ISSN: 0001-5113 AADRAY	ACTA ADRIAT., 52(2): 183 - 200, 2011	UDC: 597.556.333.7: 593.1 (262.16)

The evolution of Greek fisheries during the 1928-1939 period

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In the present study, Greek fisheries landings were extended back to 1928, for the first time, from data derived by the General Statistical Service of Greece during the 1928-1939 period. In particular, we: (a) present the annual fisheries landings for all species combined, fishing effort for all gear-types combined and species-specific landings during 1928-1939, (b) re-allocate the spatial resolution of landings during 1928-1939 to that during 1964-2007, and (c) compare the landings for different periods during 1928-2007. Results showed that during 1928-1939, landings and effort generally increased. The time series of all species landings exhibited a strong between-year variability, with 23 out of 40 species displaying a significant increasing trend. The analysis of fisheries landings over time (1928-2007) displayed four distinct patterns corresponding to four phases of Greek fisheries development: (1) a gradual increase during 1928-1949 (pre-development phase of fisheries), (2) a steeper increase during 1950-1969 (growth phase), (3) a much steeper linear increase during 1970-1994 (fully to over-exploited phase) and (4) a declining trend during 1995-2007 (collapse phase). These phases coincided chronologically with significant socio-economic and political events that took place in Greece since 1928.

Key words: Fisheries landings, fishing effort, fisheries history, historical development, Greek waters, Mediterranean

INTRODUCTION

Incorporating knowledge from pre-industrial fisheries into national or international statistics will increase our understanding of the impact of fisheries on marine ecosystems. One major problem in identifying fisheries impacts on marine ecosystems is that routine fisheries monitoring takes place often only well after such impacts became felt. Although fisheries is one of the oldest extractive activities (SAHRHAGE & LUNDBECK, 1992), there are, so far, relatively few quantitative studies dealing with historical fisheries data at multi-species level (BAGER *et al*., 2007; LESCRAUWAET *et al*., 2010; OJAVEER *et al*., 2007). Thus, shifting the baseline (PAULY, 1995) backwards to the pre-industrialization of fisheries will provide valuable repositories of knowledge for defining more pristine conditions and thus reference points necessary for fisheries management (ZELLER *et al.,* 2005; ZELLER & PAULY, 2007).

In Greece, the first organized effort for the collection of fisheries statistics (i.e. marine,

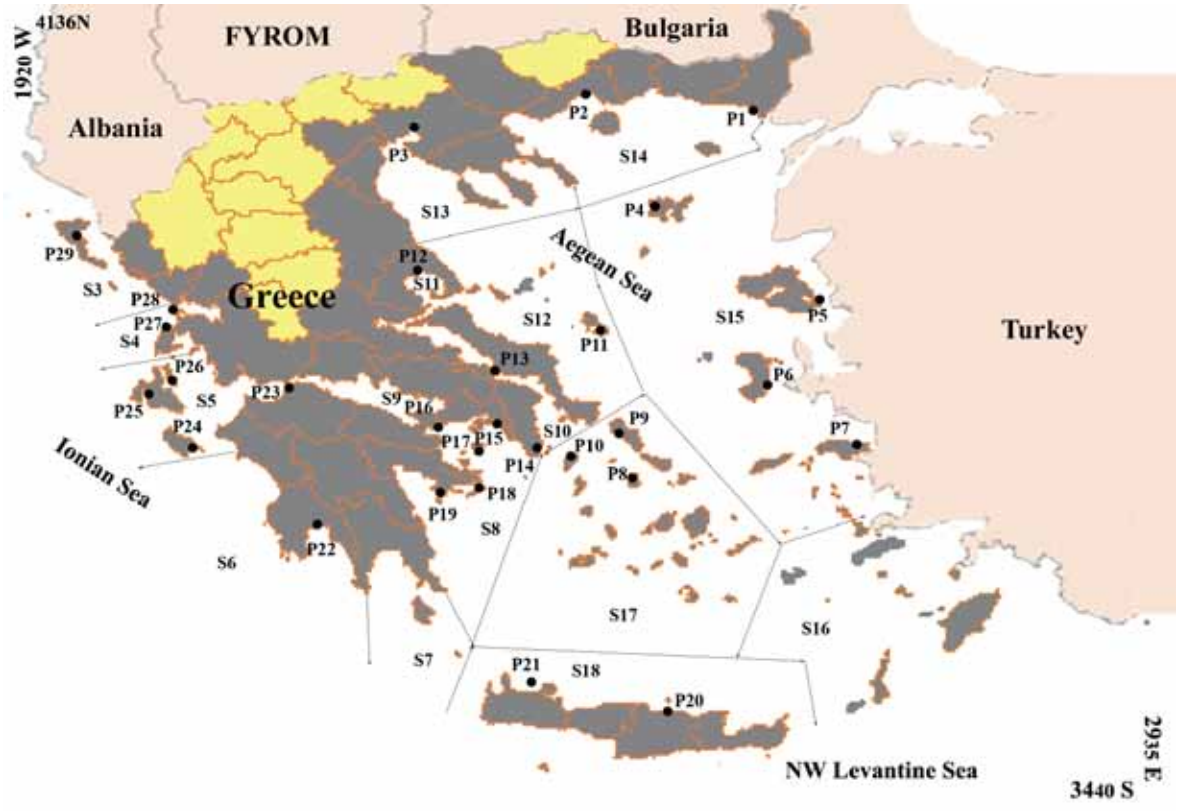

Fig. 1. Map of Greek waters showing the division of the fishing sub-areas allocated by the different fisheries statistical sources; legends P1 to P29 indicate the General Statistical Service of Greece (GSSG) custom port authorities from where the GSSG collected fisheries statistics during 1928-1939; legends S3 to S18 indicate the 16 fishing sub-areas (each enclosed by lines) allocated by the Hellenic Statistical Authority of Greece during 1964-2007; and grey parts indicate the prefectures involved in the collection of fisheries statistics from vessels with engine power < 19 HP and professional and recreational rowing vessels by the Agricultural Service of Greece during 1975-2007. Sub-areas 1 and 2 are outside Greek waters (Atlantic Ocean and North African Mediterranean coasts, respectively)

freshwater and lagoon landing and effort data) was established in April 1928 by the General Statistical Service of Greece (GSSG) through Royal Decree 31-3-1925 and under the authority of the Ministry of National Finance (GSSG, 1934-1940). Thus, for 1928-1939 GSSG published data on annual fisheries landings per species (or group of species, henceforth called species) and fishing effort (Table 1) that were collected from 29 custom port authorities extending all around Greece (Fig. 1) (overall surveying 274 fishing ports; total number of fishing ports is not available).

GSSG also continued to record fisheries statistics during WW II and for a few years thereafter (1940-1949) (Table 1). During that period, the collection of fisheries statistics was conducted by the Directorate of Fisheries (Ministry of Industry) through fisheries cooperations and in collaboration with GSSG and the Agricultural Bank of Greece (ANANIADIS, 1968; SERBETIS, 1949a). However, during the above-mentioned decade only landing estimates and sparse effort data were made available by ANANIADIS (1968), whereas the original data are not, to our knowledge, officially available. During 1950-1963, FAO reports Greek landings per species from all fisheries (i.e. marine, freshwater and lagoons) that are most probably derived from the above-mentioned national sources. During this period, Greek official data are also scanty and refer to Greek waters as a whole (ANANIADIS, 1968).

