taiwan. Results from this study could be used to evaluate the benefit of releasing fingerling species in waters off Taiwan. In the future, results from this study could be used to understand the impacts on the environment, habitat and community structure of fishery resources, and provide suggestions for planning and adjusting release species and locations.

IV. FIGURES AND TABLES

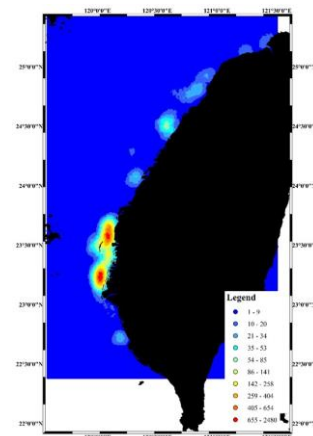


Figure 1. Distribution of accumulative fishing position of sampling gillnet vessel in 2015.

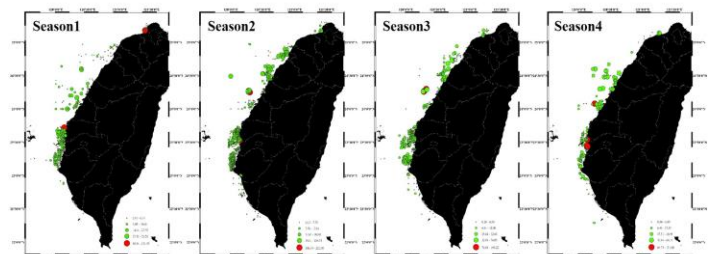


Figure 2. Seasonally distribution of fishing efforts (hr/vessel)of sampling gillnet in 2015.

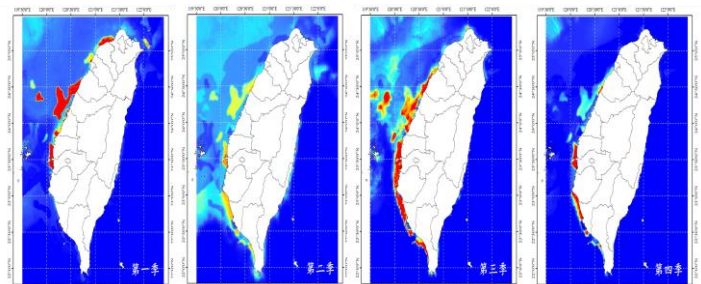


Figure 3. Spatial distribution of HSI model derived from interpolation and measured in the coastal waters off Taiwan in 2015.