Journal of Biological Research-Thessaloniki **20**: 376 – 381, 2013
J. Biol. Res.-Thessalon. is available online at http://www.jbr.gr
Indexed in: WoS (Web of Science, ISI Thomson), SCOPUS, CAS (Chemical Abstracts Service) and DOAJ (Directory of Open Access Journals)

— SHORT COMMUNICATION —

Estimation and reconstruction of shore-based recreational angling fisheries catches in the Greek Seas (1950-2010)

Dimitrios K. MOUTOPOULOS[1*], George KATSELIS[1], Konstantinos KIOS[2], Anastasia TSOTSKOU[2], Athanassios C. TSIKLIRAS[3], Konstantinos I. STERGIOU[3,4]

[1] *Department of Fisheries and Aquaculture Technology*, *Technological Educational Institute of Western Greece*, *30200 Mesolonghi*, *Greece*
[2] *Department of Ichthyology and Aquatic Environment*, *University of Thessaly*, *Volos*, *Greece*
[3] *Laboratory of Ichthyology*, *Department of Zoology*, *School of Biology*, *Aristotle University of Thessaloniki*, *UP Box 134*, *541 24*, *Thessaloniki*, *Greece*
[4] *Institute of Marine Biological Resources and Inland Waters*, *Hellenic Centre for Marine Research*, *Aghios Kosmas*, *16604*, *Athens*, *Greece*

Received: 25 November 2013 Accepted after revision: 28 December 2013

The present work aims to estimate the shore-based recreational angling fisheries catches per species and Greek subarea that are not recorded by the official authorities in order to have a better picture of the total fish biomass that is removed out of the Greek Seas. Shore-based recreational fishers (n = 406) from three coastal areas of Greece (Ionian Sea and northern and central Aegean Sea) were surveyed in 2008-2009 and in 2012, respectively, in terms of the frequency and duration of fishing per year, species caught and catch in weight. Shore-based recreational angling catches increased from 187 tn in 1950 to slightly over 2500 tn in 2010. The species dominating the catches varied with area. Overall, 48 species participated to the total catches, four of which (European seabass *Dicentrarchus labrax*, annular seabream *Diplodus annularis*, white seabream *Diplodus sargus sargus* and gilthead seabream *Sparus aurata*) contributed more than 40.0% of the total.

Key words: fisheries, shore-based recreational angling fisheries, reconstruction, Greece.

INTRODUCTION

Commercial official fisheries landings data are very useful in stock assessment and fisheries management and they have been widely used for such purposes (Pauly *et al.*, 2013). However, they have often been accused for offering limited accuracy (Garibaldi, 2012) because, among other discrepancies (Pauly & Froese, 2012), they do not include discarded, recreational and non-reported catches. All these components are referred to as Illegal, Unreported and Unregulated catches (IUU). Their proper and regular estimation is a primary target of the European Union policy (European Commission, 2011). Within this context, recreational fishing, which is considered as a booming activity in Mediterranean coastal areas (Lloret & Font, 2013) should be carefully considered.

In Greek waters, the extended coastline and the presence of numerous islands hinders various difficulties in monitoring the recreational fisheries of an area (i.e. heterogeneity of fishing types and methods involved; National Research Council, 2006) and in esti-

* Corresponding author: tel.: +30 26310 58202, fax: +30 26310 58202, e-mail: dmoutopo@teimes.gr

mating its contribution to total landings (Lloret & Font, 2013). Recreational fishing includes the fishery conducted for leisure and to supplement the diet and can be discriminated to: boat-based recreational, shore-based recreational angling fisheries, spear fishing and shellfish collection. The present study focused on the shore-based recreational angling fisheries, which were combined into a single value with subsistence fishing. The latter are not easily separated from recreational fisheries because the catches are directly used for personal consumption and thus, catches from one sector may encompass some catches of the other (Ünal *et al*., 2010).

The published official data for the recreational fisheries concern only the number of recreational boats per prefecture that are routinely collected from two agencies, the Hellenic Statistical Authority (HELSTAT) and the Ministry of Mercantile Marine, which records each fisher owning a recreational license for fishing only by boat (Moutopoulos *et al*., in press). In contrast, no data exists for shore-based recreational angling fisheries, for which no license is required.

