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Assessment of demersal resources exploited by the Albanian trawl fishery: the case studies "hake" and "red mullet"

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Assessment of demersal resources exploited by the Albanian trawl fishery: the case studies "hake" and "red mullet" [1, 2]

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Abstract

The past and current status of Albanian demersal trawl fishery is discussed on the basis of catch and effort data (time series 1960-1992) from the archives of Fisheries Research Institute of Durrës (Albania).
Fishing effort steeply increased during the eighties, while a slight reduction has been reported for 1990-1992 when important political and economic changes occurred in the country. Annual yields and CPUEs for total demersal catches have quite stable trends up to the eighties, then they increased in the following two-three years as a result of the increased fishing effort and probably the improved technology (more efficient, bigger vessels, etc.). Strong fluctuations of fishery yields and CPUEs are reported from 1984 up to 1992. With regard to demersal fishery "target species", surplus production models (biomass-dynamic models) fitted to the available data highlight the decrease of CPUE values for the hake (*Merluccius merluccius*) in the period of investigation. The same models did not provide reliable results for the red mullet (*Mullus barbatus*), a species characterised by a short life span and discrete recruitment.
Nevertheless, taking into account the processing constraints of the models used, some new information for the area investigated is reported. The results have to be considered as the first attempt to study the Albanian demersal fishery in a thirty-year period.

Key words: Demersal Fisheries; Stock assessment; Catch/effort; Potential yield; *Merluccius merluccius*; *Mullus barbatus*; Med, Adriatic Sea, South.

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[1] This paper is based on the work of Osmani *et al.*, "Past and current status of Albanian demersal fishery (Mediterranean Sea Geographical Sub-area 18)" presented at the Samed International Workshop (Rome, March 2002), now further developed and with the inclusion of a second species.
[2] The preparation of this work has been promoted by the FAO-AdriaMed Project. The opinions, interpretations, conclusions or recommendations expressed in this document are entirely those of the authors and do not necessarily reflect the view or position of FAO or of the Countries and Institutions participating in the AdriaMed Project.

1. Introduction

Trawling represents the most important fishery activity in the southern Adriatic Sea (GFCM Geographical Sub-area 18; GFCM, 2001) and a yearly catch of around 30,000 tons could be estimated for the last decade (ISTAT, 1997). Demersal species catches are landed on the western side (Italian coast) and the eastern side (Albanian coast), with an approximate percentage of 97% and 3% respectively (Mannini and Massa, 2000). Trawl fishery is targeted to a species pool (more than thirty commercial species), the mediterranean hake (*Merluccius merluccius*) contributing approx. 20% of the total catches while Norway lobster (*Nephrops norvegicus*), deep-water rose shrimp (*Parapenaeus longirostris*), red mullet (*Mullus barbatus*), mackerels (*Trachurus* spp.) and octopus (mostly *Eledone* spp) 5-10% each (Ungaro *et al*., 2002).
The bottom surface potentially exploited by trawlers is 15,000-17,000 km^2 (70 % on the western side, 30% on the eastern side). The extension of the trawlable area follows a latitudinal gradient, increasing from the south to the north of the basin.
Demersal resources are exploited by both Italian and Albanian fishery fleets, which often operate on the same stocks and fishing grounds. The Italian and Albanian trawling fleets currently consist of 900 vessels and 100-120 vessels respectively (ISTAT, 1997; Negroni, 2001; Albanian Fishery Directorate, Pers. Comm.). The last census, carried out within the framework of activities of the FAO-AdriaMed Project, shows trawlers as the main fraction of the Albanian fishing fleet (2001, Albania Fishery Directorate and FAO-AdriaMed; http://www.dfishery.gov.al/Statistical%20analysis1.pdf) (Table 1).

Table 1. Albanian fishing fleet: vessels distribution by type and port (*Albania Fishery Directorate and FAO-AdriaMed;* http://www.dfishery.gov.al/Statistical%20analysis1.pdf).

Vessel type	*Vlore*	*Sarande*	*Shengjin*	*Durres*	*TOTAL*
Purse seiners	1	0	0	0	1
Other seiners	1	0	1	5	7
Trawlers	53	7	19	43	122
Gill netter	10	23	7	15	55
Long liners	1	0	0	5	6
Multipurpose	0	0	0	6	6
Unknown	0	0	0	1	1
Total	66	30	27	75	198

2. Material and Methods

Data source
Raw data came from the declarations of fishers (time period 1960-1992). Each vessel was supplied with a fishing logbook consisting of catch and effort sheets. Each sheet was compiled at the end of the fishing trip, thus basic data consisted of effort values (fishing hours, fishing days, etc.) and catches (kg, n° of fish boxes per species, when possible), together with additional information such as haul depth, etc. The fishermen were obliged (by law) to give the sheets to the Port Cooperative Manager (one for each main port, Shëngjin, Durrës, Vlore and Sarande). The managers subsequently gave two official copies of each sheet to the Albanian Fishery Ministry and to the Fishery Research Institute of Durrës.

