ISSN: 2688-8645

Analysis and Prediction of Scottish Fish School Migration based on Habitat Index

Yangping Wu[1], Gengchen Bai[2] and Xiaocan Zhong[1]

[1]School of North China University of Science and Technology, Tangshan 063000, China;

[2]School of North China University of Science and Technology, Tangshan 063000, China;

[3]School of North China University of Science and Technology, Tangshan 063000, China.

Abstract

In recent years, due to the impact of global warming, the ocean temperature has also been rising. For Scotland, the habitat of herring and mackerel may have moved north from Scotland, which may cause some small and medium-sized fisheries companies to be severely damaged. It is important to predict future changes in the habitat of mackerel and herring in Scotland with temperature.

Keywords

Habitat suitability index; Fish school migration prediction; Marine environmental factors; Analytic hierarchy process.

1. Introduction

As a result of global warming[1], the temperature of seawater has risen, polar ice has melted, the area of the ocean has expanded, and the original land has become the ocean, while the area of tropical and temperate oceans has expanded, and the area of the cold sea has decreased. As a result, tropical and temperate warm waters migrate to higher latitudes. Large-scale abnormal migration of species can be seen in the lobster population in Maine, USA, which has affected the local marine industry.

Mackerel and herring are the largest proportion of fish in the Scottish fishery. They are sensitive to temperature and migratory. If the global temperature rises, the habitat of herring and mackerel in Scotland is likely to migrate north[2]. As a result, Scottish fisheries are affected. If fish habitats move too far north, some small and medium-sized enterprises will be unable to carry out fishing because there are no refrigerated boats to transport catches to Scottish fishing ports, and the economy will be severely damaged. Therefore, it is important to predict the future changes in habitats of mackerel and herring in Scotland with temperature, and to explain the occurrence of this phenomenon and propose solutions.

2. Establishment of the Model

2.1. Data Sources

2.1.1. Environmental Data

Sea surface temperature (SST) [3] data is from Hadley Centre HadISST dataset, with a spatial resolution of 0.1 ° * 0.1 ° and a temporal resolution of month.

Sea surface height (SSH) [4] data is from the Hadley Center HadISSH dataset, with a spatial resolution of 0.1 ° * 0.1 ° and a temporal resolution of month.

2.2. HIS Modeling

Use the arithmetic weighting method to build a habitat index model [5], as shown in Figure 1, and the formula is shown in Formula 1.

ISSN: 2688-8645

$$\text{AWM: HSI} = aSI_{SST} + bSI_{GSST} + cSI_{SSH} \quad (a+b+c=1) \tag{1}$$

In the formula, $SI_{SST}, SI_{GSST}, SI_{SSH}$ are the adaptability indexes of each influencing factor.

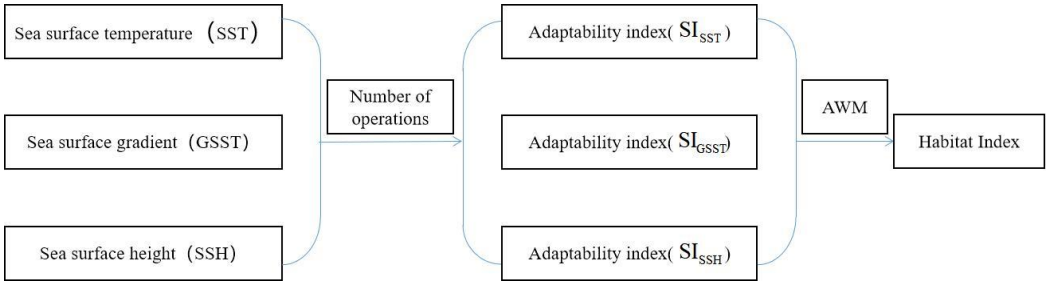

Figure 1. Schematic diagram of habitat index calculation

Mackerel herring free fish production showed a normal distribution with SST. The highest output corresponds to SST of 11.30 ° C, the proportion of output below 11 ° C is 23.84%, the proportion of output above 11 ° C is 76.16%, and the SST corresponding to more than half of the highest output is defined as mackerel herring free The suitable temperature of the school of fish[6], statistics show that the suitable temperature range for the free school of fish is 11.50 °C ~ 15.30 °C. The current habitats of mackerel and herring and the locations of operations of Scottish fishing companies are shown in Figures 2, 3, and 4.

