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State of the Fisheries Along the Turkish Mediterranean Coast

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Abstract: Historical fisheries data on Turkish Mediterranean Waters for the past 50 years are reviewed. Characteristics of the fishing ground, fishing fleet, and fish stocks are described and from the relationship between fishing power of the fishing fleet, and total amount of fish landed, maximum sustainable yield (MSY) has been estimated. On the basis of trawlable fish data, it is found that maximum yield (only for trawl fishery) to be obtained from the Turkish Mediterranean Waters should not exceed 7.700 tons, and the fishing power in terms of total HP must be about 20.000 HP to obtain the MSY value provided by the analysis. Regarding the ongoing fishery regulations, suggestions are given for better management tactics which could improve the present day situation.

Key Words: Maximum Sustainable Yield (MSY), Turkish Mediterranean Waters, Fishery management.

Türkiye'nin Akdeniz Sahillerindeki Balıkçılığının Durumu

Özet: Geçmiş elli yılın Türkiye Akdeniz sularına ait balıkçılık verileri değerlendirilmiştir. Balıkçılık alanları, avcılık filosu ve balık stoklarının özellikleri tanımlanıp, av filosunun av gücü ile kıyıya çıkarılan toplam av miktarı arasındaki ilişkiden En Yüksek Kalıcı Ürün (MSY) miktarı tahmin edilmiştir. Trol ile avlanan balık verileri Türkiye Akdeniz sularından avlanması gereken en yüksek ürünün (yanlız trol avcılığı için) 7 700 tonu aşmaması gerektiği ve bu miktarı verecek av gücünün de HP cinsinden 20 000 HP olması gerektiği bulunmuştur. Mevcut avcılık yönetimi dikkate alınarak bugünkü durumun geliştirilmesine yönelik düzenleyici önlemler tavsiye edilmiştir.

Anahtar Kelimeler: En Yüksek Kalıcı Ürün (MSY)- Türkiye Akdeniz suları, Düzenleyici önlemler.

Introduction

The richness of the fishing grounds along the Northeastern Mediterranean Sea (especially Mersin and Iskenderun bays), relative to the Mediterranean standard, was discovered during the 1940's. Kosswig ranked the Gulf of Iskenderun, which is located at the eastern-most part of the Turkish Mediterranean coast, to be within the most productive fishing resources of the Mediterranean Sea in the early 1950's (1). In 1953, the first scientific approach to fisheries was carried out by Numann (2), and this was followed by Aasen and Akyüz (3) and Akyüz (4). More recently, Bingel has studied various aspects of the fish stocks and fishing fleet (5-8), and has repeatedly stated that stocks are being overexploited by the fishing fleet. Finally, Gucu (9) developed a multispecies model for the fish stocks of Mersin Bay, and depicted interspecies connections via prey-predator interactions and species-fishery relations.

The aim of the present study is to briefly describe major characteristics of the fishing grounds, fishing fleet, fish stocks, and evaluate the state of trawlable fish biomass. The study is mainly concentrated around the trawl fisheries in the Iskenderun and Mersin bays because due to topography of the fishing grounds and due to the structure of fish fauna, trawling is the most effective fishing method and Mersin and Iskenderun bays have the most suitable trawling grounds along the Turkish Mediterranean coast today, as well as in the past.

Characteristics of the fishery

The local continental shelf in these areas, over which nearly all fishing activity occurs, is relatively wide and its margins are bordered by relatively shallow water (40-100m on average) as compared to the other parts of the Eastern Mediterranean. Therefore, trawling is the most effective fishing gear for the area. The best trawling grounds are located in the Iskenderun, Mersin and partly in Antalya bays. Due to the topography of the region, fishing grounds are located between 10 to 150 meters. There are also suitable trawling grounds beyond the shelf area located

off the Bay of Mersin (10) which have been lightly exploited so far, although they are within reach of the fishing fleet (Figure 1).

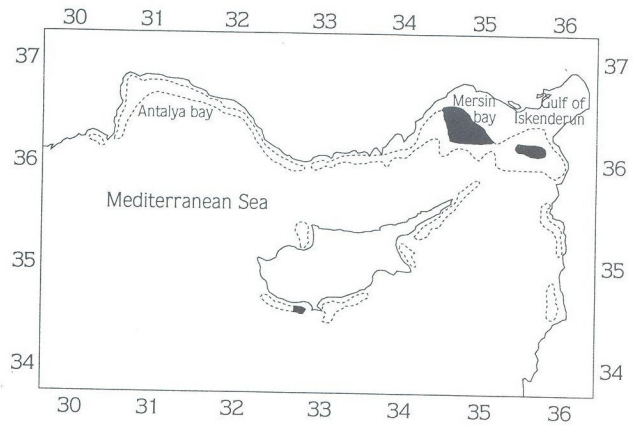

Figure 1. Suitable Deep Sea Trawling Grounds Between 100-500 Meter Depth in the Eastern Mediterranean (Circled by Dots) and the Surveyed Areas (Black Patches) by Israeli Scientists (Redrawn From (10)).