A detailed systematic recording of fish landings in Greek waters started in 1964 by the National Statistics Service of Greece (NSSG, formerly GSSG and now Hellenic Statistical

Table 1. Summary of fisheries landing statistics recorded by the different statistical organizations for Greek waters, 1928-2007

Period	Fishery type	Species resolution	Spatial resolution (see Fig. 1)	Source
1928-1935	Marine fisheries	33 fish species, 3 cephalopod species, 3 crustacean species and 1 other custacean-cephalopod group	Total for Greek waters	GSSG
1936-1939		26 fish species, 3 cephalopod species, 3 crustacean species and 1 other custacean-cephalopod group	For 29 local custom authorities	GSSG
1940-1949	All fisheries combined (i.e. marine, freshwater and lagoons)	Total landings (i.e. all species combined)	Total for Greek waters	Ananiadis (1968)
1950-1957	All fisheries combined (i.e. marine, freshwater and lagoons)	18 fish, 1 cephalopod and 1 crustacean species	Total for Greek waters	FAO
1958-1963		27 fish, 1 cephalopod and 2 crustacean species		
1964-1969	Marine fisheries	17 fish, 4 cephalopods and 1 crustacean species	For 16 fishing sub-areas	NSSG
1970-1981				
1982-2007		56 fish, 5 cephalopods and 5 crustacean species		
1975-2006	Rowing professional and recreational fishery	Total landings (i.e. all species combined)	For 41 perfectures	ASG

Authority, HELSTAT). NSSG collected fisheries landings and effort data (except rowing boats) from 16 fishing sub-areas (Fig. 1, Table 1) (National Law No 30112/254/9-10-1963) (NSSG 1967-2006) that are spatially allocated into 18 fishing sub-areas (Fig. 1), two of which are outside Greek waters (i.e. the Atlantic and off the North African coast). These national data are the basis for FAO statistics (TSIKLIRAS *et al.*, 2007). During 1964-1969, NSSG recorded the landings from all engine-powered vessels, whereas since 1970 NSSG recorded the landings and effort data from vessels with engine power ≥ 19 HP. Since 1975, Agricultural Statistics of Greece (ASG), a different branch of NSSG, monitors the fisheries landings and effort from professional and recreational rowing vessels and the number of vessels with engine power < 19 HP for 41 prefectures (ASG, 1977-2006; see also TSIKLIRAS *et al.*, 2007). Table 1 summarizes all sources of fisheries landing statistics recorded by the different statistical organizations for Greek waters during 1928-2007. TSIKLIRAS *et al.* (2007) have estimated the total Greek landings during 1970-2004, after including the landings of ASG from vessels with engine power < 19 HP.

So far, GSSG data for the period 1928-1939 have been published only for a few species: *Engraulis encrasicolus*, *Pagellus erythrinus* and *Merluccius merluccius* (STERGIOU, 1987a); *Mullus* spp. and Scorpaenidae (STERGIOU, 1988); total cephalopods (STERGIOU, 1987b, c); and total crustaceans (STERGIOU, 1986).

The aim of the present study is to summarize the fisheries statistics published by GSSG (GSSG, 1934-1940) during 1928-1939. These data consisted only of commercial landings (i.e. not including discards, illegal and unreported catches as well as recreational fisheries landings). In particular, we present: (a) the total annual landings and effort data (i.e. number of vessels, tonnage capacity and number of fishers), and landings/vessel and landings/tonnage capacity ratios for Greek waters; (b) the mean (1928-1939) species composition of the landings and (c) the spatial re-allocation of landings per

species from the GSSG 29 custom port authorities to the present 16 NSSG fishing subareas in order to harmonize the spatial distribution of landings between 1928-1939 and 1964-2007. Finally, we also summarize the landings recorded from the different statistical organizations for Greek waters for different periods during the 1928-2007 period.

MATERIAL AND METHODS

Datasets

Greek fisheries landings and fishing effort data have been recorded by the General Statistical Service of Greece (GSSG) through 29 local custom port authorities (Fig. 1) during 1928-1939, and have been published in yearly bulletins (GSSG, 1934-1940) (Table 1). GSSG also recorded the number of vessels per gear-type category (i.e. trawl, purse seine, beach seine and other small-scale gears) from all custom authorities combined (i.e. there is a total for the country) (online Appendix Table A1) and the tonnage capacity and number of fishers for all gear-types combined for each of the 29 custom port authorities. A monthly statistical questionnaire was provided by GSSG to each professional fisher for recording in three 10-day periods the quantity of each species that was caught during the previous month (or indicating that the vessel did not operate) (GSSG, 1934-1940).

Taxonomic disaggregation and spatial re-allocation

For 1928-1935, landings are available for 40 species: 33 fish species, three cephalopod species, three crustacean species and one other crustacean-cephalopod group. For 1936-1939, landings are available for 33 species (i.e. 26 fish species, three cephalopod species, three crustacean species and one other crustacean/cephalopod group) (Table 1). Hence, we disaggregated the taxonomically aggregated landings for 1936-1939 from 26 to 33 fish species using the methodology of TSIKLIRAS *et al*. (2007).

With respect to the spatial resolution of landings, during 1936-1939 GSSG provided landings per species separately for 29 custom port authorities (Fig. 1, Table 2), whereas during 1928-1935 landings per species are derived from all custom authorities combined (i.e. there is a total for the country). Thus, we used the mean (1936-1939) proportion of the landings of each species for each of the 29 custom authorities in order to disaggregate the total landings for each species during 1928-1935 into landings per species for each of the 29 custom authorities.

In order to harmonize the spatial allocation of the landings per species during 1928-1939 (i.e. landings for 29 custom port authorities; overall 274 fishing ports surveyed) with that during 1964-2004 (i.e. landings for 16 sub-areas), we re-allocated the GSSG landings for each of the 29 custom authorities into 15 fishing sub-areas (online Appendices Tables B1 to B15) surveyed by NSSG during 1964-2007 using the data shown in Table 2. We note that during 1928-1939, the NSSG sub-area S16 (Dodecanese Islands: Fig. 1) was under Italian rule until 1947 and thus no GSSG data are available from this area. When one GSSG custom authority belongs to more than one NSSG fishing sub-area (Table 2) we disaggregated the GSSG landings from that custom authority according to the proportion of the number of the GSSG fishing ports belonging to that custom authority and located within each of the NSSG fishing sub-areas to the total number of GSSG fishing ports belonging to that custom authority (Fig. 1, Table 2). In contrast, when two or more GSSG custom authorities belong to one NSSG fishing sub-area, the sum of the GSSG landings from these custom authorities was used (Fig. 1, Table 2).

Finally, we also compared the landings during 1928-1939 with those during 1940-2007 using data from different sources (Table 1). Given that during 1940-1949 landings refer to all fisheries combined (open sea, small-scale, lagoon and freshwater) as a whole, we estimated the marine landings (open sea and small-scale) using the proportion (0.75) recorded by GSSG for 1939 for the landings derived from these fisheries to the total landings from all fisheries (GSSG 1934-1940).