The present work aims to estimate, for the first time in Greek waters, the shore-based recreational angling fisheries catches per Greek subarea and species during 1950-2010 that are not reported to and/or recorded by the official authorities in order to have a better picture of the total fish biomass that is removed out of the Greek Seas, thus contributing to our effort of the reconstruction of fisheries landings in Greek waters (Tsikliras *et al.*, 2007; Moutopoulos & Stergiou, 2012). The study was based on two major axes: (a) a questionnaire-based survey and (b) assumption-based techniques that facilitate the spatio-temporal expansion of our estimates to the entire country since 1950. This will shift the baseline of Greek fisheries (Pauly, 1995) back to its early stage using "pieces of information" (Zeller & Pauly, 2006) and will lead to the re-evaluation of the state of Greek fisheries for comparing with global fisheries trends (Pauly, 2008).

MATERIALS AND METHODS

Three coastal areas from different parts of Greece (i.e. Kavala Gulf in the northern Aegean Sea, Pagasitikos Gulf in the central Aegean Sea and Patraikos Gulf in the Ionian Sea: Fig. 1) were surveyed based on personal interviews from 406 recreational fishers in 2012 (Kavala and Pagasitikos Gulfs) and during 2008-2009 (Patraikos Gulf). Following the different

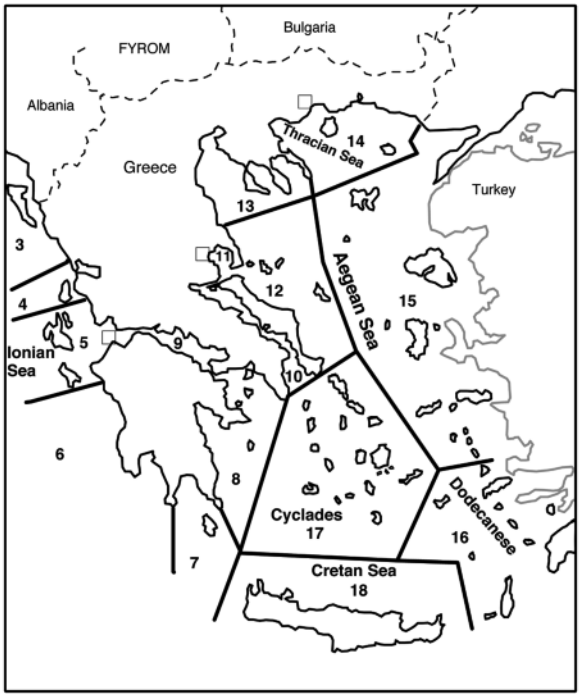

FIG. 1. Map of Greek waters showing the division to 16 fishing subareas (subareas 3 to 18) of the Hellenic Statistical Authority of Greece and the three surveyed coastal areas (indicated by white boxes).

types of sampling methods (Lockwood, 2000), the present study based on a roving-access survey conducted by structured questionnaires in which recreational fishers were asked to declare, among other aspects (for details of the survey see Moutopoulos *et al.*, in press), the: (a) frequency of fishing per year, (b) daily fishing hours, (c) species caught and (d) daily, monthly or annual catch in weight.

To estimate the shore-based recreational angling fisheries catches during 1950-2010 we firstly estimated the number of shore-based recreational angling fishers as follows. The time series of the resident population, which was derived from the corresponding census of HELSTAT conducted in each coastal prefecture since 1950 (HELSTAT, 1955-2012; www.statistics.gr), was multiplied by the ratio of shore-based angler to resident coastal population. This ratio was conservatively assumed to be 1.5% of the coastal population that fishes recreationally in Greek Seas and this number varied over time along with population trends per prefecture. The above ratio lies within the values estimated by other studies conducted for recreational fisheries in the Eastern Mediterranean Seas (ranging between 1% and 3.3% in Turkish waters: Ünal & Franquesca, 2010; Ünal *et al.*, 2010). Then, the estimated time series of shore-based recreational angling fishers

was multiplied by the yearly catch per fisher for each study area, as estimated by multiplying the mean number of fishing days with the daily catch per fisher that were derived from the outputs of the interviews.

The spatial harmonization of the shore-based recreational angling catches estimated for the three studied areas with the 16 fishing subareas surveyed by HELSTAT (Fig. 1) is described in details in Moutopoulos *et al.* (in press). The shore-based recreational angling catches per species for each HELSTAT subarea during 1950-2010 was estimated from the multiplication of the species ratio per each studied area (as derived from the study) to total catches per subarea.

RESULTS

The mean number of fishing days per year were 180, 191 and 193 days year^{-1} and the average daily catch was 0.711, 0.804 and 0.861 kg fisher^{-1} day^{-1}, in Kavala, Pagasitikos and Patraikos Gulf, respectively (Table 1). Three species or groups of species (gilthead seabream *Sparus aurata*, Mugilidae and *Diplodus* spp.) made up more than 48% of the total catch (Table 1). Total shore-based recreational angling catches increased from 187 tn in 1950 to 2553 tn in 2010 (Fig. 2).