Today, fishing activity along the Eastern Mediterranean coast of Turkey may be considered to be "coastal" and "artisanal", meaning that fishing boats operate within the coastal shallow zone not exceeding the continental shelf, and all operations are small-scale (11).

There are 194 registered trawlers and 17 purse seiners in operation between Antalya and Iskenderun (12). Furthermore, according to the local authorities, there are more than 2.500 small boats, either registered or not-registered, which contribute to the local fishing activity.

The trawlers typical to the region are wooden hull vessels with length ranging between 10-20 m and engine power of 80-200 HP (12). Recently some steel trawl boats, mostly built in the Black Sea area, have also been introduced to the fleet. However, it should be noted that the fishing fleet of the region also contains steel hull trawlers and especially purse seiners with a LOA of 20 m and more; this can hardly be considered small-scale with respect to their wooden hull counterparts.

In a broad sense, there are two types of trawl nets in use: bottom trawls and shrimp trawls. There are also a few individual attempts to use midwater trawls, but this has not yet gained wide application. The shrimp trawl net is relatively smaller than the ordinary bottom trawl net, and is designed to solely catch shrimps and prawns; however, it can catch a considerable amount of demersal fish, including juveniles and other bottom-dwelling marine organisms, as well.

The contribution of purse seiners to the fisheries of the Northeastern Mediterranean Sea increases every fishing season. Before 1982, there were practically no purse seiners operating in Mersin Bay (7). However today, in addition to some native purse seiners, many others have immigrated from the Black Sea after a sudden decline in the anchovy catch. The main catch of purse seiners includes sardines, mackerels, grey mullet, and other inshore pelagic fishes.

Small wooden boats with 4-10 m length are used for beach seining, long lining, and fishing with trammel and gill nets. Some of the members of this category do not have an engine, while others have only small-sized, diesel inboard engines.

Fishing Power and Yield

Turkish fishermen have begun to exploit the stocks in the Gulf of Iskenderun and Mersin Bay since Turkey gained sovereignty of the Iskenderun Province. In 1940, there were only two trawlers operating in the region (3); the total number of trawlers and engine power of the boats increased to fourteen in 1952 (Tablo 1). After this rapid increase in the fishing effort during the early fifties, it was feared that the

Table 1. Fish Landing and Fishing Effort (Total HP) in the Gulf of Iskenderun During the Period Between 1940-1954 (Compiled From (3))

Years	Catch (Tons)	Effort (HP)	# of Trawlers
1940	66.661	120	2
1941	28.660	155	3
1942	70.406	180	3
1943	40.407	180	3
1944	60.447	180	3
1945	48.228	180	3
1946	120.122	265	4
1947	207.746	370	5
1948	219.664	515	7
1949	401.873	570	6
1950	685.635	640	7
1951	532.663	1.154	13
1952	498.771	1.304	14
1953	582.520	1.184	12
1954	432.927	955	11

stocks of the region had been overfished (3, 4). Since these first concerns, the number of boats has continued increasing dramatically, and Bingel (5) reported nearly 60 trawlers in the Iskenderun Bay for the 1980 fishing season. Today, nearly 200 registered trawlers operate in the Turkish Mediterranean Waters (Table 2) causing heavy fishing pressure on the fish stocks in question.

Parallel to the increasing effort, catch values have also increased since 1968 with annual fluctuations (Table 2). These fluctuations were extremely high between 1968 and 1970. If the trends within these periods are examined more precisely, increment rate of effort has not resulted in an equal increment rate for catch values, or in other words, catch was not proportional to the effort spent, but much less instead. This is more clear from the slopes of the trends; rate of increase is 747 per year for effort, while it is only 307 per year for catch, nearly half the rate of effort (Table 3).

Table 2. Catch and Effort Data For Turkish Mediterranean Fishery (Compiled From (12))

Years	Catch (Tons)	Effort (HP)	# of Trawlers
1968	3.519	5.595	-
1969	2.669	6.800	-
1970	1.746	3.390	-
1971	1.283	4.420	-
1972	1.301	3.880	-
1973	1.311	5.805	-
1974	2.218	6.385	-
1975	2.206	5.315	-
1976	2.338	6.120	-
1977	2.605	6.640	-
1978	5.611	9.655	-
1979	3.840	9.190	-
1980	5.064	11.550	-
1981	6.596	7.990	-
1982	6.503	11.950	-
1983	6.904	10.035	-
1984	5.633	9.140	55
1985	5.276	13.140	71
1986	7.170	13.660	63
1987	5.295	12.020	94
1988	5.714	23.355	86
1989	9.531	17.320	161
1990	8.814	25.030	104
1991	7.760	21.425	194

Table 3. Results of Trend Analysis of Total Catch, Fishing Effort and CPUE

Type	Period	Rate of increase per year
Catch	1968-1991	307
Effort	1968-1991	747
CPUE	1971-1981	+0.037
CPUE	1981-1991	-0.038

CPUE (Catch per unit effort) shows a similar tendency. If extreme fluctuations in 1968-1970 are excluded, before 1981 there was an increasing trend; then this reversed and has shown a negative trend since after 1981 (Figure 2).