Different types of time-varying regressions (i.e. linear, quadratic, exponential: trend analy-

Table 2. Spatial aggregation or disagreggation of the 29 custom port authorities (legends showed in Fig. 1) participating in the collection of fisheries data by the General Statistical Service of Greece (GSSG) 1928-1939 into 15 fishing sub-areas (S) surveyed by the National Statistical Service of Greece (NSSG) during 1964-2007.
1referred to the custom port authorities that surveyed fishing ports belonging to more than one NSSG sub-area (not including Skyros Island)*

Legends	GSSG port custom authorities (29 ports)	Number of GSSG surveyed fishing ports within each GSSG custom authority	Allocation of ports per each of the 16 NSSG sub-areas (fig. 1)	Proportion of the number of the GSSG fishing ports belonging to the custom port located within each of the NSSG sub-areas, to the total number of GSSG fishing ports belonging to that custom port
P1	Alexandroupoli	4	S14	1.00
P2	Kavala	5	S14	1.00
P3	Thessaloniki[1]	19 (in Thermaikos-Chalkidiki)	S13	0.76
		6 (in East coast)	S14	0.24
P4	Kastro Limnou	7	S15	1.00
P5	Mitilini	19	S15	1.00
P6	Chios	9	S15	1.00
P7	Samos	11	S15	1.00
P8	Syros	34	S17	1.00
P9	Andros	3	S17	1.00
P10	Kea	1	S17	1.00
P11	Skyros	1	S12	1.00
P12	Volos[1]	6 (in North Evvoikos)	S10	0.23
		11 (in Pagassitikos Gulf)	S11	0.42
		9 (in Sporades Islands*)	S12	0.35
P13	Chalkida	8 (in Evvoikos gulf)	S10	0.73
		3 (in Skyros Island)	S12	0.27
P14	Lavrio	4	S10	1.00
P15	Peiraeus	7	S8	1.00
P16	Isthmia[1]	1 (in Saronikos gulf)	S8	0.25
		3 (in Korinthiakos gulf)	S9	0.75
P17	Aigina	2	S8	1.00
P18	Hydra	1	S8	1.00
P19	Spetses	5	S8	1.00
P20	Heraklio	5	S18	1.00
P21	Chania	17	S18	1.00
P22	Kalamata[1]	9 (in Mesinia)	S6	0.38
		15 (in Lakonia)	S7	0.62
P23	Patras[1]	2 (in Patraikos gulf)	S5	0.22
		7 (in Korinthiakos gulf)	S9	0.78
P24	Zakynthos	6	S5	1.00
P25	Argostoli	8	S5	1.00
P26	Ithaka	4	S5	1.00
P27	Lefkada	7	S4	1.00
P28	Preveza	3	S4	1.00
P29	Kerkyra	13	S3	1.00

sis) (STERGIOU & CHRISTOU, 1996) were fitted to species landings time series and selection of the best model was based on the value of R^2. Regressions and slopes that were significantly ($P<0.05$) different from 0 were identified.

RESULTS

Total landings, fishing effort and species composition during 1928-1939

Greek landings for all species and gear types combined during 1928-1939 are shown in Fig. 2a. Landings generally increased from 4597 t in 1928 to 17308 t in 1939, with a maximum of 17358 t in 1938. Fish made up the major part of the total landings (93.7%), whereas cephalopods and crustaceans represented 4.5% and 1.8% of the landings, respectively. The number of vessels for all gear types combined increased from 1281 vessels in 1928 to 2197 in 1939, with a maximum of 2480 vessels in 1932 (Fig. 2b). The vessel tonnage capacity (GT) for all gear types combined almost doubled between 1928 (2417 GT) and 1939 (4513 GT) (Fig. 2c). For all gear types combined, during 1928-1935 there was a gradual replacement of sailing and rowing vessels by motor vessels and after 1936 all vessels operating in Greek waters were engine-powered (Fig. 2d).

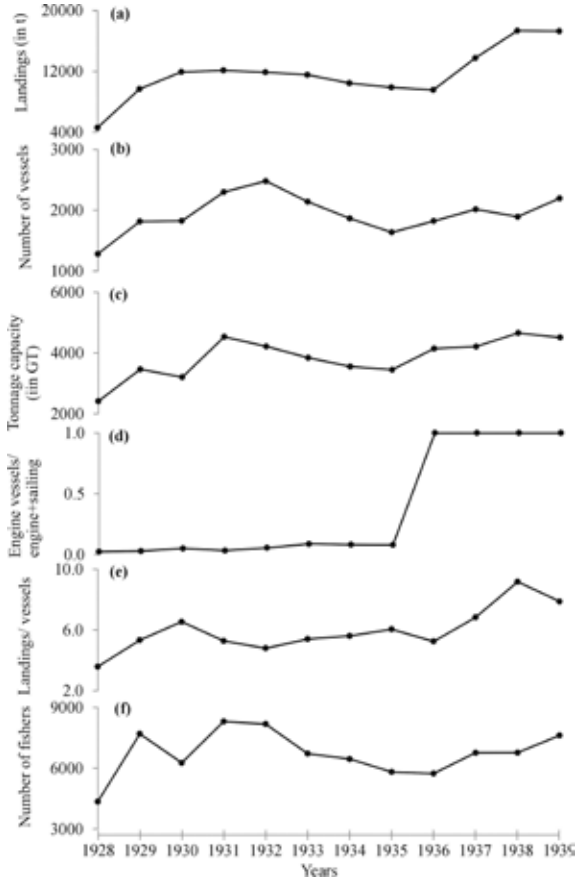

Fig. 2. (a) Annual landings, (b) number of vessels, (c) tonnage capacity (in GT), (d) number of engine-powered vessels/total number of vessels (engined-powered + sailing and rowing vessels), (e) landings/vessels (t/vessels), and (f) landings/tonnage capacity (t/GT), for all gear type categories combined, for Greek waters during 1928-1939

The ratio of landings per number of vessels more than doubled between 1928 (3.59 t/vessel) and 1939 (7.88 t/vessel) (Fig. 2e). The same was also true for the ratio of landings/GT (from 1.90 t/GT in 1928 to 3.84 t/GT in 1939) (figure not shown). Finally, the number of professional fishers increased from 4350 in 1928, to 7618 in 1939 (Fig. 2f).

Overall, seven fish species contributed 62.5% of the mean annual landings during 1928-1939, with *Sardina pilchardus* and *Spicara* spp. dominating the landings (18.2% and 15.2%, respectively), followed by *Boops boops*, *Mullus* spp., *Sarda sarda*, *Engraulis encrasicolus* and *Trachurus* spp., each contributing less than 6.0% (Table 3).

The time series of landings for the 40 species during 1928-1939 all exhibited strong interannual variability and various trends (Fig. 3). In particular, *Scomber* spp. displayed a significant ($P<0.05$) quandratic declining trend, whereas six species (*B. boops*, *Conger conger*, *Epinephelus marginatus*/*E. aeneus*, *Galeorhinus galeus*, other Osteichthyes and *Trachurus* spp.) exhibited strong variability without any significant ($P>0.05$) trend. In addition, six species (*Anguilla anguilla*, *Merluccius merluccius*, Mugilidae, *Mullus* spp., Octopodidae and *S. sarda*) displayed a significant ($P<0.05$) exponential increasing trend, six species (*Dentex dentex*, *E. encrasicolus*, *E. alexandrinus*, Natantia, *Sparus aurata* and *Spicara* sp.) displayed a significant ($P<0.05$) linear increasing trend and the remaining 21 species displayed a significant ($P<0.05$) quandratic increasing trend (Fig. 3).

