

Analysis of long term landings of some economically important pelagic species of the Mediterranean Sea

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ABSTRACT

In the Mediterranean Sea important pelagic fish species in terms of commercial interest are: swordfish (*Xiphias gladius*), European pilchard-sardine (*Sardina pilchardus*), European sprat (*Sprattus sprattus*), Atlantic mackerel (*Scomber scombrus*), chub mackerel (*Scomber japonicus*), European anchovy (*Engraulis encrasicolus*), frigate tuna (*Auxis thazard*), little tunny (*Euthynnus alletteratus*), Atlantic bonito (*Sarda sarda*) and Atlantic bluefin tuna (*Thunnus thynnus*). This paper gives the general insight into the relation between catch statistics of these species in the Mediterranean and Black Sea. These species are influenced by different environmental and anthropogenic factors that might have effects on fish and consequently on their catch. We used FAO statistic data while analysis were obtained using program Statistica and Excel. This paper points out trends in fishery statistics in the last 68 years and knowledge about important interactions, helping to understand progress towards a better fishery management in the region.

Keywords: catch, pelagic fish, economically important species, fluctuations, Mediterranean

INTRODUCTION

In the Mediterranean Sea small pelagic fish is the most important species in terms of biomass and commercial interest (FAO, 2018), while representatives of tuna family and sword fish have beside commercial also recreational fishery importance. Small pelagic fish have important role in the food web, getting the whole ecosystem functioning (Palomera *et al.*, 2007). Three groups of species constitute around 68% of the total reported landings in the entire Mediterranean, among them

herrings, sardines, anchovies and miscellaneous pelagic fishes comprised 48% of total landings (FAO, 2018). Landings increased from 1960s due to improvements in fishing activities (more efficient fishing gears), increasing fishing capacity and high productivity of the ecosystem (Fortibuoni *et al.*, 2017). Even though catch statistics are not reliable, most widely available source of the state of fish stocks are catch statistics, which will probably remain the dominant basis for

fishery assessments (Jarić *et al.*, 2014).

Small pelagic fish are subject to considerable fluctuations caused by environmental variability and relatively short life cycle (2–3 years). Tuna catch oscillation recorded from 1950s up to nowadays has been considered as a change in the migration patterns influenced by environmental and trophic origins related by North Atlantic Oscillation (NAO) (Regner *et al.*, 2015). NAO index is found to be important for the atmospheric circulation in the north Atlantic and Mediterranean (Grbec *et al.*, 2002). Since the Atlantic and Mediterranean bluefin tuna (*Thunnus thynnus*) was overexploited and threatened by the highest fishing pressure of its entire history (Ravier & Fromentin, 2005), total allowable catch quota (TAC) was introduced in 2007. Sometimes implementation of more restrictive regulations without stronger control increase uncertainties in the catch statistics data and made the standard stock assessment inoperative (Regner *et al.*, 2015).

There is a doubt that there might be gradual transition in landings from species that are highly protected and/or overexploited species to other species. Grbec *et al.* (2002) pointed out that the fish catch does not depend only on environmental conditions and fluctuations of the stock, but also on changes

of fishing technique, fishing effort, and a number of economic and social factors. The aim was to analyze existing data on long-term fluctuations of the most common pelagic species present in the Mediterranean and Black Sea.

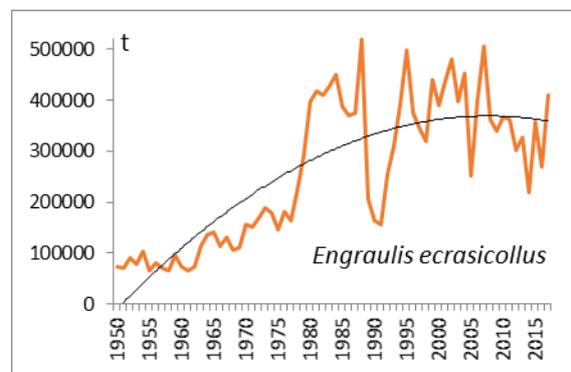
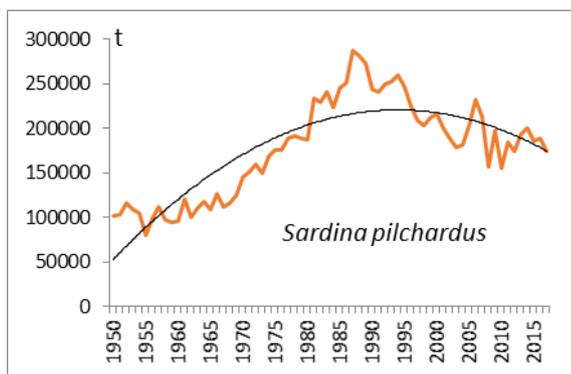
MATERIAL AND METHODS

