FLUCTUATIONS OF THE CATCH OF SOME PELAGIC SPECIES OF THE MEDITERRANEAN SEA

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FLUKTUACIJE ULOVA NEKIH PELAGIČNIH VRSTA RIBA U MEDITERANU

Apstrakt

U radu su analizirani 63 godine dugački podaci o ulovu tune (*Thunnus thynnus*) i srdele (*Sardina pilchardus*) u Mediteranu, metodom spektralne (Fourierove) analize i kros korelacjom. Analiza je pokazala da ulov tune sadrži ciklične komponente od 2.6, 3.65, 5.64, 7.75, 10.34 and 15.5 i verovatno 31 godinu, dok su u ulovu srdele najizraženije bile amplitude od 2.44, 3.65, 6.2, 7.75 i 10.34 godina. Prema tome, oba su vremenska niza bila koherentna u ciklusima od 3.65, 7.75 i 10.34 godina. Takođe je ustanovljeno da je ulov tune koherentan sa indeksom severoatlantske oscilacije (NAO) i to u periodima od 2, 3.35, 4.43, 6.89, 10.34 i verovtno 31 godina. Ovo ukazuje da klimatski ciklusi utiču na fluktuacije populacije ove ribe. Nadalje, upoređenje fluktuacija ulova tune u zapadnom i istočnom Mediteranu je pokazalo da su one potpuno sinhrone.

Ključne reči: Thunnus thynnus, Sardina pilchardus,ulov, fluktuacija, Mediteran
Key words: Thunnus thynnus, Sardina pilchardus, catch, fluctuations, Mediterranean

INTRODUCTION

In the Mediterranean Sea sardine (*Sardina pilchardus*) are one of the most important species in terms of biomass and commercial interest (Palomera et al. 2007). Small pelagic fish have important role in the food web and connecting lower and upper trophic levels, getting the whole ecosystem functioning (Palomera et al. 2007). In general small pelagic populations are subject to considerable fluctuations caused by environmental variability and relatively short life cycle (2–3 years) (Palomera et al. 2007).

Bluefin tuna (*Thunnus thynnus*) was exploited in the Mediterranean Sea since antiquity, but recently it become highly profitable. Their stock is likely overexploited and threatened by the highest fishing pressure of its entire history (Fromentin and Ravier, 2005). Implementation of a Total Allowable Catch – quota (TAC), induced in 2007, increased uncertainties in the catch statistics data and made the standard stock assessment inoperative. Oscillation in the tuna catch recorded from 1950s up to nowadays has been considered by some authors as a change in the migration patterns influenced by environmental and trophic origins in relation to the North Atlantic Oscillation. NAO index is found to be important for the atmospheric circulation in the north Atlantic and Mediterranean (Grbec et al. 2002). The aim of this paper was to analyze existing data on long-term fluctuations of the two pelagic species present in the Mediterranean Sea, and to assess whether there is a relationship between them, and to connect climatic fluctuations to fish-catch fluctuations.

MATERIAL AND METHODS

The fish landing data used in the analysis correspond to the fish caught in the coastal and open seas of Mediterranean. Data on the total annual catches of sardine and bluefin tuna, from 1950 to 2013 (63 years) were taken from the FAO FishStat Plus data basis. Fisheries statistics for the period presented the catch data by species. We decided to analyze just two representatives from the trophic food chain, prey and predator species, both very commercially important and threatened by overexploitation in the recent decades.

Catch statistices of sardine and bluefin tuna from all Mediterranean countries were taken and analysed. Some of the countries gave the aproximated catch data, for example Malta, some countries had very small, not comparative catch data, so we decided to make the analises of the cumulative catch from all Mediterranean countries.

RESULTS

Analysed catches of bluefin tuna and sardine in the period from 1950 to 2013 have similar fluctuations. Bluefin tuna schools migrate each spring in Mediterranean for the spawning and leaves in autumn (Ravier and Fromentin, 2001). According to available statistical data, catch increased from 1950 and reached peak in 1995 when highest bluefin tuna catch was 33975 t. From 2007, when quotas were established catch statistics show downward trend and achives the same values like in 1950s.