*Table 3. Annual species landings (in t) in Greek waters, 1928-1939. Superscript numbers indicate the species groups that were aggregated during 1936-1939 and were disaggregated using the data for 1928-1935. * Landings were derived from the last nine months of the year. Scientific names for fish follow FishBase (www.fishbase.org; Froese & Pauly 2011*

Species	1928*	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	% of mean 1928-1939
Anguilla anguilla	5.7	4.6	1.5	3.0	2.2	2.8	10.6	8.1	63.4	6.3	9.6	8.8	0.09
Boops boops	242.0	600.8	830.3	1119.2	805.6	634.9	710.0	548.5	507.6	653.8	827.0	921.1	5.99
Conger conger	6.6	19.4	26.3	33.9	20.4	15.8	17.9	10.9	14.2	15.7	31.1	16.1	0.16
Dentex dentex	24.2	34.4	40.3	49.8	45.1	45.2	44.6	35.0	35.2	41.5	40.4	53.5	0.35
Dicentrarchus labrax	21.6	33.0	41.4	54.8	29.7	22.0	19.9	12.8	17.6	19.5	59.2	43.6	0.27
Diplodus annularis	80.9	44.7	47.0	86.0	68.7	48.2	46.8	56.8	49.2	80.0	103.0	50.1	0.54
Engraulis encrasicolus	186.0	359.3	232.9	545.0	199.9	299.0	943.6	504.7	441.8	1163.7	1213.4	1618.1	5.50
Epinephelus alexandrinus[1]	9.4	32.4	18.0	42.1	29.7	26.1	43.7	34.7	26.4	35.6	40.1	37.3	0.43
Epinephelus marginatus, Polyprion americanus[1]	28.4	36.1	45.1	105.3	55.2	39.1	40.4	28.7	42.7	57.7	65.0	60.5	0.27
Epinephelus spp., Polyprion americanus[1]									69.1	93.4	105.1	97.8	
Galeorhinus galeus[2]	11.5	5.0	21.9	27.8	30.7	8.7	12.9	12.0	19.0	24.3	22.0	12.6	0.09
Galeorhinus galeus, Scyliorhinus spp., *Mustellus* spp.[2]									186.4	238.3	215.9	124.0	
Gobius spp.[3]	6.8	5.7	5.1	7.1	11.1	13.4	14.3	17.3	7.5	11.4	11.3	13.2	0.06
Lithognathus mormyrus	10.9	22.7	13.9	21.9	28.2	13.0	14.0	9.8	20.8	41.9	74.2	47.1	0.23
Merluccius merluccius	125.5	317.1	427.1	443.9	376.3	436.2	463.3	472.1	396.8	444.8	917.2	633.6	3.89
Mugilidae	155.3	138.9	139.2	254.9	202.1	116.9	138.9	153.4	431.4	266.8	253.2	241.5	1.78
Mullus spp.	333.4	461.3	739.5	773.5	728.5	623.8	774.3	757.7	839.2	1003.0	1339.5	1081.6	6.75
Oblada melanura	31.0	54.4	46.0	72.3	76.5	54.4	49.1	69.6	38.6	47.5	62.9	51.5	0.47
Pagellus erythrinus	89.4	159.4	227.8	323.9	297.3	244.3	315.4	315.6	395.4	412.5	406.0	364.5	2.53
Pagrus pagrus	30.4	40.6	48.2	66.2	90.0	61.4	54.2	37.1	44.4	42.2	47.8	47.8	0.44
Raja spp.	61.2	119.3	134.9	123.3	74.7	80.5	74.9	142.1	108.4	159.0	154.2	206.8	1.03
Sarda sarda	57.9	146.4	248.0	252.0	734.4	2509.8	130.9	366.2	354.7	784.6	1960.2	709.0	5.89
Sardina pilchardus[4]	901.5	2421.0	2499.1	2032.9	2331.1	1572.6	1957.3	1806.3	1050.1	2357.5	2368.1	4277.3	18.55
Sardinella aurita[4]	35.7	90.1	166.6	94.4	65.4	86.6	65.2	35.8	43.3	97.1	97.6	176.2	0.46
Sardina pilchardus, Sardinella aurita[4]									1093.4	2454.6	2465.7	4453.5	
Scomber spp.	68.5	324.1	716.4	279.9	186.1	78.1	156.1	72.0	49.4	166.2	170.1	165.0	1.74
Scorpaenidae	30.2	74.5	80.9	128.3	104.6	75.3	109.2	132.9	140.7	113.0	124.5	128.1	0.89
Scyliorhinus spp., *Mustellus* spp.[2]	84.8	128.4	131.4	148.2	138.9	178.5	199.2	147.8	167.4	214.0	193.9	111.4	1.37
Seriola dumerili[3]	4.4	3.0	3.0	1.4	2.1	6.2	1.5	0.7	2.1	3.2	3.2	3.8	0.02
Serranus cabrilla[3]	14.6	8.3	6.3	14.3	13.8	11.6	8.1	7.8	8.1	12.3	12.2	14.2	0.06
Solea spp.	40.3	21.7	41.4	32.8	31.4	21.7	6.4	9.9	6.5	18.7	40.3	50.7	0.23
Sparus aurata	28.4	36.1	45.1	105.3	55.2	39.1	40.4	28.7	52.7	78.5	154.4	90.9	0.53
Spicara spp.	711.0	1295.2	1511.4	1755.4	1762.4	1636.2	1673.1	1881.4	2051.7	2037.2	2643.9	2422.8	15.3
Trachurus spp.	257.2	695.9	719.5	732.8	707.7	485.3	426.4	443.9	256.5	636.5	894.3	674.6	4.9
Tuna-like fish	21.4	22.8	23.6	30.9	22.4	35.8	22.9	25.9	8.6	70.4	53.0	21.8	0.3
Reconstructed other Osteichthyes group[3]	657.8	1444.1	2043.8	1785.1	2001.8	1439.9	1263.8	1128.1	1094.7	1668.3	1649.8	1933.8	12.9
other Osteichthyes group[3]									1112.4	1695.2	1676.4	1965.0	
Cephalopods													
Loligo sp.	15.9	34.9	32.7	26.0	36.5	32.1	84.4	78.8	76.9	86.5	145.1	156.8	0.58
Octopodidae	65.8	205.0	209.7	221.2	194.5	229.8	230.1	253.7	421.1	505.5	380.8	300.4	2.30
Sepia officinalis	100.2	85.4	125.2	140.6	111.2	141.8	119.1	121.7	171.9	225.1	334.6	275.6	1.39
Crustaceans													
Nephrops norvegicus	16.1	46.1	76.5	101.4	68.0	42.2	0.1	0.4	2.3	2.4	242.2	160.3	0.54
Natantia	13.5	75.2	87.8	107.1	81.2	88.9	103.8	37.8	86.4	143.0	189.6	100.8	0.80
Homarus gammarus	8.5	15.3	14.4	19.1	17.8	19.2	14.6	22.0	17.8	17.6	14.5	23.0	0.15
Other cephalopods-crustaceans	3.1	27.7	63.5	42.3	58.3	36.2	20.4	37.6	17.7	23.4	35.0	32.8	0.28
Total landings (t)	4596.8	9690.8	11933.0	12204.9	11896.7	11552.5	10422.0	9866.5	9580.15	13788.2	17384.5	17338.7	