The fish landing data used in the analysis correspond to the fish caught in the coastal and open seas of Mediterranean and Black Sea. Data on the total annual catches from 1950 to 2017 (68 years) were taken from the FAO FishStat Plus data basis. Program Statistica 8 (StatSoft) and Excel were used for the analysis.

RESULTS

According to available statistical data, catch of all analysed species increased from 1950's reaching peak during 1980's and 1990's (Fig. 1).

Analysed catches from 1950 to 2017 have similar fluctuations, showing the decreasing trend through the observed period except for *Sprattus sprattus*, *Scomber scombrus* and *Euthynnus alleteratus* (Fig. 1).



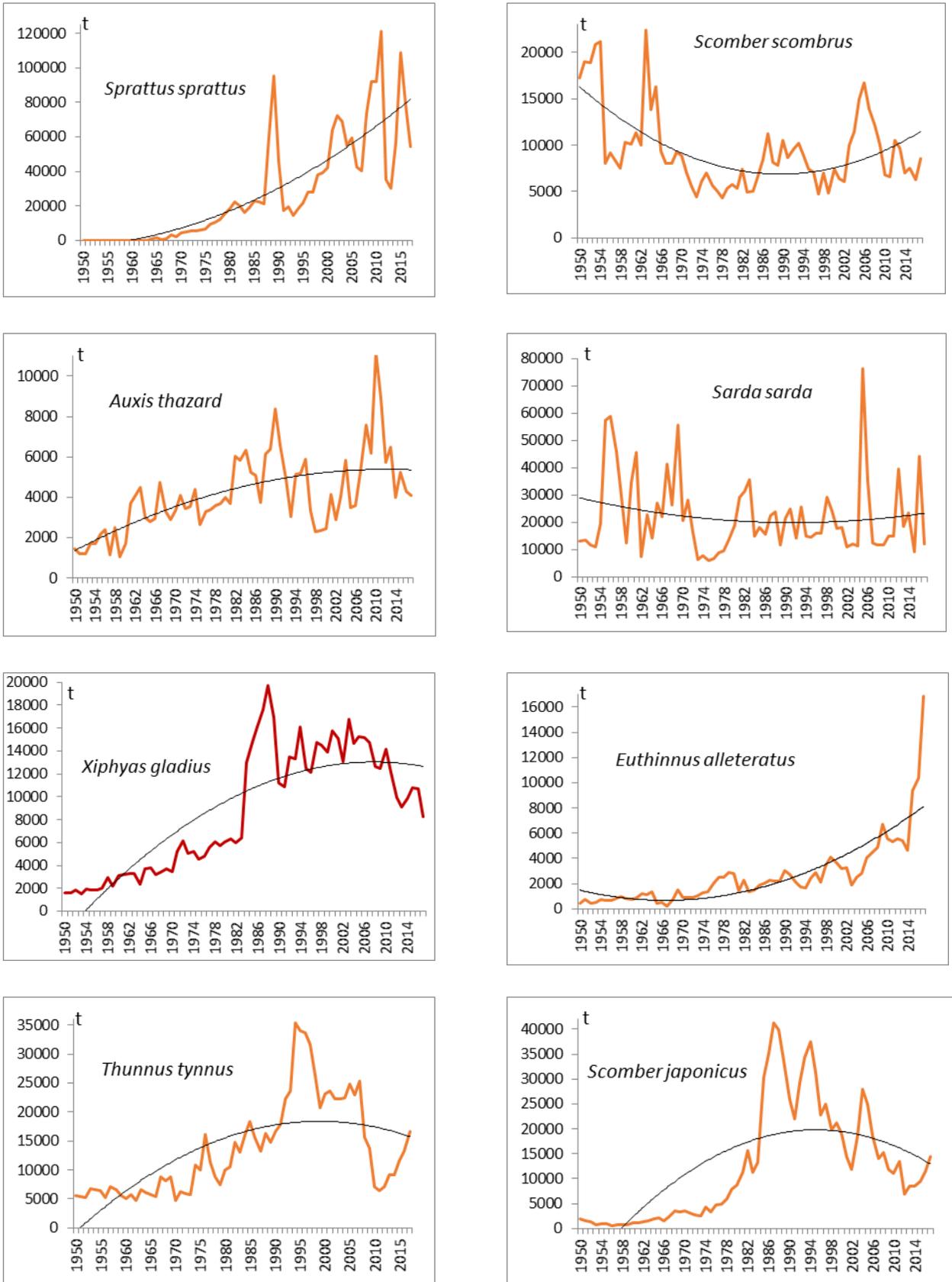


Figure 1. Total catch (t) of particular pelagic species in the Mediteranean and Black sea

The highest landing were recorded for European pilchard-sardine (*Sardina pilchardus*) and European anchovy (*Engraulis encrasicolus*).

Spectral analyses of the annual landings of certain species are presented in the Fig. 2. We used spectral analyses to determine whether there are cyclic (deterministic) components in time series. Statistically significant amplitudes of all analyzed catch time series, showed amplitudes at the same periods (Fig. 2).

Species experienced common periods according to amplitudes at the periods of 2.1, 3.1, 3.8, 6.2, 7.5, 11.33 that were common for most of the species.

DISCUSSION

Fluctuations of fish catch are the result of cumulative effects of cyclical natural processes in the environment and anthropogenic factors that significantly affect environment. The dependence of fish catch and 11-year solar cycles was found by Regner & Gačić (1974). According