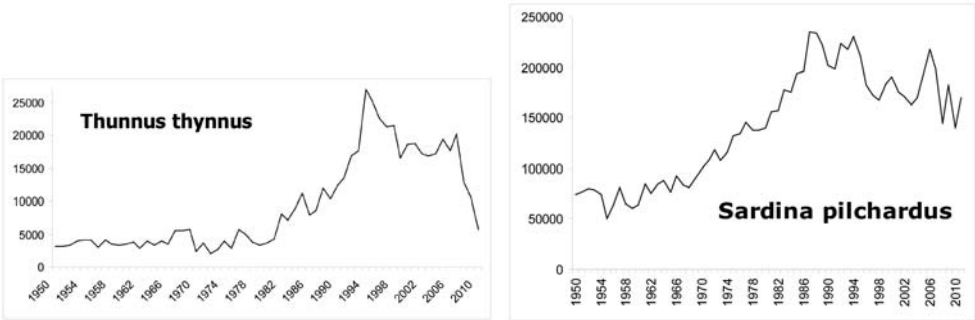

Figure 1. Total bluefin tuna and sardine catch in Mediterranean Sea

On the other side sardine catch, which has no quotas, also increased until 1987, when it reached maximal value of 289317 t. After that time catch gradually decreased, but it still was higher then in 1950s.

Analysis of bluefin tuna catch time series performed in this paper, showed amplitudes at the periods of 2.6, 3.65, 5.64, 7.75, 10.34, 15.5 and probably 31years. Sardine catch showed amplitudes at the periods of 2.44, 3.65, 6.2, 7.75 and 10.34 years. Consequently, both species experienced common periods of 3.65, 7.75 and 10.34 years (Figure 2).

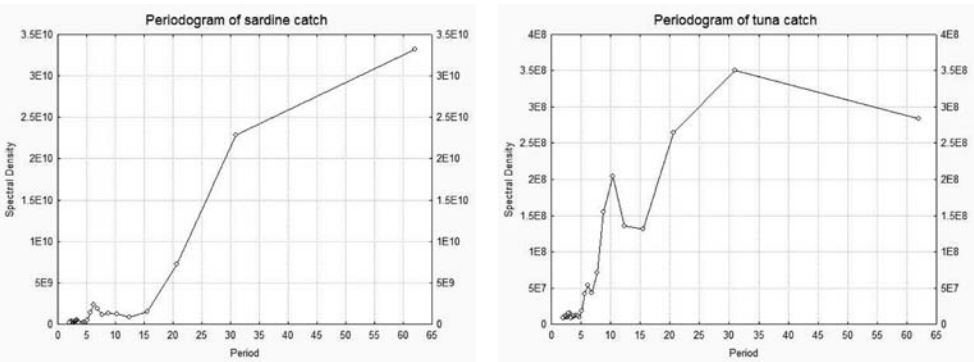

Figure 2. Periodograms of sardine and bluefin tuna catch in Mediterranean Sea

We found that there are no significant differences between West and East Mediterranean catches of both species (Figure 3).

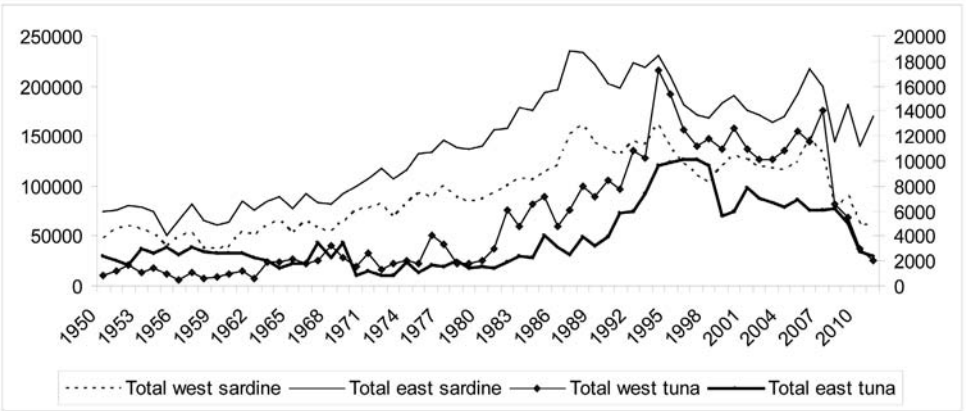

Figure 3. West and East Mediterranean catches of bluefin tuna and sardine species.