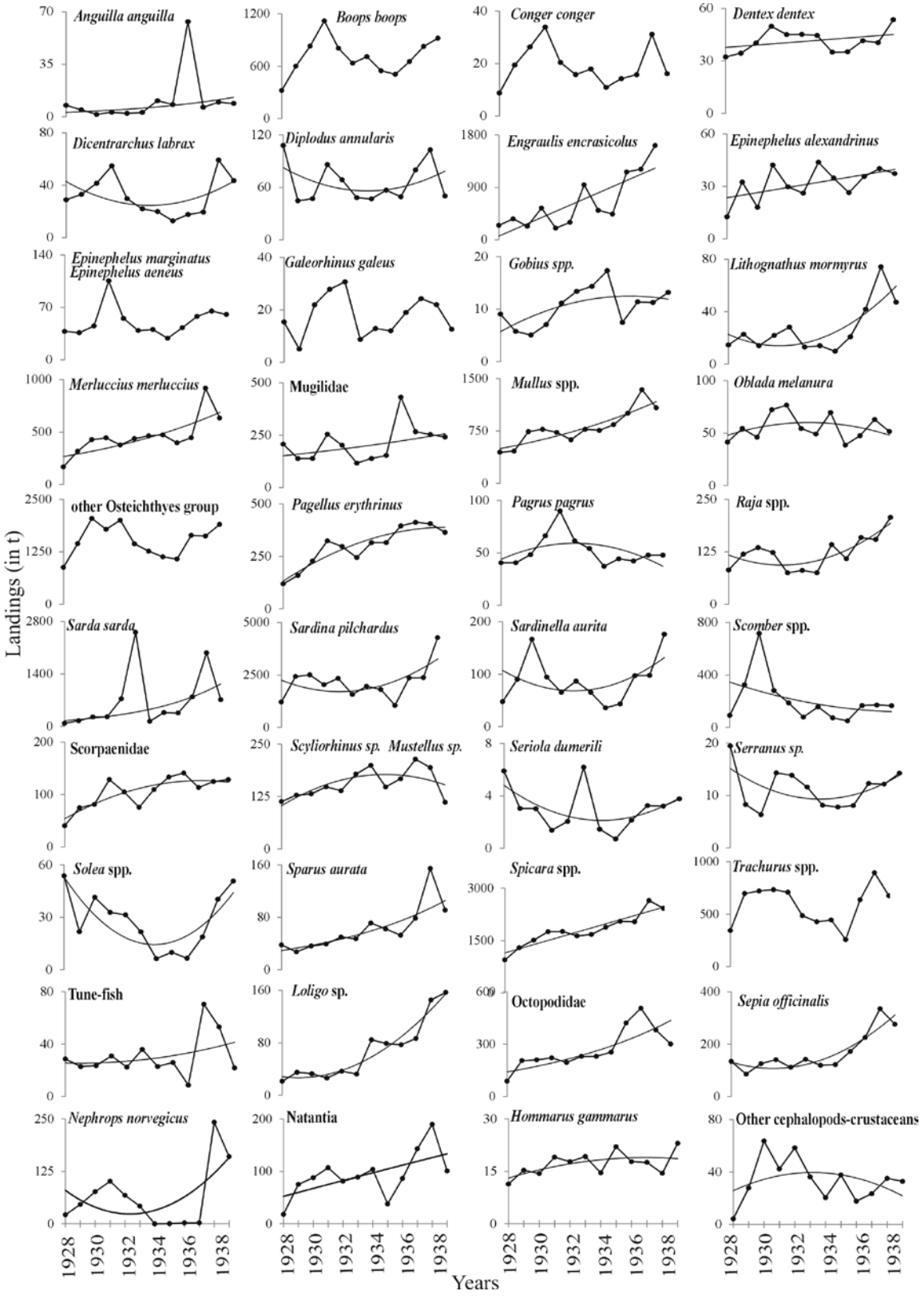

Fig. 3. Annual landings (in t) of the 40 species or group of species recorded by the General Statistical Service for Greek waters during 1928-1939.

Spatial distribution of landings during 1928-1939

Five customs authorities (Thessaloniki 16.0%, Patras 11.7%, Chalkida 10.0%, Volos 7.9% and Mitilini 7.2%) contributed 52.7% of the mean annual landings during 1928-1939 (online Appendix Table C1). Such information is not available for the number of vessels but only for GT for which the above-mentioned ports contributed 48.5% of the total Greek GT (data not shown). The reconstructed annual landings per species for each of the 15 NSSG fishing sub-areas showed that NSSG sub-areas S10, S13, S14 and S15 contributed more than half (59.0%) of the mean 1928-1939 landings (Table 4).

Table 4. Reconstructed annual landings and mean (1928-1939) contribution (%) of landings per fishing sub-area (S) as defined by the National Statistical Service of Greece (NSSG) (see Fig. 1) for Greek waters, 1928-1939

NSSG subareas	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	% of Mean 1928 -1939
S3	78.3	112.5	128.3	158.8	141.1	112.3	113.2	115.8	437.9	93.8	93.1	87.4	1.2
S4	92.7	163.2	197.8	218.4	208.2	174.4	170.7	159.1	221.5	306.9	227.5	223.0	1.7
S5	181.8	390.0	474.7	488.3	452.3	385.9	455.1	417.4	491.1	520.1	598.0	679.1	3.9
S6	42.1	79.6	100.2	115.5	107.3	90.2	94.2	91.7	106.9	128.6	123.2	107.4	0.8
S7	70.1	132.7	167.0	192.5	178.9	150.3	157.0	152.9	178.1	214.3	205.3	179.0	1.4
S8	349.9	723.0	881.1	949.3	954.2	1035.9	810.5	780.9	827.2	1159.2	1409.5	1290.8	8.0
S9	381.0	862.7	1034.1	1048.2	947.9	800.6	1004.1	871.5	1095.4	1269.6	1269.2	1378.4	8.5
S10	556.7	1233.0	1603.8	1582.0	1566.3	1800.6	1312.5	1244.8	878.8	1507.4	3024.8	2620.0	13.5
S11	141.2	298.2	334.4	369.1	361.4	473.7	361.1	320.4	367.1	312.7	731.0	748.8	3.4
S12	211.4	457.4	546.5	576.8	586.2	781.9	513.5	476.0	490.4	546.9	1300.4	921.5	5.3
S13	750.7	1612.5	1946.2	1836.7	1946.6	1819.9	1543.0	1493.7	508.6	2521.9	2744.9	2849.9	15.4
S14	767.7	1671.7	2005.2	1987.0	1947.1	1714.9	1714.1	1613.8	1372.1	2538.8	2865.8	2925.2	16.5
S15	653.1	1291.8	1652.1	1731.2	1635.0	1449.2	1495.5	1475.2	1858.0	1723.7	1751.7	2315.1	13.6
Sub-area S16 (Dodecanese Islands) was annexed by Greece in 1948													
S17	120.4	262.0	359.9	357.2	336.2	288.8	272.0	261.6	331.3	323.3	389.4	308.0	2.6
S18	199.8	391.6	492.8	528.0	522.7	482.1	436.3	425.3	397.8	594.0	624.2	674.0	4.1