to their research, periods at 2.3; 3.5; 8; 11; 19; 27 years are well matched with fluctuations of other parameters such as: herring catch in Denmark, years on conifers in Sweden, air pressure in Venice and Trieste, sea level in Germany, air temperature in Trieste and Berlin, Baltic Sea level, Asian anticyclone. There is a strong link between solar activity and organic production, fish reproduction and maturation. The sun can have a significant impact on climate factors that dictate catch fluctuations (Smederevac-Lalic *et al.*, 2017).

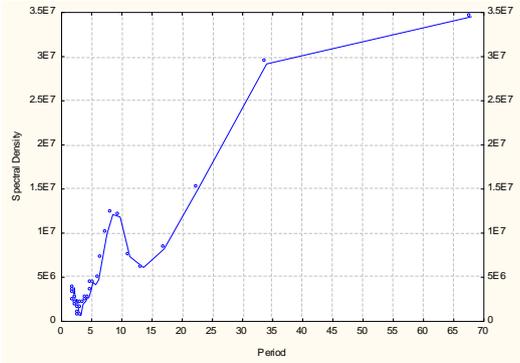
Fishing commonly changes the relative abundance of fish species but may also change the structure and functioning of the ecosystem (Regner *et al.*, 2015). The large majority of assessed fish stocks are shrinking and some are on the verge of depletion. Only 9% of fish

stocks assessed are fished at levels below MSY (maximum sustainable yield). Despite recent improvements, the number of stocks whose status is unknown remains still large. Fishermen report that they catch less and less fish every year, with potentially consequences on the industry and coastal areas economy. There are several reasons for the poor state of fish stocks: pollution and climate change certainly play a role (Dragičević *et al.*, 2017), but there can be no doubt that extensive overfishing is one of the key causes (EU, 2019). Eutrophication and overfishing have similar and synergistic effects on fish communities, i.e., a decline in diversity, an increase in productivity and change in pelagic food webs, then the progressive dominance of the production by short-lived, especially pelagic species (Fortibuoni *et al.*, 2017).