Overall (for all surveyed areas combined), 48 species participated to the total catches, four of which contributed more than 40.0% to the total shore-based recreational angling catches (i.e. European seabass *Dicentrarchus labrax*, annular seabream *Diplodus annularis*, white seabream *D. sargus sargus* and seabream *S. aurata*) (Table 1).

The species dominating the catches varied with studied area (Table 1). In Pagasitikos Gulf, six fish species contributed 64.8% of the total catches, with *S. aurata*, Mugilidae and *D. annularis* being the most dominant taxa. In the Patraikos Gulf, *S. aurata*, Mugilidae, *Diplodus sargus* and *D. labrax* made up 92.7% of the total catches. In the Kavala Gulf, eight species contributed more than 90% of the total catches, with Mugilidae and *D. annularis* representing 37.8% of the total catches (Table 1).

DISCUSSION

Shore-based recreational fishing is a typical activity in the Greek seas as more than 80% of the total Greek inhabitants are located in the proximity of the coastal zone (HELSTAT, 1955-2012). In the present work, the frequency of fishing per year (number of fishing days) was higher than the values reported for other Mediterranean areas (75.5 days in Marmara strait: Ünal *et al.*, 2010; 67 days in Majorca island: Morales-Nin *et al.*, 2005). The total shore-based recreational catches represent, on average for 1950-2010, the 8% of the professional small-scale fisheries catches (data from Moutopoulos & Stergiou, 2012) with this value ranging between 3% (in 2000) and 22% (in 1952). These catches are higher when compared with the corresponding ones reported for South Portugal (1%: Veiga *et al.*, 2010), and considerably lower than those reported for Majorca Island (27.44%: Morales-Nin *et al.*, 2005) and the Gulf of Mexico (from 38% to 64%: Coleman *et al.*, 2004). It should be mentioned that the current economic/financial crisis, which is also evident in other Mediterranean countries, may lead to intensification of shore-based recreational fishing and thus will enhance the pressure on coastal organisms

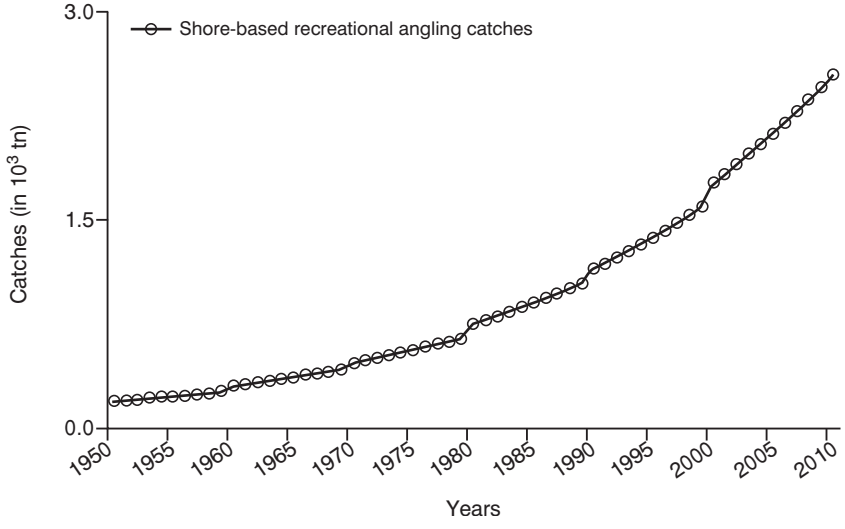

FIG. 2. Shore-based recreational angling catches in Greek waters during 1950-2010.

TABLE 1. Species composition (%) of shore-based recreational angling catches in Greek waters based on interviews in three coastal areas (for more details, see Materials and Methods section). The species listed in Osteichthyes category represent the species contributed less than 1.5% of the total catches