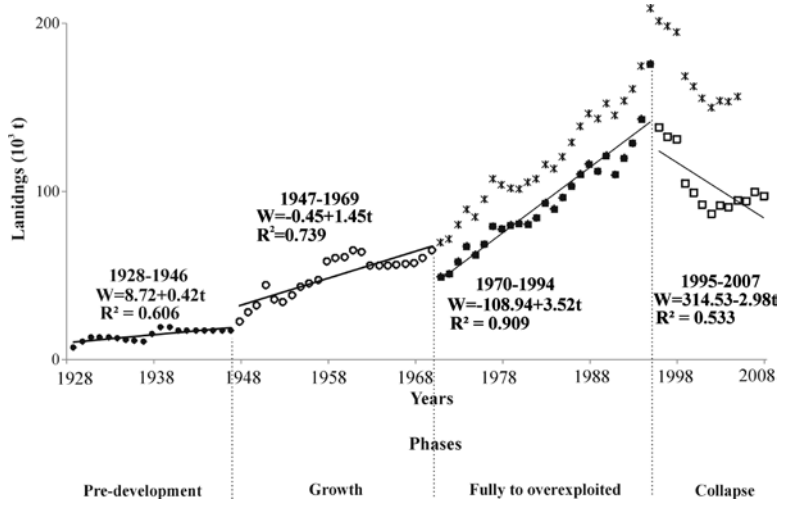

Fig. 4. Annual total fisheries landings (in 10^3t) recorded from the various statistical organizations (see Table 1) for Greek waters for 1928-2007. Phases indicate the periods of development of the Greek fisheries modified from HILBORN & WALTERS (1992). Crossed points indicate the reconstructed Greek landings during 1970-2004, after inclusion of the landings from vessels with engine power < 19HP (TSIKLIRAS et al. 2007). GSSG fisheries landings in 1928 were standardized to the entire annual period (12 months: 6129.0 t).

Greek landings during 1928-2007 period

Greek fisheries landings during 1928-2007 displayed different trends with time. In particular, during 1928-1994, fisheries landings significantly ($P<0.05$) increased and the increase took place in three phases (Fig. 4): (a) a gradual increase during 1928-1946 (slope b=0.42), (b) a steeper (slope b=1.42) increase during 1947-1969 and (c) a much steeper (slope b=3.52) linear increase during 1970-1994. In contrast, during 1995-2007 fisheries landings significantly ($P<0.05$) decreased (i.e. landings decreased by 37.0% during this period).

DISCUSSION

The present study analyzed Greek fisheries statistics that were published by the GSSG during 1928-1939, a period in which Greek fisheries was most probably affected by the prevailing socio-economic and political events (Table 5). During the period from the establishment of modern Greece in 1832 (PAPARRIGOPOULOS, 1932) to 1910, Greek fisheries policy was limited to a few Royal Decrees (Table 5) (TSAKAKIS, 1950). The fisheries sector in Greece was officially established in 1911 (Table 5) after the establishment of the first fisheries department under the authority of the Ministry of Economy. During 1911-1924, Greek fisheries were at an essentially pre-industrial stage, had started to be organized in terms of administration (Table 5) and with the most common gears used being the sailing beach seines operating in enclosed gulfs (i.e. the trawl-type net was towed manually from the coast) and the Italian sailing trawls (TSAKAKIS, 1950).

Greek fisheries started to develop after the immigration of more than a million people from Turkey during 1923-1924 (Treaty of Lausanne) (PAPARRIGOPOULOS, 1932; MARTIN, 1924). Many of the immigrants were professional fishers operating in the Black Sea (ANANIADIS, 1984) and their arrival in Greece triggered fisheries development, in large part due to the introduction of new fishing gears for open waters (i.e. purse-seine) and the small-scale sector (e.g. specialized gear for squid fisheries) (ANANIADIS, 1962). Immigrants received economic aid of 15.3 million "golden" British sterling during 1924-1928 from the League of Nations (MARTIN, 1924) for their re-establishment, part of which was used for obtaining the first engine-powered fishing vessels (i.e. trawlers and purse-seiners) and gears (PAPARRIGOPOULOS, 1932; TSAKAKIS, 1950). This can be viewed as an early capacity-enhancing subsidies scheme (SUMAILA *et al*., 2010).

Apart from this aid, there was no national initiative for the development of the fisheries sector during 1928-1932 (Table 5). Thus, Greek fisheries during that period were characterized by a small number of engine-powered vessels when compared to sailing and rowing ones (Fig. 2) and a small number of fisher cooperation organized at a pre-industrial stage (TSAKAKIS, 1950) (i.e. in 1934 there were only nine fishing cooperations which increased to 39 in 1939) (SERBETIS, 1949a, b). Moreover, the fact that most vessels used sails, especially for trawling, rendered fishing a time-consuming and less productive activity mainly conducted during the daytime (ANANIADIS, 1962). However, during this pre-industrial stage of Greek fisheries, the first signs of fisheries depletion in heavily exploited gulfs (sub-areas 9, 10 and 13) were reported (TSAKAKIS, 1950; ANANIADIS, 1970). This led to the collapse of existing fishing enterprises (TSAKAKIS, 1950) and to the spatial expansion of the trawlers further from their bases and operating to greater depths (ANANIADIS, 1970).

The financial bankruptcy of Greece in 1932 (VERGOPOULOS, 1975) ceased or postponed the government initiatives that had been planned to take place in Greece for the development of the fisheries sector and/or the protection of fisheries resources (TSAKAKIS, 1950) during 1930-1932 (Table 5). In particular, the agreement (National Law Number 4762/1930) between the Greek government and a European investment group for the economic funding of Greek fisheries was not realized (PAPARRIGOPOULOS, 1932). In addition, the Agricultural Bank of Greece (ABG) (which was established in 1929) also incorporated into its funding, apart from the agricultural sector, the fisheries sector, through the National

Law Number 5262/1931, but this was realized after 1936 (SERBETIS, 1949b). Thus, during 1932-1935, the number of fishing vessels and professional fishers involved in the professional fisheries actually gradually decreased (a 34% and 28.9% decline, respectively, between 1932 and 1935), resulting in a decline in fisheries landings by 20% during the same period.

After 1936, the Greek fisheries, through ABG funding, started to modernize by means of: (a) the introduction of engines for all vessels, (b) the increase in the number of vessels and tonnage capacity (by 34.2% and 30.7%, respectively, between 1935 and 1939), and (c) the increase in the number of fishers employed in the professional fisheries (from 5738 in 1936 to 7618 in 1939; a 24.7% increase).

In order to identify patterns and trends for the Greek fisheries during 1928-1939, we compared the fisheries landings during this period with those from 1940 onwards. The analysis during 1928-2007 depicted four main phases (modified from HILBORN & WALTERS, 1992) of the Greek fisheries (Fig. 4): (a) the pre-development phase (1928-1946) with a moderate increase in landings, (b) the growth phase (1947-1969) marked by rapid increases in landings, (c) the fully to over-exploited phase (1970-1994) characterized by a much faster increase in landings, and (d) the decaying phase (1995-2007) exhibiting a significant decrease in landings.