Data processing
Time series (1960-1992) of catch and effort data have been retrieved from the archives of the Fisheries Research Institute of Durrës have been used to estimate CPUE (tons/trawler) per year for the total demersal catch (Albanian trawl fishery fleet). Two target fishery species have also been analysed, the Mediterranean hake (*M. merluccius*) and the red mullet (*M. barbatus*).
Data available for *M. Merluccius* and *Mullus barbatus* have been used to fit the Schaefer and Fox models (Surplus Production Models) in order to estimate Maximum Sustainable Yield (MSY), fishing effort at Maximum Sustainable Yield (f_{MSY}), carrying capacity (K), current biomass (B) and current depletion rate of the stock (B/K). The Schaefer model has been fitted both under the assumption of equilibrium (Punt and Hilborn, 1996) and non-equilibrium (dynamic method) (Butterworth, 1988) conditions. In the latter case the error estimator in the relationship between the biomass and the index of abundance has been calculated by minimizing procedures (observation-error estimators) (Pella and Tomlinson, 1969; Butterworth and Andrew, 1984; Ludwig and Walters, 1985; Walters, 1986). In particular sampling errors and catchability fluctuations have been assumed as sources of errors (Kirkwood, 1981; Punt and Hilborn, 1996). The *ad hoc* software provided by FAO (BIODYN) was used for data processing (Punt and Hilborn, 1996).

3. Results

Data from fishing logbooks have been checked and selected as a first step. Indeed the aggregation level of reported data was often different, both referring to fishing effort and catch composition. For example, some fisherman indicated the number of fishing days, others the number of trawling hours (as an effort index). The catches were often reported as a "total amount", with the exception of target species such as the hake, red mullet and some others. Thus, due to the non homogeneous nature of raw data, a high level of aggregation was chosen for further elaboration, the total catches per year and the total number of operating vessel per year have been used to calculate CPUE values. The list of species considered for the estimation of "total catch" is reported in Table 2.

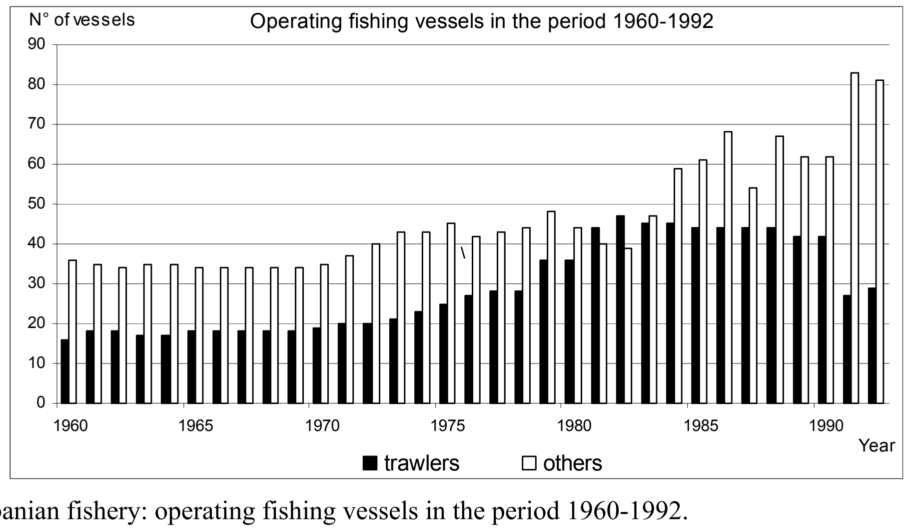


Figure 1. Albanian fishery: operating fishing vessels in the period 1960-1992.

With regard to the time-course of the Albanian fishing fleet, the steepest increase occurred during the eighties, while a slight reduction could be noticed during the period 1990-1992, the latter was probably due to the political and socio-economic changes in the country (Figure 1). The same trend was observed if only the number of trawlers is considered.

Table 2. List of demersal species used for the estimation of the annual total catches

Bogue	*Boops boops*
Common dentex	*Dentex dentex*
Common sole	*Solea vulgaris*
Cuttle fish nei	*Sepia spp.*
Dogfish sharks nei	*Mustelus ssp.*
European seabass	*Dicentrarchus labrax*
Gilthead seabream	*Spaurus aurata*
Groupers nei	*Epinephelus spp.*
Gurnards, searobins nei	*Trigla,Eutrigla spp.*
Hake	*Merluccius merluccius*
John dory	*Zeus faber*
Mackerels nei	*Trachurus spp.*
Octopuses nei	*Eledone,Octopus spp.*
Picarels nei	*Spicara spp.*
Porgies, seabreams nei	*Pagellus spp.*
Rays nei	*Raja spp.*
Red mullet	*Mullus barbatus*
Scorpionfish nei	*Scorpaena spp.*
Shi drum	*Umbrina cirrosa*
Shrimps and Prawns nei	*Parapenaeus,Penaeus,Plesionika,Solenocera spp.*
Silver scabbardfish	*Lepidopus caudatus*
Squids nei	*Illex,loligo spp.*
Sturgeons	*Acipienser sturio*

Annual yields and CPUEs for total demersal catches have quite stable trends up to the eighties, then they increased in the following two-three years as a result of the increased fishing effort. Strong fluctuations in the fishery yields and CPUEs have been highlighted from 1984 up to 1992. During 1991 the lowest values were obtained (Figure 2).