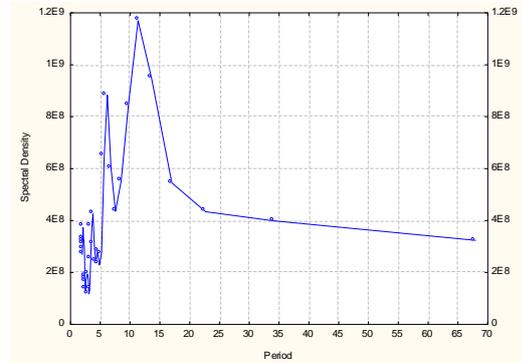
Ecosystem has changed over the last 70 years, since different metrics emphasize distinct aspects of the communities, and consequently unscramble the role of different drivers. The Mediterranean Sea is warming and the consequences of climate change on fishing communities will depend on exposure and sensitivity of species and ability to adapt to climate change. Increase of warmer-water species in relation to colder-water ones, and shifts in distribution affect their availability to fisheries (Dulčić *et al.*, 2004). The Mediterranean area is expected to suffer changes in temperature and precipitation more accelerated than the global mean alteration rate. Fisheries landings fluctuations of the Mediterranean states in the period 1985-2008 showed significant year-to-year correlations with temperature for nearly 60% of the cases (Tzanatos *et al.*, 2014). Increasing trends were found, mainly in the landings of species with short life spans (Matić-Skoko *et al.*, 2017). Analysis of the landings composition by functional group showed that the most abundant group was small pelagic fish (mainly

European anchovy *Engraulis encrasicolus* and European pilchard *Sardina pilchardus*). Fishing is usually size-selective, both within and among species; these indicators are

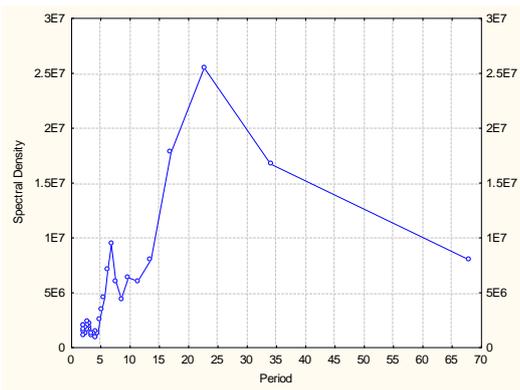
considered to be sensitive to fishing disturbance and are expected to decrease under unsustainable exploitation (Fortibuoni *et al.*, 2017).