The squared coherency analysis showed that NAO and bluefin tuna catch were coherent at the periods of 2, 3.35, 4.43, 6.89, 10.34 and probably 31 years (Figure.4a), which confirms their functional relationship, while for sardine it is already known that it is related with NAO (Grbec et al. 2002). We also found that fluctuation of bluefin tuna catch follows NAO fluctuations with the four years delay (Figure. 4b).

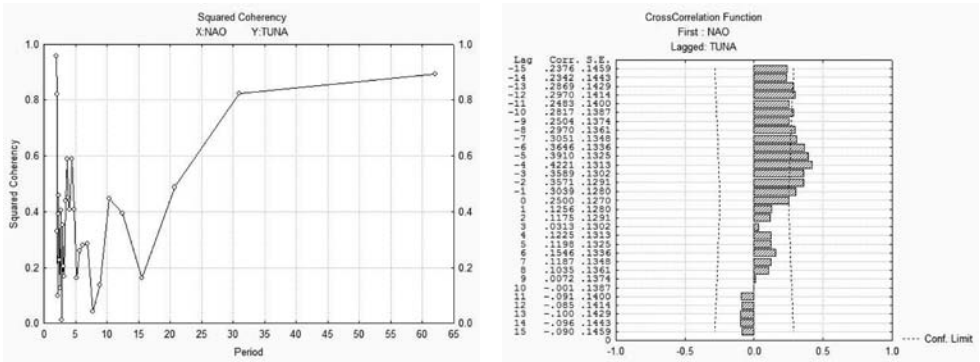

Figure 4. a) Squared coherency between bluefin tuna catch and NAO, b) Crosscorrelation function between bluefin tuna and NAO

DISCUSSION

Fluctuations of fish catch are the result of cumulative effects. In addition to cyclical natural processes in the environment, anthropogenic factors significantly affect environmental characteristics and catch. Fishing commonly changes the relative abundance of fish species but may also change the structure and functioning of the ecosystem (Cury et al. 2000).

The decline in the catches is suspected to be primarily due to under-reporting, following the implementation of quotas particularly for the tuna species.

The quality of catch statistics depends on the methodology of collecting data, which affects their reliability (Welcomme et al. 2010; Baigún et al. 2013).

The dynamics of pelagic fish species is strongly influenced by environmental factors, determining food availability both in time and space for larvae and juveniles (Grbec et al. 2002). Fluctuation of the fish resources in Mediterranean are influenced by the geostrophic current, front system which brings nutrients to Mediterranean Sea. These fronts are usually characterised by high levels of biological activity, and particulary, of primary production. Geostrophic fronts exhibit complex current and hydrological structures (Videau et al. 1994).

There is evidence about connection between the hydroclimate variables and pelagic species. Grbec et al. (2002) compared year-to-year fluctuations of small pelagic fish landings in the eastern Adriatic coast with climatic fluctuations over the Northern Hemisphere and salinity fluctuations in the Adriatic. They found interrelation between climatic fluctuations over the Northern Hemisphere and small pelagic fish landing data. Years with positive pressure differences, which are years of higher salinity, cause the increase of phytoplankton productivity. Strong correlation of the species landing data to the pressure difference could also be due to the connection of fish to plankton productivity.

We found that catch of bluefin tuna and sardine had the same periods of 3.65, 7.75 and 10.34 years, which coincide with some of the coherent periods for bluefin tuna and NAO.

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