The hake yields and CPUEs follow quite different trends concerning total catches. Maximum values were recorded at the beginning and at the end of the available time series (1960) and large fluctuations have been reported between 1980 and 1990 (Figure 3). The red mullet yields and CPUEs fluctuated during the years. The trend of yields highlighted two main peaks in the last decade of the investigated period while highest values for CPUEs were estimated mainly for years from 1960 and 1975 (Figure 4).

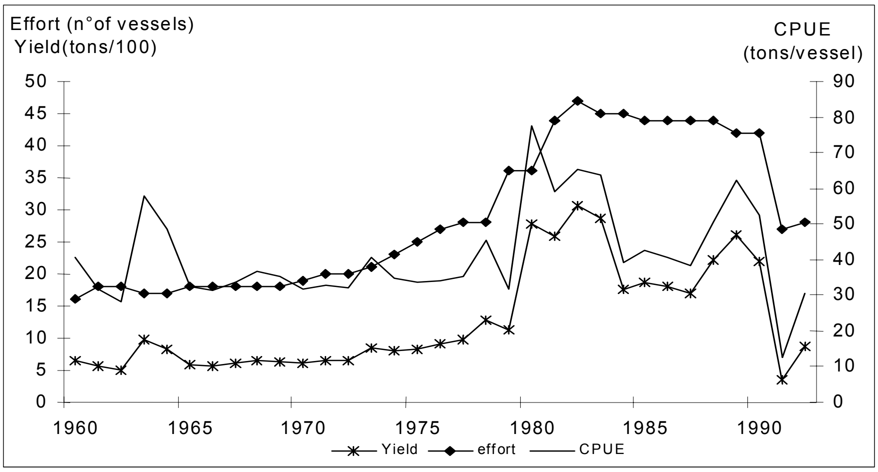


Figure 2. Annual fluctuations of fishery Yield, effort and CPUE for the total demersal catch during the period 1960-1992.

The distribution of hake CPUE values to be used for Schaefer's surplus production model fitting (equilibrium condition) pointed out a very clear distribution of yearly data (Figure 5). Most CPUE values are grouped on the opposite limits of effort range. The first cluster (lower effort) mostly includes the 1960-1980 period, the second one the following years. MSY estimation by the model was 95.24 tons and the same value was often exceeded in the last decade of the period studied (1980-1990) (Figure 6). The Fox model provided quite similar results (data not reported).

The MSY estimations from the Schaefer model fitted in a non-equilibrium condition were quite close to the previous one (equilibrium condition). The fitting of such a biomass dynamic model allowed additional information to be obtained. The trend of CPUE values predicted by the model is shown in Figure 7, where the values observed are also reported. A decreasing trend is reported, as was confirmed by depletion rates during the whole period. These analytical results are summarised in Table 3 together with other estimations such as fishing effort at Maximum Sustainable Yield (f_{MSY}), carrying capacity (K) and current biomass (B).

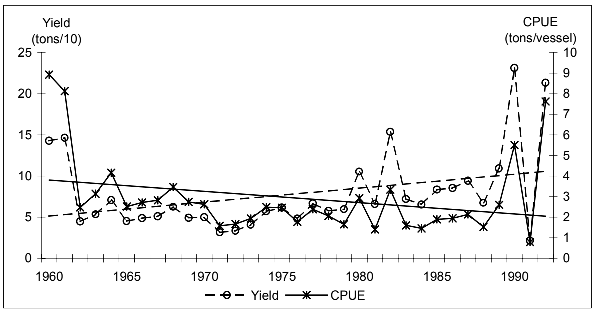


Figure 3. Trends of Yield and CPUE in the period 1960-1992 for *Merluccius merluccius* (European Hake).

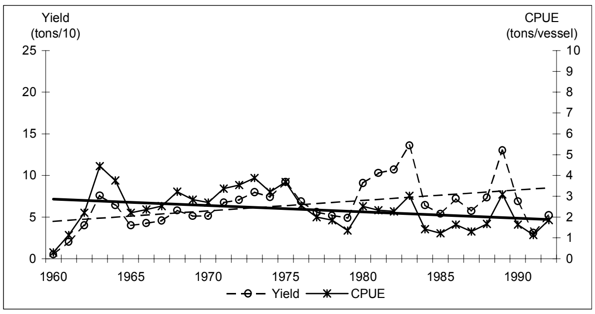


Figure 4. Trends of Yield and CPUE in the period 1960-1992 for *Mullus barbatus* (Red Mullet).