Species	Pagasitikos Gulf	Patraikos Gulf	Kavala Gulf
Auxis thazard	0.60		
Belone belone	0.62		
Boops boops	0.64	0.38	
Dentex dentex	0.44		1.56
Dicentrarchus labrax	7.78	6.22	11.15
Diplodus annularis	11.26	1.57	18.25
Diplodus sargus sargus	4.46	11.45	3.51
Epinephelus aeneus	0.10		
Epinephelus alexandrinus	0.10		0.78
Epinephelus marginatus	0.10		
Euthynus alletteratus	0.63		
Gobius spp.	0.32		
Lithognathus mormyrus	2.24		4.68
Merluccius merluccius	0.13		
Mugilidae	18.32	24.54	19.50
Mullus barbatus	0.14		
Mullus surmuletus	0.10		
Oblada melanura	2.03		
Pagellus erythrinus	3.08	0.36	
Polyprion americanus	0.00		0.39
Pomatomus saltatrix	10.28		
Sarda sarda	0.42		
Sarpa salpa	0.77		
Sciaena umbra	0.20		
Scomber japonicus	2.45		8.97
Serranus spp.	0.07		
Seriola dumerili	0.00		0.78
Solea spp	0.00	0.63	
Sparus aurata	15.30	50.46	12.87
Sphyraena sphyraena	0.21		
Spicara flexuosa	2.91		
Spicara maena	1.06		
Spicara smaris	0.07		
Spondyliosoma cantharus	0.17		1.17
Thunnus spp.	0.14		
Trachurus mediterraneus	2.09	2.53	7.80
Umbrina cirrhosa	0.07		
Osteichthyes	6.38	1.86	8.58
Cephalopods			
Loliginidae, Ommastrepidae	1.08		
Loligo vulgaris	1.06		
Octopus vulgaris	1.83		
Sepia officinalis	0.35		
List of Osteichthyes category			
Caranx sp.	0.71		
Coryphaena spp.	0.47		
Dentex gibbosus	0.10		0.78
Diplodus vulgaris	1.53	0.07	7.80
Diplodus puntazzo	0.00	1.79	
Labridae	0.07		
Lichia amia	0.34		
Pagellus acarne	1.06		
Pagellus bogaraveo	1.89		
Trachinus spp.	0.21		
Mean annual number of fishing days	**191.0**	**193.3**	**180.0**
kg fisher^{-1} day^{-1}	**0.804**	**0.861**	**0.711**

(Tsikliras *et al*., 2013). The financial turmoil may trigger the expansion of fishing for subsistence purposes not only for personal consumption, but also to generate income for the households; this may lead to the increase of unrecorded biomass removal and the uncertainty in monitoring and estimating the true catches.

Various demersal species, their number ranging from 11 to 48 species depending on the area, made up an important part of the catch. This is in accordance with the large number of species exploited in other Mediterranean regions (51 species in Marmara strait: Ünal *et al*., 2010; 48 species in South Portugal: Veiga *et al*., 2010; 32 species in Majorca Island: Morales-Nin *et al.*, 2005), a fact showing the multispecies nature of the recreational fisheries in southern European waters.

Shore-based recreational angling fisheries target the more highly prized species of Sparidae family, a fact that creates a personal motivation for fishers and therefore affects the frequency and intensity of fishing i.e. it determines fishing effort. This is enhanced by the common presence of these species in the shore-based recreational fisheries of other Mediterranean countries (approximately 25% in Marmara Strait: Ünal *et al.*, 2010; more than 50% in Southern Portuguese waters: Veiga *et al.*, 2010). The diversification of the species composition in the study areas (Table 1) probably reflects the heterogeneity of the ecosystems. In particular, Kavala and Pagasitikos Gulfs are characterized by a larger number of species (7 and 6 species contributed 89.9% and 67.4% of the total catches, respectively) compared to the Patraikos Gulf, where 75% of catches consisted of two species (*S. aurata* accounted for 50% and Mugilidae for 25%). Patraikos Gulf is located in close distance to the Messolonghi-Etoliko lagoon system, in which more than half of its catches are represented by these two euryhaline species (Katselis *et al.*, 2003). In parallel, a remarkable increase (about 80%) in *S. aurata* landings from the fish trap fisheries of the Messolonghi-Etoliko lagoon has been observed, probably due to accintentally escapees from the adjacent fish farm units (Dimitriou *et al*., 2007), a fact that might justify the high contribution of this species to the shore-based recreational angling catches in the study area.

The results of the present study should be interpreted with caution given the limited spatial representation of collected data and the extended coastline of Greece. The incorporation of a larger sample including most coastal and island areas in the future will reduce the uncertainty in estimating the "true" production of shore-based recreational fisheries. In addition, the present study suffers from certain limitations: (a) the ratio of the shore-based recreational angler to coastal population in each subarea (1.5%), may differ both spatially (among subareas due to differences in topography, demographic and social characteristics) and temporally (during 1950-2010) and (b) the two major urban centers of Greece (Athens and Thessaloniki) in which most of the Greek population is concentrated, and the Aegean and Ionian islands, in which such activities are probably very important, were not sampled.

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