The Migration Coefficient Prediction Based on BP Neural Network

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ABSTRACT. *Changes in ocean temperature will greatly affect the survival of marine life. Herring and mackerel, which are important sources of the Scottish fisheries economy, migrate as seawater temperatures rise. As consultants to the Scottish North Atlantic Fisheries Management Association, we need to investigate the migration of these two fish. In this paper, we first found out the concentrated factors that may affect fish migration, and processed them through principal component analysis. And then through BP neural network we predict the migration coefficient and scaling ratio, and finally uses ARCGIS software to draw the migration trajectory of the two fish species over the next 50 years and concluded that the school of fish should migrate northward beyond Norway.*

KEYWORDS: *BP neural network, Migration coefficient*

1. Introduction

Changes in global ocean temperature will affect changes in the habitat of marine organisms. When temperatures rise enough, marine animals can no longer survive and have to search for new habitats and conditions. The Maine lobster population, for example, had to migrate north to Canada in search of a better environment in the face of rising ocean temperatures. This geographic population shift can significantly disrupt the livelihood of companies who depend on the stability of ocean-dwelling species.

Similarly, climate change is causing huge changes in fish populations off the coast of Europe. The North Atlantic Ocean off the coast of Scotland is warming four times faster than the global climate, and its average annual temperature has risen by about 2 degrees Fahrenheit over the past 30 years, which is critical to the growth and survival of fish and the maturation of their eggs, and the plankton-supported food chain and commercial fisheries have had a profound impact.

2. Influencing Factors of Fish Migration

(1) Sea Surface Temperature (SST)

Sea surface temperature is the surface temperature of the ocean which depends on the heat budget are obvious diurnal and seasonal variations.

(2) The ocean water quality

In this problem, we only consider the effect of chlorophyll content in ocean water quality, because chlorophyll content affects ocean water oxygen content.The higher the chlorophyll content, the lower the oxygen content.

(3) Ionic concentration

In this case, it means the hydroxide and hydrogen ions per unit volume of seawater.

(4) The salinity of ocean water

Salinity is the ratio of all dissolved solids in seawater to the weight of seawater.

(5) Total allowable catch

Total allowable catch is an index reflecting the production achievements of marine fishery, including the amount of fish and other Aquatic animal caught in fishery production.By using principal component analysis, the above factors are reduced, and the results showed that the two main factors affecting fish migration are the sea surface temperature (SST) and the ocean water quality. Therefore, we first set up a model of the factors that affect the migration of fishes.

3. Model Construction

BP neural network is a kind of multi-layer fed before trained by error back propagation Algorithm. Its learning rule is to use gradient descent to adjust the weight and threshold of the network through back propagation so as to minimize the square sum of the network.

For the neural network can approximate any nonlinear function characteristics, we use BP neural network to calculate the transfer coefficient and scaling ratio. The concrete model is as the chart shown:
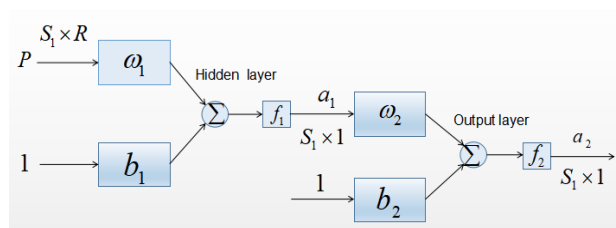

Figure. 1 BP Neural Network Model

STEP1: Input sample forward propagation

In hidden layer, the output of neurons i is as follow:

$$a_{1i} = f_1(\sum_{j=1}^{n} \omega_{1ij} p_j + b_{1i}), i = 1, 2, ..., s_1$$

In output layer, the output of neurons k is as follow:

$$a_{2k} = f_2(\sum_{i=1}^{s_1} \omega_{2kj} a_{1i} + b_{2k}), k = 1, 2, ..., s_2$$

STEP2: The output error is corrected by back propagation

The error function is as follow.

$$E(\omega, b) = \frac{1}{2} \sum_{k=1}^{s_2} (t_k - a_{2k})^2$$

To correct the weight of Hidden Layer and gain the weight from the J input to the I output are as follow.

$$\Delta \omega_{ij} = -Y \frac{\sigma E}{\sigma \omega_{2ki}} = Y \times \sigma_{ij} \times P_j, 0 < Y < 1$$

4. Model Results

We pick points randomly in the research area in arcmap for mask analysis. The grid values are assigned to random points, and these points are exported to the excel table for statistics and calculations to obtain the migration index of each suitability range of each species for each month. Then, raster analysis is performed on the fitness map to calculate the area of each fitness.

Then, a raster analysis is performed on the fitness map to calculate the area of each fitness. To improve data visibility, we perform raster data extraction by attributes.

Using the BP neural network to predict the data of the next 50 years from the data of the past 50 years, we can finally obtain the corresponding migration index and scale change coefficient, so as to understand the migration and population of fish.Based on the migration index and the coefficient of scale change, the appropriateness ranges extracted were shifted and scaled to obtain the herring distribution map for the next 50 years. The distribution diagram of mackerel is the same.
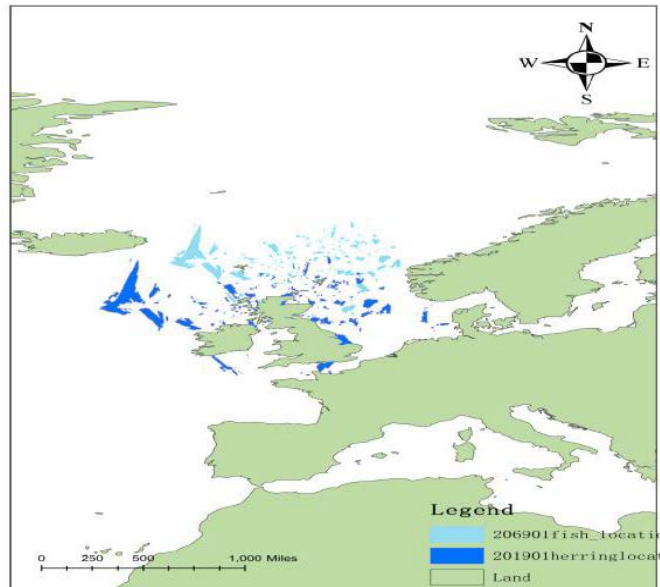
Figure. 2 The likely locations of Scottish herring

From Figure 2, we know that the trajectory of herring will move northward beyond Norway in the next 50 years.

5. Conclusion

In this paper, we establish a mathematical model to predict where herring and mackerel populations will change over the next 50 years if water temperatures change enough. First, we identify the factors that affect the migration of fish stocks and analyze the data. Based on the MODIS data of sea surface temperature and water quality as well as its latitude and longitude, the SST retrieval method and BP Neural Network are used to predict the location of these two species in the next 50years. Besides, the trajectory of the shoal could be mapped the ARCGIS.

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