The distribution of red mullet CPUE values to be used for Schaefer's surplus production model fitting (equilibrium condition) mostly overlapped the results for hake and two clusters appeared on the opposite limits of the effort range (Figure 8). MSY estimation by the model was 87.23 tons and the same value was exceeded at the beginning and at the end of the eighties (Figure 9).

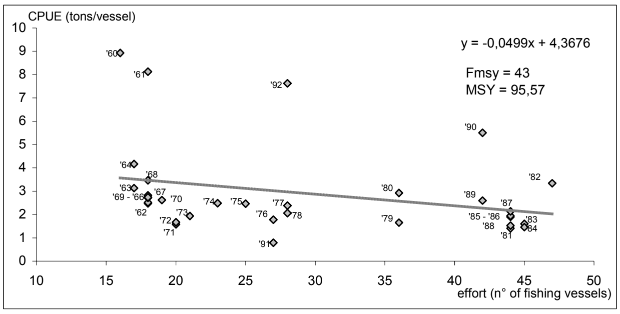


Figure 5. Distribution of CPUE values used for the fitting of the Schaefer Model, data from hake landings.

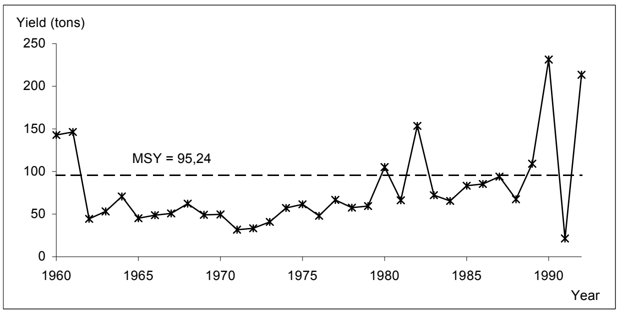
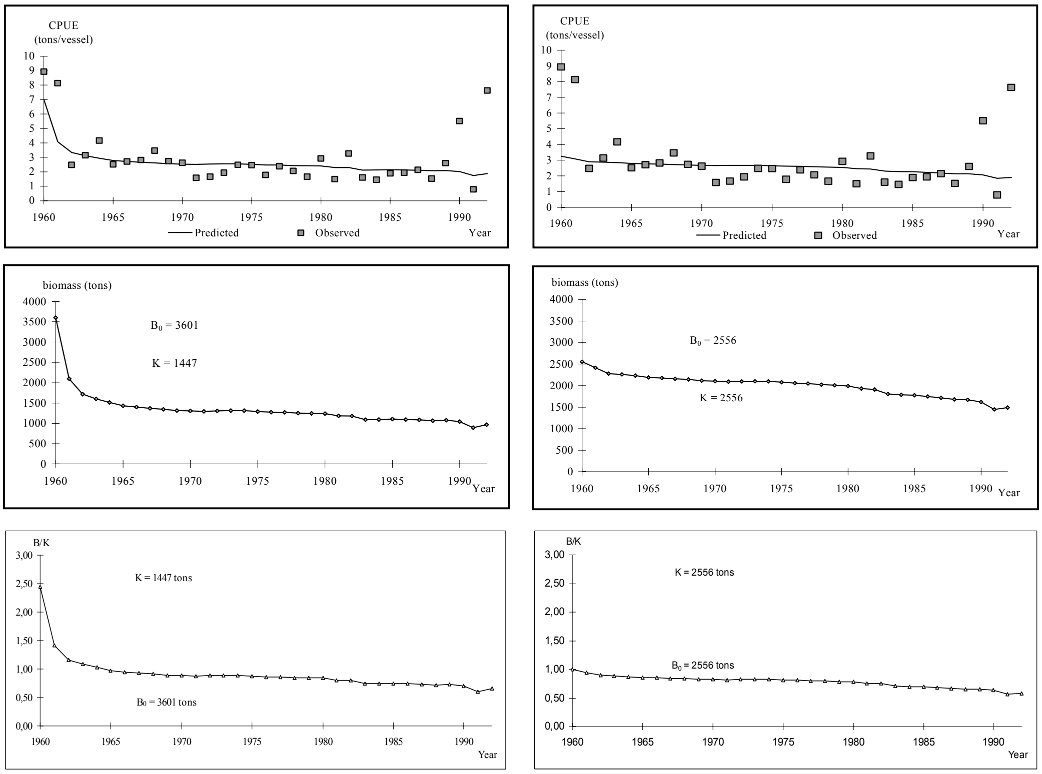


Figure 6. Yield trends for *Merluccius merluccius* in the period 1960-1992: comparison with the estimated MSY from the Schaefer model fitting (equilibrium conditions).



a) without constrains

b) superimposed $B_0 = K$

Figure 7. *Merluccius merluccius* assessment results fitting Schaefer model under non equilibrium conditions (observation-error estimators).

Model computations in non-equilibrium conditions provided highly contrasting results. In fact, the red mullet resource assessment seems to be too sensitive to the starting inputs for the dynamic models. Thus, opposite estimations could be easily achieved by means of minor changes in input values (Figure 10) (Table 4).