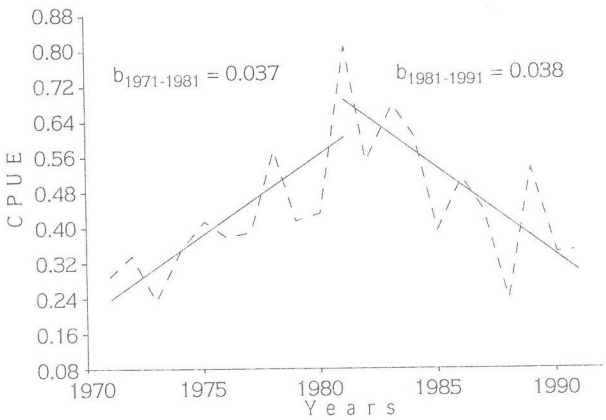

Figure 2. Historical Variations of CPUE (Catch Per Unit Effort) and the Trends For 1971-1981 and 1981-1991 Periods.

Over-all Schaefer Surplus Production Model (MSY)

Maximum sustainable yield (MSY) indicates the steady highest yield which can be obtained in the long term without any further meager years due to overfishing (13). The estimation of the optimum level of effort which produces the maximum sustainable yield (MSY) is one of the main objectives of fishery sciences. There are several approaches for the estimation of optimum effort level; however, the method used in this work utilizes the surplus production model of Schaefer (14). This method assumes a parabolic function between catch and fishing effort; hence a parabolic curve fitted to catch vs. fishing effort data provides an estimate of maximum value of yield, which

sustains severe fluctuations, and of fishing effort value corresponding to the MSY to be obtained.

The surplus production model was originally derived for the stocks containing only single fish species. The simplest way of extending this model to the multispecies situation is to consider the equation as decribing the changes in the total biomass of all species combined. This form of the method, so called "over-all Schaefer model", has been applied to various groups of stocks, and the results show that the model fits the combined data better than it fits the various individual components of the stocks. A summary of the reasons is given by FAO (15; page 17) as follows:

" (a) Total biomass does react in a simpler way to overall fishing effort than does the biomass of individual stocks, i. e., the production model gives a more realistic description of total biomass than it does of the biomass of individual species.

(b) The better fit results simply from the averaging process.

(c) The overall biomass/overall effort fit is an artifact of the method of fitting in the time series of species exploitation. For example, exploitation starting on lower density high value species with low mortality and then moving on to the high density low value high mortality species.

(d) Because the shifts in the preference of the commercial fisheries between species are not taken account of in the statistics of nominal effort, the available effort data give a more accurate index of mortality exerted on the total biomass than they do of the mortality on any individual species."

It is important to note that (disregarding whether the above statements are true or false), as it has been repeatedly shown, the total biomass models do provide reliable information on the behavior of a fish stock (16-19). On that premise, it is decided that treating the multispecies complex as a whole would give a preliminary evaluation for the state of the stocks.

Data used in the MSY analysis were obtained from Fishery Statistics published by the State Institute of Statistics (12). These data are only available since 1968 before which fishery production was complied by the Ministry of Commerce.

Inspection on fishery statistics revealed that effort criterion are not sufficiently detailed to arrive at a meaningful result concerning the state of fishing power along the Eastern Mediterranean coast. One of the major discrepancies encountered in the statistics is that there had been no meaningful classification for fishing vessels until 1984 (Table 2). The data published since 1984 are obviously not sufficient to evaluate the state of fishery. Therefore, instead of separate effort criteria for trawlers, total effort of the fishing fleet was used assuming that the trend in the total fishing effort is parallel to that of trawl fishery. Again assuming that the fishing capacity of a vessel is in a linear relation with its engine power (HP), total HP of the fishing fleet was calculated by simply summing up the individual HP of each boat, and this was used as the total fishing effort of the Mediterranean coast of Turkey.

As it has been stressed above, fish stocks are exploited in different ways. Moreover, catches from lagoons (such as grey Mullet), where the fishing operations are restricted by engineless boats, are included in the statistics; however, fishing effort spent for that kind of fishery is not comparable to the effort spent for trawl fishery. To combine them might lead to an erroneous conclusion since effort spent by trawlers on demersal stocks would not be comparable to that spent for pelagics by purse seiners or of lagoon fishery. Therefore, separation of the trawl catch which comprises the main portion of the total landing is necessary, and in the analysis, only the total of catch values of the demersal fish listed below are taken into account.

