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100 years of Baltic Sea Changes

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Historical reconstruction is a tool to understand the ecosystem dynamic, which is essential for making prediction models. Most of the studies concerning Baltic ecosystem took place in the second half of XX century. Although the Baltic ecosystem is relatively well understood, there are still some missing elements as stock dynamic of flounder and its role in the ecosystem. The aim of this project is to perform the reconstruction of the biomass dynamics of the Baltic Sea flounder in the light of environmental conditions. To achieve this, the historical catch data and environmental conditions characteristics were compiled and analyzed. Preliminary results showed that the rapid decrease in flounder's biomass was caused mainly by extremely high catch during so called the salinity "stagnation period" at 1930s - which probably effected weak recruitment. Both of these factors: high catch level and low salinity might contribute to reduce reproductive capacity of flounder stocks. According to our models the biomass of flounder started to rebuilt after ca. 20 years.

Introduction

Flounder is assessed by the Baltic Fisheries Assessment Working Group, however it belongs to category "data-limited stocks" and so far there are no accepted quantitative assessments. There are 4 flounder stocks in the Baltic Sea; one with demersal-spawning and three with pelagic-spawning. These two groups differ in their spawning habitat and eggs characteristic. Each of them needs different environmental conditions for spawning. Demersal eggs require first of all sufficient oxygen concentration, so the spawning area for those fish will exclude places where there is hypoxia condition at the bottom, while flounder with pelagic eggs needs appropriate salinity level to obtain the neutral egg buoyancy. There are also population differences within the pelagic-spawning flounder, which has led to the definition of three assessment units.

Baltic flounder was important species from both the ecological and economic aspects over entire XX century. Historically, flounder catches reached maximum in 1930s (about 60 thousand tons) in a very short time and rapidly collapsed at the beginning of 1940s. After that period, catches fluctuated, but stayed at relatively low level in comparison to 1930s. There is an ecological puzzle - what happened to flounder stocks that catches increased to so high level and collapsed so rapidly afterwards? Was that an environmental factor or a human impact? Answering that question is the first step to reconstruct Baltic flounder stock dynamic and understand pelagic-benthic coupling in the Baltic Sea.

Materials and Methods

In this project we tried to reconstruct the biomass of two flounder stocks defined during WKFLABA: flounder in SD 24-25 and flounder in SD 26, as we have the input data and settings for XSA for them until 1978 and 1955, respectively. Based on SSB estimated for that period and historical catch data back to 1906 from Central Baltic (Hammer at Feistel et al., 2008) we reconstructed stock dynamic using different approaches: i) constant Stock Per Recruit (SPR) estimated as an average of the observed values (Eero and MacKenzie (2011)), ii) assumed that SPR was depend on the biomass linearly or logarithmically (Horbowy, 2013).

Furthermore, the historic environmental data (salinity, oxygen, primary production) based on Gustafson et al (2012) and flounder reproductive volume defined by Ustups et al. (2013) were used to explain flounder historical stock dynamic. Our results were also compared with cod biomass

reconstruction made by Eero et al. (2007), to recognize potential food competition between these two species.

Results and Discussion

Our preliminary results show that reconstructed biomass in general follow the dynamic of observed catches and reach the peak of 70 000 tonnes (Fle 24-25) and 20 000 tonnes (Fle 26) just before the highest observed catches. After 1930' reconstructed biomass values based on three applied approaches were similar. However, the method limitations do not allow to fully recognition the flounder stock dynamic before catches peak in 1930'. The biomass from that period was successfully reconstructed by using approach, which assume constant SPR (for Fle 24-25 and Fle 26) and by method that assumed linear dependency of SPR to biomass (for Fle 26).

The highest historical catch was parallel in time with so called "stagnation period" characterized by: no inflows from the North Sea, decrease in salinity and slightly oxygen concentration at deeper water layers. Depletion of salinity possibly caused unfavorable recruitment conditions. At the same time fishing pressure increased and extraordinary high catch level reduced the biomass (Figure 1). Both of those factors, probably, contributed to reduce reproductive capacity of flounder stocks. According to our models the biomass of flounder started to rebuilt after ca. 20 years.

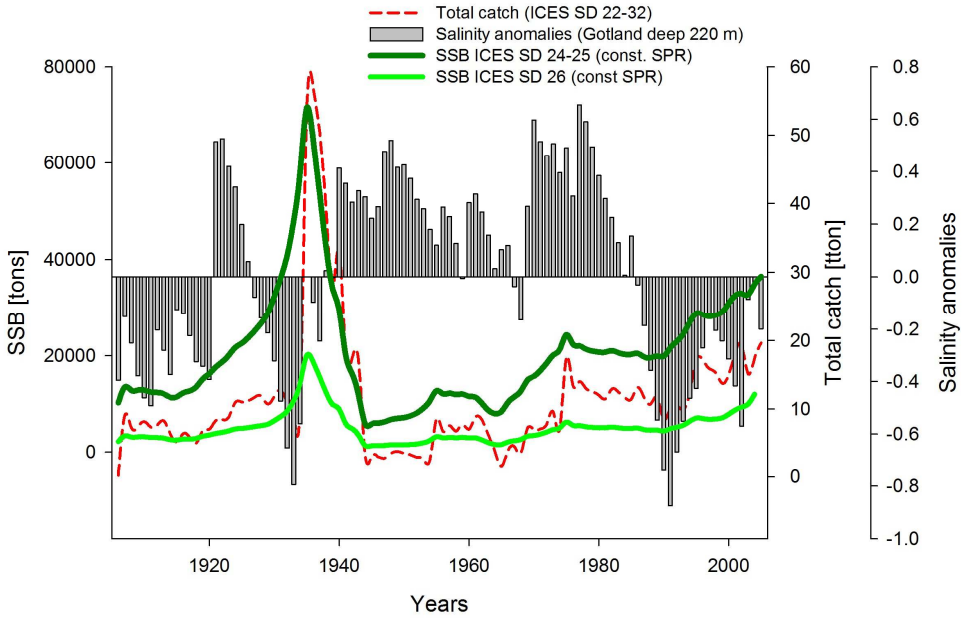

Figure 1. The reconstruction of the biomass dynamics of the two stocks: Fle in SD 24-25 and Fle in SD 26.

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