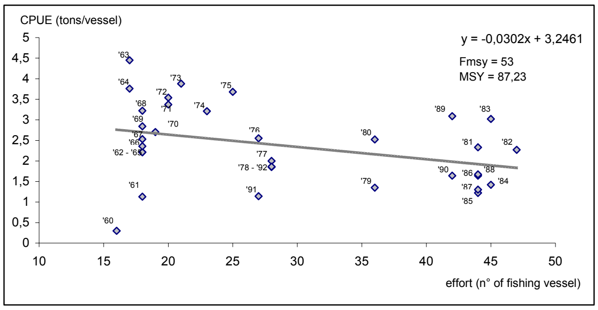


Fig. 8. Distribution of CPUE values used for the fitting of the Schaefer Model, data from red mullet landings.

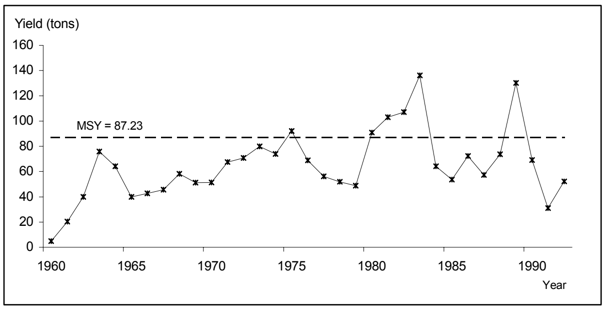
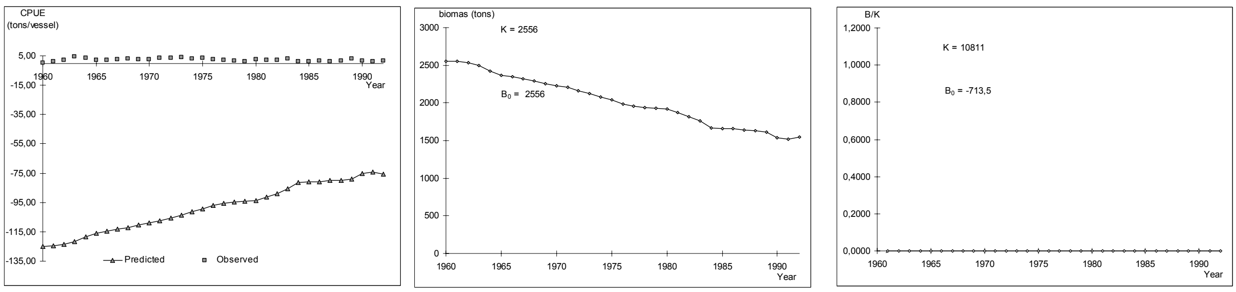
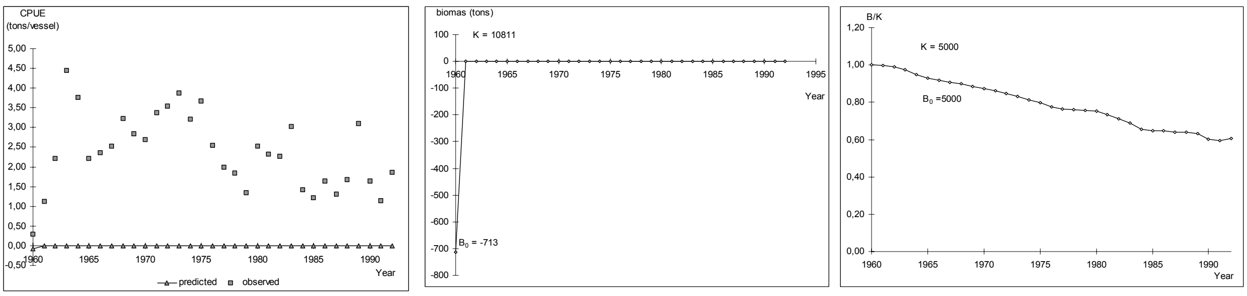


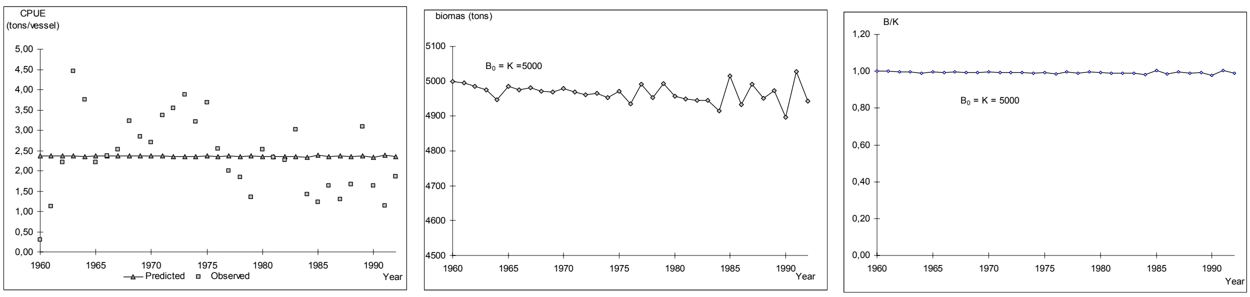
Fig. 9. Yields trend for *Mullus barbatus* in the period 1960-1992: comparison with the estimated MSY from the Schaefer model fitting (equilibrium conditions).