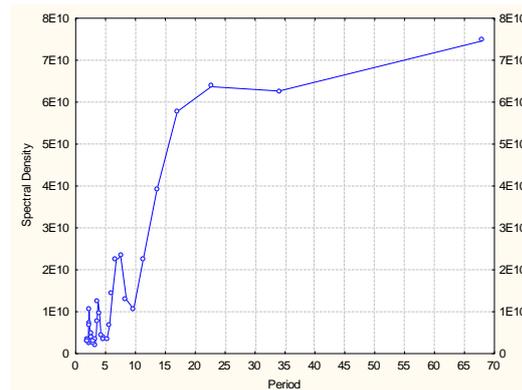
Euthynnus alleteratus



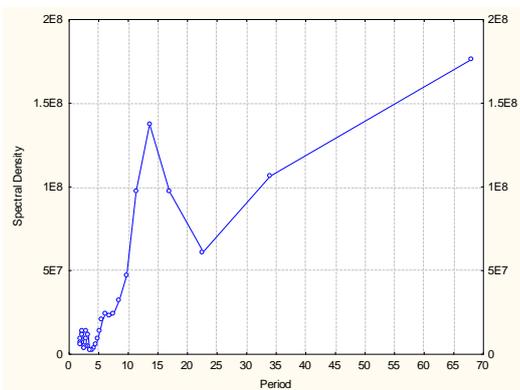
Sarda sarda



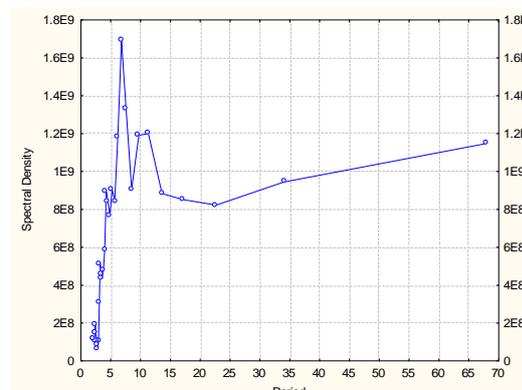
Auxis thazard



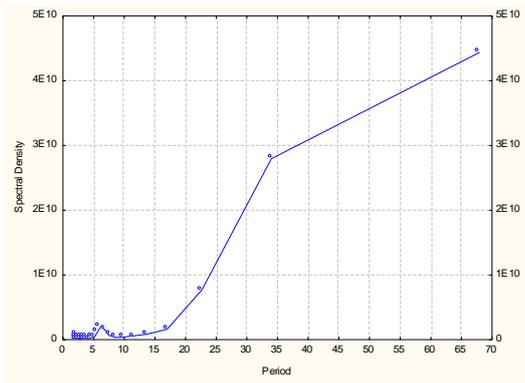
Engraulis encrasicolus



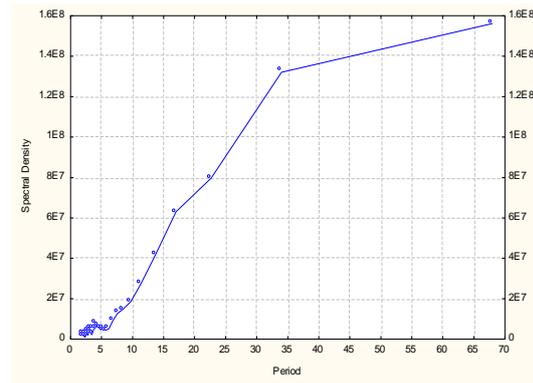
Scomber scombrus



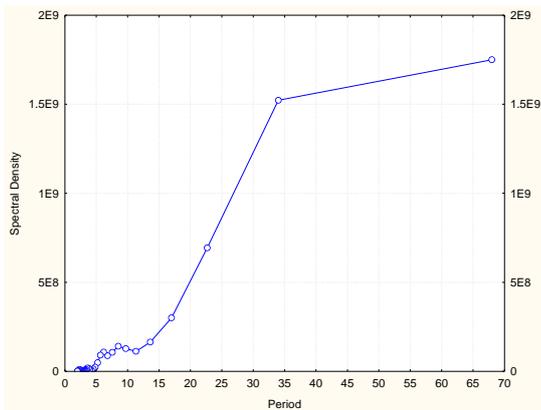
Sprattus sprattus



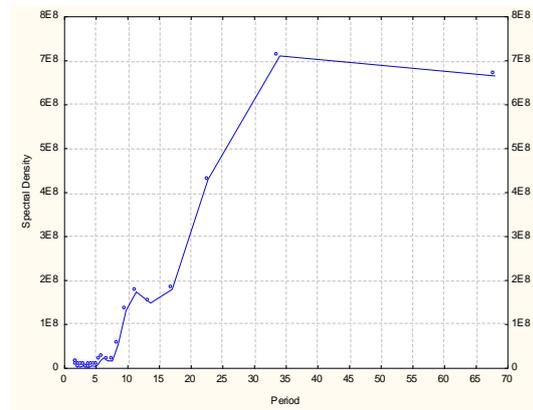
Sardina pilchardus



Xiphias gladius



Scomber japonicas



Thunnus thynnus

Figure 2. Spectral analysis of the catch showing periods (x axis in years) with the highest amplitudes (y axis)

Major changes in community composition from 1950's until recent decade included collapse of large-sized species. In the 1950s medium pelagic species reached a maximum in landings, and dramatically declined afterwards. Medium pelagic fish (mainly Atlantic mackerel *Scomber scombrus*) represent an important group of species for the local fish market, whose decline is a consequence of changes in market demand (Meneghesso *et al.*, 2013). Decline in catches for medium pelagics reflects a dramatic decline of populations.

Our analysis would like to stress potential existence of the shift, not just influenced by the climatic drivers that played a role, but rather to point impact of local pressures, shift from small pelagic species (European anchovy

Engraulis encrasicolus and European pilchard *Sardina pilchardus*) and large pelagic species (bluefin tuna *Thunnus thynnus*) to other pelagic species, *Scomber scombrus*, *Euthynnus alletteratus*, *Sarda sarda*, *Sprattus sprattus*, transition in landing from protected species to less protected species. The decline in the catches is suspected to be primarily due to under-reporting, following the implementation of quotas.

However, in multi-species fisheries in the Mediterranean and the Black Sea, identifying target species is not simple, since most fisheries are multi-target and rely on different types of gears, fishing techniques and market forces playing a significant role in commercial fisheries. The target species may also be subject to daily change (FAO, 2016).