In particular, during the pre-development phase, the mean (during 1928-1946) annual landings were 11.3 times lower when compared to the landings of the 1994 peak (Fig. 4). During this period, apart from the above-mentioned events described for 1928-1939, WW II (1940-1945) delayed any attempts at the modernization of Greek fisheries (Table 5) and even shifted Greek fisheries slightly backwards. This was mainly because most of the fishing vessels for open waters (i.e. trawlers and purse seiners) were not engaged in fishing operations (about 65% of the fishing vessels during 1941-1945 were either destroyed, or transported to the Middle East, or participated in war efforts) and most of the small-scale fishing gears were destroyed (ANANIADIS, 1968; SERBETIS, 1949a).

Thus, during 1928-1946, the Greek fisheries were characterized by a small number of well-equipped fishing vessels (ANANIADIS, 1984) that limited the spatial (i.e. fisheries were frequently conducted in proximity to main ports and cities and rarely expanded to offshore areas, at depths < 100 m before 1928 and extending to 200 m depth after 1928) (ANANIADIS, 1984) and temporal (150-170 fishing days in 1938 (ANANIADIS, 1970) compared to about 240 days in the late 1990s (ANONYMOUS, 2001) extent of fishing activities. In addition, a part of the landings did not reach fish markets and was discarded (an estimated 8% of the total production; ANANIADIS, 1968) due to the absence of well organized transportation systems and fish wholesale markets (SERBETIS, 1949a), as well as because of the low number of seafood processing enterprises, from three during 1928-1939 (PAPANASTASIOU, 1990) compared to more than 50 after 1965 (ANANIADIS, 1968).

After the end of WW II and for a few years thereafter (1946-1954), Greece was funded by international economic aid (Table 5), a substantial part of which (12.1%) was directed to the fisheries sector (ANANIADIS, 1968). This funding, which represented more than the total economic value of Greek pre-war fisheries (SERBETIS, 1949b), had supported the fisheries sector during its growth phase (1946-1969). Thus, the Greek fisheries started to modernize (ANANIADIS, 1970) and, in combination with the annexation of the Dodecanese areas to Greece, expanded to fishing grounds not previously exploited by Greek vessels. In addition, since 1965, fisheries monitoring, research and legislation started to be organized simultaneously with the development of a well-organized transportation system through the establishment of fish wholesale markets all around Greece (i.e. wholesale markets increased from 5 to 11 during 1964-1994) (ANANIADIS, 1968) (Table 5).

The above-mentioned features resulted in rapidly increasing landings during 1970-1994 (fully to overexploited phase). The entrance of Greece to the European Union (in 1981) and the subsequent development programmes (Table 5) also highly contributed to the strong

Table 5. Main socio-economic and political events that took place in Greece and its fisheries from the establishment of the modern Greek state (1832) to the first integrated measure for the conservation of fisheries resources in the Mediterranean (1994) (year periods identified in figure 4). NL, National Law; RD, Royal Decree; ND, National Decree; ER, European Regulation; and PD, Presidential Decree

Period	Mean landings (in 10^3t)	Main event	Source
1832-1927		1834: Framework for the spatial operation of the sardine fishery in Patraikos and Korinthiakos gulfs	RD 14/26-3-1834 (TSAKAKIS 1950)
		1839: Framework for the leasing terms in Greek lagoons	RD 23-3-1839 (TSAKAKIS 1950)
		1853: Directives for fishery administration aspects	NL 9-5-1853 (TSAKAKIS 1950)
		1878: Spatial prohibition of towed fishing gears beyond 3 nautical miles from the coastline	RD 9-1-1878 (TSAKAKIS 1950)
		1892: Directives for fishery administration aspects	RD 21-10-1892 (TSAKAKIS 1950)
		1911: Establishment of the first Department of Fisheries in the Ministry of Economy	(TSAKAKIS 1950)
		1920: Establishment of the first Greek Marine Committee participating to the Committee for the Exploration of the Mediterranean Sea	(TSAKAKIS 1950)
		1923: Spatial prohibition of towed fishing gears beyond 1.5 nautical miles from the coastline	RD 9-5-1923
		1923: Treaty of Lausanne (24-7-1923)	(MARTIN 1924)
		1925: Establishment of the General Statistical Service of Greece (GSSG)	NL No 31-3-1925
1928-1946	12.9	1924-1928: Economic funding by the League of Nations (15.3 million "golden" British sterlings) for the relief of immigrants	(PAPARRIGOPOULOS 1932)
		1929: Establishment of the Agricultural Bank of Greece (ABG)	NL No A 283/16-8-1929
		1930: Decision for the economic funding of Greek fisheries from the European Central Bank (more than 120000 "golden" British sterlings)	NL 4762/1930
		1931: Apart from the agricultural sector, ABG incorporated into their funding the fisheries sector	NL No 5262/1931, (Serbetis 1949b)
		1932: Financial bankruptcy of Greece	(VERGOPOULOS 1975)
		1937: Framework for the spatial operation and technical aspects of trawl fishery	RD 29-4-1937
		1939-1941: Establishment of the Fisheries Organization under the authority of the Ministry of Economy	NL 2078/1939
		1940-1945: World War II	
		1941: Repeal of the law for the establishment of the Fisheries Organization	ND 18-6-1941

Table 5. (cont'd)

Period	Mean landings (in 10^3t)	Main event	Source
1947-1969		1946-1954: Greece was funded by international organizations with 1180.2 million $, of which approximately 12.1% was directed to the fisheries sector	(ANANIADIS 1968); VETSOPOULOS (2007)
		1948: The Dodecanese was annexed to Greece	NL No 518/9-1-1948
		1948: Fundings of vessels with tonnage capacity < 70 GT and of vessels operating in sponge fishery	ND 571/1948
		1953: Framework for the operation of purse seine fishery	RD 23-3-1953
		1963: Establishment of a monthly statistical survey for marine fishery	NL No 30112/254/1963
		1964: Reduction of the interest on loans for professional fishers by ABG	(ANANIADIS 1968)
	44.6	1965: Establishment of the operational framework for wholesale markets	RD 939/1965, NL No 4457/1965 ar 5 par 1
		1965: Establishment of the Oceanographic and Fisheries Research Institution (now Hellenic Centre of Marine Research)	(ANANIADIS 1968)
		1966: First organized effort at establishing an intergrated Greek fisheries legislation concerning technical measures, licencing system and minimum landing sizes for several marine species	RD 666/1966
		1966-1970: Increase in funding for Greek fisheries derived from ABG (from 20% to 42%)	(ANANIADIS 1968)
1970-1994	84.9	1981: Greece joined the European Community	
		1986: Fishers were subsidised by EU to modernise their vessels	ER 4028/1986
		1991: Common Fisheries Registry	ER 163/1989, P.D. 261/1991
		1993: Management of vessel capacity and restructuring of the fishery vessels	ER 3699/1993
		1994: Technical measures for the conservation of fisheries resources in the Mediterranean	ER 1626/1994

modernization of Greek fisheries (STERGIOU *et al*., 1997; 2007a). Thus, fishing vessels either expanded their spatial operational activities to previously unexploited fishing areas (i.e. in the distant waters of sub-areas S7 and S16 and the deeper waters of the Ionian Sea down to 500 m; Fig. 1) and/or increased their operational fishing time both on a daily (i.e. 24 hours per day for trawls) and annual basis (i.e. for small-scale vessels) (ANONYMOUS, 2001). Hence, the mean annual landings derived from sub-areas further away from main ports and cities (sub-areas S6, S7, S17 and S18) increased by 12.9 times between 1928-1939 and 1970-1994, whereas the landings from enclosed gulfs (sub-areas S8, S9, S10, S11 and S13; Fig. 1) increased only by 0.6 times between the same two periods. In addition, fisheries started to exploit new species: *Pagellus bogaraveo* (ANONYMOUS, 2001), deep-water shrimps (POLITOU *et al*., 2003), *Polyprion americanus* (MACHIAS *et al*., 2003) and Chrondrichthyes (MEGALOFONOU *et al*., 2009).