a) starting input data: r = 0.02; B_0 = 5000; K = 5000; q = 0.0005 (without constraints)



b) starting input data: r = 0.09; B_0 = 2556; K = 2556; q = 0.001 (without constraints)



c) starting input data: r = 0.02; B_0 = 5000; K = 5000; q = 0.0005 (B_0 = K)

Figure 10. *Mullus barbatus* assessment results fitting Schaefer model under non-equilibrium conditions (observation-error estimators).

4. Discussion

The results of the analysis carried out could be affected by data quality and availability as well as by the bio-ecological features of the species. In fact, both the estimated CPUE values and data fitting to surplus production models are subject to the influence of some assumptions, for example the presence of a "stock unit", and the invariance of the catchability coefficient (q) over time which can make the inclusion of too long time series of data in the analysis problematic (Sparre and Venema, 1998). Moreover, due to the relatively poor quality of the information, it was not possible to standardise the effort (Gulland, 1991).

Nevertheless, biomass-dynamic models (Hilborn and Walters, 1992) have been used when the information on the age structure of the population is not available (Punt and Hilborn, 1996). Some examples on the subject could also be found for temperate geographic areas (Punt, 1994). The last two circumstances fit the Albanian situation.

The biomass-dynamic models fitted to the available data highlight the decrease of CPUE values for the hake in the period concerned. The results could be considered conservative because the fishing power (catchability) probably increased during the period 1960-1992. Moreover, the high growth rate of fishing effort during the eighties produced large fluctuations in the observed yields and CPUE in the following years. This effect could be linked to a higher exploitation rate on some cohorts of the hake population or to the expansion of fishery activity on a spatial scale.

The same biomass-dynamic models seem to provide unreliable results if fitted to the red mullet data. This could be due to the bio-ecological features of the species such as the short life span (if it is compared with the hake), the relatively high intrinsic growth rate, and the discrete recruitment that is spatially (mostly soft coastal bottoms) and seasonally (mostly in summer and early autumn) localised. These are particularly important aspects for species whose changes in population size are directly linked to large recruitment fluctuations (Punt and Hilborn, 1996).

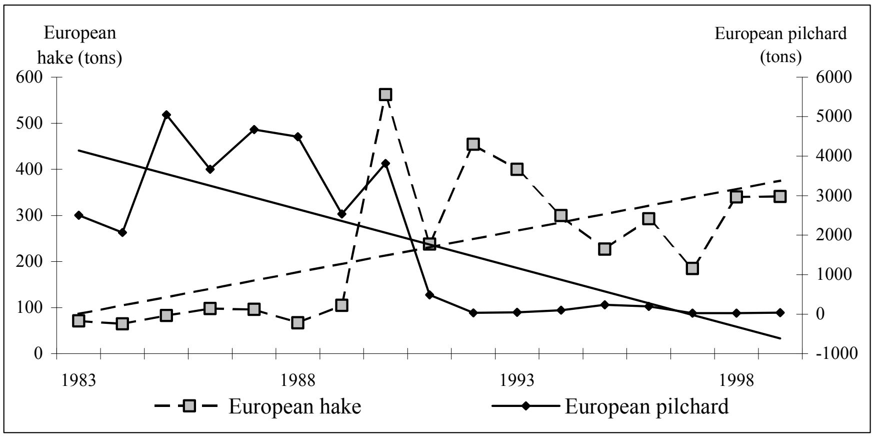


Figure 11. Trends of demersal and pelagic fishery in Albanian waters as indicated by target species (Hake and Pilchard).

5. Conclusions

The results reported have to be considered as a first attempt to study Albanian demersal fishery in a thirty-year period and as a real data exercise using surplus production models. Data processing, although it was affected by data quality and elaboration constraints, provided some new information for the area investigated. In fact, preliminary but interesting output could be discussed, even if the use of surplus production models is questionable in the Mediterranean (Lleonart, 1993). Unfortunately the present availability (and quality) of data and the lack of age-structured catches allowed the application of these models only.

The main indications from total catch data analysis are the marked increase in trawl fishing effort during the eighties and nineties, as was confirmed in the following years (up to recent times) (Mannini and Massa 2000), together with the high variability of annual yields in the same years. In the last decade trawl fishery rapidly increased while small pelagic fishery decreased and hake landings overtook sardine catches (Fig. 11; Kapedani, 2001). Currently the number of Albanian trawlers exceeds the estimated f_{msy} from surplus production models, at least for the hake resource and close monitoring would be advisable, based on updated data, of the demersal fishery. However, considering the assessment uncertainties and that important assumptions most likely have not been fully met, the current assessment should be made with care and needs to be further verified including more recent catch and effort data.