According to Matic-Skoko *et al.*, (2017) there is difference in the catch composition depending of the type of fishing gears. Thus, the most important species in the small scale fisheries in Montenegro were *S. pilchardus* and *E. encrasicolus* (33%), together with Atlantic bonito (*Sarda sarda*). In Montenegro, Atlantic bonito is dominated species both in gillnets and trammel nets, but there are no monthly values for this species in landings. In Croatia, the landing composition accomplished by the drift longlines was dominated by the swordfish (*Xiphias gladius*; 63%) and bluefin tuna (*Thunnus thynnus*; 8%) (Matic-Skoko *et al.*, 2017).

In the whole GFCM (General Fisheries Commission for the Mediterranean area), European anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*) continue to be the main species, followed by European sprat (*Sprattus sprattus*). The only large pelagic species contributing more than 1 percent to the landings is Atlantic bonito (*Sarda sarda*) (FAO, 2016).

In Balearic region the most important species considering official landings was picarel (*Spicara smaris*). Official landings of these species declined from 1950's and this high decrease is attributed to cultural reasons. Whereas in the past this species was highly appreciated, today it is difficult to sell (Carreras *et al.*, 2015). There was an increase in the proportion of the main commercial species (red mullets, European hake, Norway lobster, red shrimp, spiny lobster, transparent goby and common dolphinfish) from 10% (1950) to 23% (2010). Fish decreased in official landings (78% in 1950 to 62% in 2010), and invertebrates increased (from 22% in 1950 to 38% in 2010) (Carreras *et al.*, 2015).

In the Mediterranean the volume of recreational fishing can be equal or even greater than of commercial fishing. The

amount of catches in recreational fishing in the Mediterranean regions represents between 10% and 50% of the total of small-scale fishing (Matic-Skoko *et al.*, 2017). Despite its importance, this fishing is not as controlled or studied as commercial ones.

Structural changes in landing may have important information about altered food-web structure. There has been a long-term fishing-down food web phenomenon (Pauly *et al.*, 1998), but also large, slow-growing and late-maturing species are expected to suffer greater population declines. ‘Fishing through the food web’ phenomenon is catch of the high-trophic level species maintained or even increased, while the overall trophic level decrease due to serial addition or increases in catch (Jarić *et al.*, 2014). On the other hand, ‘fishing for profits’ represents the situation where fisheries prefer to target abundant, highly-priced, easy-to-catch species.

The change in biodiversity of landings is concurrent to the significant decrease of total landings, suggesting that main modification of marine communities affected local fisheries. Degradation regarding overexploitation of trophic levels and a simplification of food-web structure reduce its recoverability from environmental driven imbalance (Fortibuoni *et al.*, 2017).

Despite the limitations of fishery statistics data, landings are the most widespread information that can be used to analyse marine ecosystem changes in the past, and probably the cheapest information that can be collected by surveying archives and statistical bulletins (Jarić *et al.*, 2014; Fortibuoni *et al.*, 2017).

This work gives the possibility of using landings statistics for inferring changes in marine ecosystems through the analysis of landings composition. Landings of certain species composition can detect community changes.

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Analiza dugoročnih ulova nekih ekonomski značajnih pelagičnih vrsta riba u Mediteranu

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SAŽETAK

U Sredozemnom moru pelagične vrste riba od komercijalnog značaja su: sabljarka (*Xiphias gladius*), sardela (*Sardina pilchardus*), papalina (*Sprattus sprattus*), skuša (*Scomber scombrus*), lokarda (*Scomber japonicus*), inćun (*Engraulis encrasicolus*), trup (*Auxis thazard*), luc (*Euthynnus alletteratus*), palamida (*Sarda sarda*) i tuna (*Thunnus thynnus*). Rad daje generalni pregled statističkih podataka o ulovu ovih vrsta u Sredozemnom i Crnom moru. Na ove vrste utiču različiti ekološki i antropogeni faktori koji mogu imati uticaja samim tim i na njihov ulov. Korišćeni su FAO statistički podaci, a analize su urađene korišćenjem programa Statistica i Excel. Ovaj rad ukazuje na trendove u ribarstvenoj statistici u poslednjih 68 godina i saznanja o važnim interakcijama, što pomaže u razumijevanju napretka ka boljem upravljanju ribarstvom u regionu.

Ključne riječi: ulov, pelagične vrste riba, ekonomski važne vrste riba, fluktuacija, Sredozemlje