The overexploitation of fisheries resources resulted in a considerable decline in Greek fisheries landings during 1995-2007, clearly showing that fisheries resources were not sustainably fished (STERGIOU *et al*., 1997; 2007a, b). Field studies during the same period (POLITOU, 2007) also show high exploitation rates for the most commercially important demersal species caught by Greek trawlers (i.e. *Merluccius merluccius*, *Mullus barbatus* and *Pagellus erythrinus*). In addition, landings/day for trawls and purse seines were steadily declining in the most important Greek fishing grounds (i.e. N. Aegean, Cretan and Ionian Seas) during 1996-2000 (MACHIAS *et al*., 2008). Although during 2002-2007 fisheries landings showed a slight increasing trend, and which might indicate a recovery stage of the fisheries resources (HILBORN & WALTERS, 1992), the small number of years does not allow any definitive conclusion to be drawn.

With respect to the species composition during 1928-2007 (Table 6), although *Sardina pilchardus*, *Engraulis encrasicolus*, *Spicara* spp., *Boops boops* and *Trachurus* spp. dominated the landings in all periods, fisheries during 1928-1939 focused more on *S. pilchardus* rather than *E. encrasicolus*, possibly because of higher prices for the former species (STERGIOU, 1989). However, ecological factors cannot be ruled out (e.g. see CADDY & GARIBALDI, 2000). In addition, the higher trophic level species, such as *Mullus* spp., *Merluccius merluccius*, *Pagellus erythrinus* and *Sarda sarda*, were relatively more abundant during 1928-1939 when compared to 1970-2007 (Table 6). Since, high trophic level species are more vulnerable to exploitation when compared to low trophic level taxa (PAULY, 1998), this is an indication of overfishing. Previous studies on Greek fisheries have also shown decreasing trends both for the mean trophic level (especially in the southern part of the Aegean Sea) (NSSG data during 1967-1997: STERGIOU & KOULOURIS, 2000) and for the landings of the highest trophic level species (FAO data for Greek waters during 1950-2001; STERGIOU, 2005). PAULY *et al*. (1998) also confirmed that there has been a significant decline in the mean trophic level of the Mediterranean landings during 1950-1994.

The same has been also observed for fisheries landings (87 species or groups of species) in the northern Adriatic Sea during 1800-2000, i.e. a significant decrease in the percentage contribution of large-sized demersal species during the same period (FORTIBUONI *et al*., 2010). In contrast, medium-sized pelagic species (i.e. *Scomber* spp. and *Trachurus* spp.) were relatively more abundant during 1982-2007, probably due to the operational expansion of purse seiners (ANONYMOUS, 2001).

The patterns of marine fisheries landings presented in this study are based on the official statistical data that are subject to certain biases and limitations (STERGIOU *et al*., 1997). Some of these biases were partially resolved after the reconstruction of Greek landings (TSIKLIRAS *et al*., 2007), which accounted for small-scale landings previously not reported by the official authorities. In any case, these are the best available data and the historic reconstruction of the Greek fisheries landings integrated with historical socio-economic aspects is essential for the establishment of reference points for Greek fisheries, the development of mass-balance ecological models, and finally the implementation of ecosystem-based management of Greek fisheries.

Table 6. Percentage composition (%) of the most abundant fish species or group of species present in the Greek marine landings during different periods. Bold values indicate maximum values (%).

Species composition (%)	1928-1939[A]	1950-1963[B]	1964-1969[C]	1970-1981[C]	1982-2004[C]
Boops boops	6.0	4.7	5.6	**8.4**	7.7
Engraulis encrasicolus	5.5	9.3	**11.3**	10.1	10.8
Merluccius merluccius	**3.9**	2.6	1.9	2.6	3.3
Micromesistius poutassou					0.9
Mugilidae	1.8	2.5	1.7	2.3	2.5
Mullus spp.	**6.8**	6.3	4.6	3.8	4.3
Oblada melanura			0.8		0.6
Pagellus erythrinus	**2.5**		1.3		0.8
Sarda sarda	**5.8**	4.1	3.4		1.2
Sardina pilchardus	18.3	**20.0**	19.9	18.0	14.4
Scomber spp.	1.7	1.4	2.0	2.0	**4.1**
Sepia officinalis		**7.3**	1.2	1.3	1.9
Solea spp.		0.6	0.9	1.2	1.0
Spicara spp.	15.3	14.2	**15.6**	14.1	10.1
Squalidae		2.5			
Trachurus spp.	5.0	5.0	5.4	**7.9**	6.2
Tuna-like fish			1.1		2.0

[A]: present study; [B]: FAO; [C to E]: STERGIOU et al. (2007a)

ACKNOWLEDGEMENTS

The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 244706/ECO-KNOWS project. However, the paper does not necessarily reflect EC views and in no way anticipates the Commission's future policy in the area. The authors wish to thank Dr A.C. TSIKLIRAS for his comments on an earlier version of the manuscript, and two anonymous reviewers for their useful comments and suggestions.

On-line Appendix (Supplementary data)

Supplementary data associated with this study are presented in the on-line version.

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Received: 17 May 2011
Accepted: 6 August 2011

Razvoj grčkog ribarstva tijekom razdoblja 1928. -1939.

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SAŽETAK

U ovom radu, po prvi put, je iznesen status ulova u grčkom ribarstvu i to u razdoblju od 1928. do 1939. godine prema podacima iz Opće statističke službe u Grčkoj. Konkretno, izneseno je slijedeće: a) predstavljen je godišnji ulov ribarstva za sve vrste zajedno, ribolovni napor za sve vrste alata u kombinaciji i vrste specifičnih ulova tijekom razdoblja 1928.-1939., b) ponovno dodijeljive prostorne rezolucije ulova tijekom 1928.-1939., te tijekom 1964.-2007., i c) uspoređen je ulov za različita razdoblja tijekom 1928.-2007. Rezultati su pokazali da su se tijekom 1928.-1939., ulov i ribolovni napor općenito povećali.

Vremenske serije svih vrsta ulova su bile izložene jakim međugodišnjim varijabilnostima, te od 40 vrsta njih 23 su pokazale značajan trend rasta.

Analiza ukupnog ulova ribarstva tijekom vremena (1928.-2007.) prikazuje četiri različita uzoraka koji obilježavaju četiri faze razvoja grčkog ribarstva: 1. postupno povećavanje tijekom 1928.-1949. (pred-faza razvoja ribarstva), 2. strmo povećanje tijekom 1950.-1969. (faza rasta), 3. značajan linearni porast tijekom 1970.-1994. (faza potpunog do prekomjernog ulova) i 4. opadajući trend tijekom 1995.-2007. (kolaps faza).

Ove faze se kronološki poklapaju sa značajnim socio-ekonomskim i političkim događanjima koja su se zbivala u Grčkoj od 1928. godine.

Ključne riječi: ribarstveni iskrcajni ulov, ribolovni napor, povijest ribarstva, povijesni razvoj, grčke vode, Mediteran