3. Temperature Factor Analysis

In recent years, due to the impact of global warming, the average global temperature has increased, with an average annual increase of 0.01 ° C. According to data released by the US Oceanic and Atmospheric Administration, the surface temperature of most land areas is higher than usual. Among them, the ocean is very sensitive to climatic variability, and the increase in temperature has led to large-scale migration of social submarine animals. The mackerel and herring studied in this paper have certain requirements for survival temperature. Regarding global warming, the tropopause heights in different regions of the world show seasonal and different trends. Du Yibo [9]et al. Pointed out that in the past 36 years, the global tropopause height has risen overall, while the troposphere temperature has decreased, and the temperature has dropped by about 0.1°C · (10 a) $^{-1}$.

3.1. Model Corrections

In general, SST is the dominant factor affecting the migration of mackerel herring, which is ideal for the simulation of sea areas where mackerel herring habitat quality is controlled by SST. In fact, other environmental impact factors can also affect the distribution of mackerel herring habitat, such as ocean surface height, dissolved oxygen, and ocean surface salinity. The HIS model based on SST in this study has poor indexing of undesired habitats. Maybe the mackerel herring is dominated by other environmental impact factors other than SST when migrating to the undesired habitat. The impact of mackerel herring habitat quality needs further research and analysis.

In addition, the quality of the data entered into the HIS model also affects its performance. In the early stage of modeling, the spatial resolution of fishery data is also a new factor to be controlled [11]. This study uses remote sensing data and fisheries that only target a single type of spatial resolution. The model established by the data is evaluated, and the impact of different spatial resolution data on the performance of the HIS model needs to be further explained. Similarly, the time resolution of the data used in this model is monthly. The model established in this way is feasible to evaluate the changes in habitats of each month or even each year, but

it cannot be performed with more detail. In the future, it can be established with higher time resolution data. HIS models are necessary.

3.2. Evaluation based on AHP Strategy

According to the established Scottish Herring-Mackerel Habitat Adaptation Index model and the temperature forecast in Scotland, it is found that in the next 50 years, large-scale migration will occur in Scottish fish schools, and some small fisheries companies will cause economic losses. Therefore, these small fisheries companies should change their operations[13].

There are several strategies below, and the best strategy needs to be selected.

A. Transfer some or all of the company's assets from its current location in Scottish ports to a location where two schools of fish are moving.

B. premise of ensuring the freshness and quality of the catch, it can operate normally without relying on land support for a period of time.

C. subdivided local fish species, classified fishing during the fishing process, and improved fishing efficiency.

All three methods are subjective, so they are evaluated using AHP to select the best solution.

4. Conclusion

Analytic Hierarchy Process (AHP) is a simple and easy way to make decisions on more complex and fuzzy questions. It is suitable for problems that are difficult to quantify. This is a simple and flexible method proposed by the American operations researcher Professor TLSaaty [14] in the early 1970s. It is a practical multi-criteria decision-making method.

References

[1] Shakirudeen Lawal,Christopher Lennard,Bruce Hewitson. Response of southern African vegetation to climate change at 1.5 and 2.0° global warming above the pre-industrial level [J]. Climate Services, 2019, 16.

[2] Amanda R. Hart,Gavin Fay. Applying tree analysis to assess combinations of Ecosystem-Based Fisheries Management actions in Management Strategy Evaluation [J]. Fisheries Research, 2020, 225.

[3] Hua Yang,Qingqing Gao,Huifeng Ji,Peidong He,Tianmao Zhu.Sea surface temperature data from coastal observation stations:quality control and semidiurnal characteristics[J].Acta Oceanologica Sinica, 2019, 38(11): 31-39.

[4] Zhang Chang, Gao Guoping, Chen Xinjun. Preliminary Study on the Relationship between the Distribution of Ommastrephes bartrami and the Sea Surface Height in the Northwest Pacific Ocean [J]. Journal of Guangdong Ocean University, 2015, 35 (04): 93-98.

[5] Chuanxiang Hua,Fei Li,Qingcheng Zhu,Guoping Zhu,Lingwen Meng. Habitat suitability of Pacific saury (Cololabis saira) based on a yield-density model and weighted analysis[J]. Fisheries Research, 2020, 221.

[6] Iria García-Lorenzo,María José Cabaleiro-Casal,Manuel María Varela-Lafuente. Fishermen's associations of the small-scale fisheries: Study applied to the participation in the Cofradías of Galicia (NW Spain)[J]. Ocean and Coastal Management, 2019, 178.