With regard to the red mullet, the use of the surplus production models provided unreliable results. The specific biological features probably affect the estimations, thus both the application of such models and the output have to be carefully investigated according to the different species, environmental characteristics and fishery patterns.

Nevertheless, the information obtained could be helpful for a better understanding of fishery dynamics in the Adriatic Sea where many stocks (e.g. the hake) are shared by the fishing fleets of the coastal countries and the trawl fishery is targeted to a species pool (multispecies fishery).

Finally, despite the availability of a large amount of bibliographic references on “Adriatic” fishery biology (Vrgoc *et al.*, in prep.), this document represents one of the few papers which refers to long time series (Jukic *et al.*, 2001; Ungaro *et al.*, in press b) which are rarely available for Mediterranean fisheries.

Table 3. Summary of results. Parameter values from Surplus Production Models for European hake (*Merluccius merluccius*).

Equilibrium condition	Fmsy	MSY	r	K	B_0	q	a (intercept)	b (slope)
Schaefer model	43	95,6	***	***	***	***	4,36	-0,0499
Fox model	67	95,2	***	***	***	***	1,36	-0,0149

Non equilibrium condition	Fmsy	MSY	r	K	B_0	q	a (intercept)	b (slope)
Schaefer model								
without constrains	68	95,4	0,26	1477	3601	0,0019	***	***
superimposed B_0=K	39	64,3	0,10	2556	2556	0,0013	***	***

OBSERVED DATA				PREDICTED DATA					
Year	Total catch (tons)	Effort (n° of fishing vessels)	C.P.U.E. (tons/vessel)	Biomass (tons)		Current depletion (B / K)		C.P.U.E. (tons/vessel)	
				without constraints	B_0 = K	without constraints	B_0 = K	without constraints	B_0 = K
1960	142,9	16	8,93	3601	2556	2,44	1,00	7,01	3,26
1961	146,3	18	8,127	2095	2413	1,42	0,94	4,08	3,07
1962	44,63	18	2,479	1718	2280	1,16	0,89	3,34	2,90
1963	53,32	17	3,136	1600	2260	1,08	0,88	3,11	2,88
1964	70,79	17	4,164	1511	2233	1,02	0,87	2,94	2,84
1965	45,24	18	2,513	1431	2191	0,97	0,86	2,79	2,79
1966	48,84	18	2,713	1398	2177	0,95	0,85	2,72	2,77
1967	50,8	18	2,822	1369	2161	0,93	0,85	2,66	2,75
1968	62,4	18	3,466	1345	2144	0,91	0,84	2,62	2,73
1969	49,3	18	2,738	1314	2116	0,89	0,83	2,56	2,70
1970	49,8	19	2,621	1303	2103	0,88	0,82	2,54	2,68
1971	31,6	20	1,58	1294	2091	0,88	0,82	2,52	2,66
1972	33,4	20	1,67	1305	2098	0,88	0,82	2,54	2,67
1973	40,7	21	1,938	1311	2102	0,89	0,82	2,55	2,68
1974	57,11	23	2,483	1309	2099	0,89	0,82	2,55	2,67
1975	61,5	25	2,46	1292	2080	0,87	0,81	2,51	2,65
1976	48,11	27	1,781	1273	2057	0,86	0,80	2,48	2,62
1977	66,7	28	2,382	1271	2050	0,86	0,80	2,47	2,61
1978	57,7	28	2,06	1251	2024	0,85	0,79	2,43	2,58
1979	59,6	36	1,655	1244	2008	0,84	0,79	2,42	2,56
1980	105,3	36	2,925	1236	1992	0,84	0,78	2,41	2,54
1981	66,1	44	1,406	1184	1931	0,80	0,76	2,30	2,46
1982	153,6	47	3,339	1180	1912	0,80	0,75	2,30	2,44
1983	72,1	45	1,602	1089	1807	0,74	0,71	2,12	2,30
1984	65,5	45	1,455	1092	1788	0,74	0,70	2,12	2,28
1985	83,4	44	1,895	1102	1777	0,75	0,70	2,14	2,26
1986	85,4	44	1,94	1092	1748	0,74	0,68	2,12	2,23
1987	94,1	44	2,138	1082	1718	0,73	0,67	2,10	2,19
1988	67,3	44	1,529	1064	1681	0,72	0,66	2,07	2,14
1989	109,2	42	2,6	1075	1671	0,73	0,65	2,09	2,13
1990	231,2	42	5,504	1043	1620	0,71	0,63	2,03	2,06
1991	21,3	27	0,788	893	1449	0,60	0,57	1,74	1,85
1992	213,5	28	7,625	964	1491	0,65	0,58	1,88	1,90

Table 4. Summary of results. Parameter values from Surplus Production Models for red mullet (*Mullus barbatus*).

Equilibrium condition	Fmsy	MSY	r	K	B_0	q	a (intercept)	b (slope)
Schaefer model	54	87,2	***	***	***	***	3,25	-0,0302
Fox model	112	114,3	***	***	***	***	1,017	-0,0089

Non equilibrium condition	Fmsy	MSY	r	K	B_0	q	a (intercept)	b (slope)
Schaefer model								
scenario a	11728	6223	2,30	10811,0	-713,5	0,0001	***	***
scenario b	-1	58	0,09	2556,0	2556,0	-0,0489	***	***
superimposed B_0=K	2070	2458	1,97	5000,0	5000,0	0,0005	***	***

OBSERVED DATA				PREDICTED DATA								
Year	Total catch (tons)	Effort (n° of fishing vessels)	C.P.U.E. (tons/vessel)	Biomass (tons)			Current depletion (B / K)			C.P.U.E. (tons/vessel)		
				scenario a	scenario b	B_0 = K	scenario a	scenario b	B_0 = K	scenario a	scenario b	B_0 = K
1960	4,8	16	0,3	-713,46	2556	5000	-0,0660	1,00	1,00	-0,07	-124,86	2,37
1961	20,37	18	1,13	0,001	2551	4995	0,0000	1,00	1,00	0,00	-124,62	2,37
1962	39,88	18	2,21	0,001	2531	4984	0,0000	0,99	1,00	0,00	-123,65	2,37
1963	75,75	17	4,45	0,001	2494	4975	0,0000	0,98	1,00	0,00	-121,81	2,36
1964	64,08	17	3,76	0,001	2423	4948	0,0000	0,95	0,99	0,00	-118,38	2,35
1965	39,9	18	2,21	0,001	2371	4985	0,0000	0,93	1,00	0,00	-115,80	2,37
1966	42,6	18	2,36	0,001	2346	4974	0,0000	0,92	0,99	0,00	-114,61	2,36
1967	45,7	18	2,53	0,001	2321	4982	0,0000	0,91	1,00	0,00	-113,37	2,37
1968	58,1	18	3,22	0,001	2294	4972	0,0000	0,90	0,99	0,00	-112,08	2,36
1969	51,2	18	2,84	0,001	2257	4969	0,0000	0,88	0,99	0,00	-110,28	2,36
1970	51,4	19	2,7	0,001	2230	4978	0,0000	0,87	1,00	0,00	-108,93	2,36
1971	67,5	20	3,37	0,001	2204	4969	0,0000	0,86	0,99	0,00	-107,68	2,36
1972	70,8	20	3,54	0,001	2164	4962	0,0000	0,85	0,99	0,00	-105,71	2,36
1973	79,9	21	3,88	0,001	2123	4966	0,0000	0,83	0,99	0,00	-103,71	2,36
1974	73,92	23	3,21	0,001	2076	4953	0,0000	0,81	0,99	0,00	-101,39	2,35
1975	92,15	25	3,68	0,001	2037	4971	0,0000	0,80	0,99	0,00	-99,50	2,36
1976	68,9	27	2,55	0,001	1982	4936	0,0000	0,78	0,99	0,00	-96,82	2,34
1977	56,13	28	2	0,001	1953	4991	0,0000	0,76	1,00	0,00	-95,41	2,37
1978	51,9	28	1,85	0,001	1938	4952	0,0000	0,76	0,99	0,00	-94,69	2,35
1979	48,8	36	1,35	0,001	1929	4993	0,0000	0,75	1,00	0,00	-94,22	2,37
1980	90,8	36	2,52	0,001	1923	4957	0,0000	0,75	0,99	0,00	-93,92	2,35
1981	102,9	44	2,33	0,001	1875	4950	0,0000	0,73	0,99	0,00	-91,58	2,35
1982	107	47	2,27	0,001	1817	4945	0,0000	0,71	0,99	0,00	-88,75	2,35
1983	136,1	45	3,02	0,001	1757	4945	0,0000	0,69	0,99	0,00	-85,83	2,35
1984	64,1	45	1,42	0,001	1670	4916	0,0000	0,65	0,98	0,00	-81,60	2,33
1985	53,7	44	1,22	0,001	1658	5015	0,0000	0,65	1,00	0,00	-81,01	2,38
1986	72,2	44	1,64	0,001	1657	4932	0,0000	0,65	0,99	0,00	-80,95	2,34
1987	57,3	44	1,3	0,001	1637	4992	0,0000	0,64	1,00	0,00	-79,99	2,37
1988	73,6	44	1,67	0,001	1633	4951	0,0000	0,64	0,99	0,00	-79,78	2,35
1989	130,1	42	3,09	0,001	1613	4973	0,0000	0,63	0,99	0,00	-78,78	2,36
1990	69,1	42	1,64	0,001	1536	4896	0,0000	0,60	0,98	0,00	-75,04	2,33
1991	30,9	27	1,14	0,001	1522	5027	0,0000	0,60	1,01	0,00	-74,36	2,39
1992	52,1	28	1,86	0,001	1547	4942	0,0000	0,61	0,99	0,00	-75,56	2,35

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