Another deficiency in the rearrangement of fishery statistics for MSY analysis is that the amount of total trawl catch cannot be separated directly from the published data. Therefore, depending on the information taken from local fish markets and personal observations during research surverys, it was assumed that the trawl net is most effective for the following species: *Mullus barbatus, Pagellus erythrinus, Saurida undosquamis, Boops boops, Spicara flexuosa, Upeneus moluccensis, Trigla lucerna, Diplodus annularis, Merluccius merluccius, Solea vulgaris, Epinephelus guaza, and Penaeus* spp. The fishes listed above, in fact, comprise more than 50% of all fishes landed on the Mediterranean coast of Turkey.

It has also been realized that neither catch data nor other criterion for the 1968-1977 period are complete nor are they comparable with the rest of the data. As an example, the reported fish landing and also the fishing effort for 1968-1969 were extremely high when compared with the values for subsequent years. Also, fishing effort (HP) increased nearly one-and-a-half times between 1977 and 1978. Actually,

this cannot possibly increase so rapidly within a year, and this might be due to the reforms carried out in the enumeration process by DIE. Nevertheless, the number of boats and their engine power seem to be comparable over the period since 1978 (Table 2). The incompatibility of the fisheries data of 1968-1977 to those of the rest is also apparent from Table 4, in which correlation coefficients for a given period and critical values for P=0.01 are given. Model outputs for different periods are given in Table 4 which shows a varying tendency between 1968-1977 which more or less stabilized after 1978 at about 20.000 HP of f_{opt} and 7.800 tons of MSY. Hence the model gives both statistically and logically meaningful estimates only after the 1978-1991 period.

The final results of the analysis are summarized in Table 5 and the MSY curve is presented in Figure 3. It is evident that the curve reaches the MSY at a level of about the total effort being used in 1987-1988. Although fishery statistics are not available for the last two years, it is clear that fishing effort is in an increasing trend and an additional increase in the present day fishing effort should be expected. This means that the stock of the Mediterranean coast of Turkey has already reached and even exceeded full exploitation level. Therefore, the effort should be controlled an even reduced to the level suggested by the MSY analysis as soon as possible. This may then lead to significant advantages from the economic standpoint, without a major drop in catch.

Table 4. Estimated (r_{obs}) and Critical Values ($r_{0.01}$) of Correlation Coefficients for P=0.01 (d.f.=degrees of Freedom: **=P<0.01; ns= not significant) f_{opt} and MSY in HP

Years	d.f.	$r_{0.02}$	r_{obs}	f_{opt}	MSY
1968-1991	23	0.505	0.133**	76912	18754
1970-1991	22	0.515	0.107**	22640	94996
1971-1991	21	0.526	0.084**	115947	27190
1972-1991	20	0.537	0.154**	66554	16544
1973-1991	19	0.549	0.224**	47214	12437
1974-1991	18	0.561	0.355**	34136	9845
1975-1991	17	0.575	0.433**	29475	9008
1976-1991	16	0.590	0.500**	25904	8391
1977-1991	15	0.606	0.600**	22560	7913
1978-1991	14	0.623	0.714 ns	19950	7658
1979-1991	13	0.641	0.705 ns	19945	7659
1980-1991	12	0.661	0.781 ns	18745	7700
1981-1991	11	0.684	0.820 ns	18375	7835
1982-1991	10	0.708	0.804 ns	20248	7814
1983-1991	9	0.735	0.796 ns	20249	7814
1984-1991	8	0.765	0.801 ns	22125	7810
1985-1991	7	0.798	0.805 ns	24795	7995

Table 5. Results of MSY Analysis Deployed For the Years 1978-1991 (12).

a	=	0.7678
b	=	-1.9243e-5
r	=	-0.714
MSY	=	7 658 tons
f_{opt}	=	19 950 HP

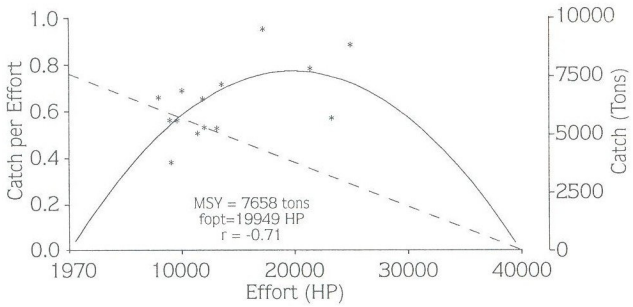

Figure 3. Yield Curve (Solid Line), CPUE (Dashed Line) and Maximum Sustainable Yield Estimates.

Implications for management

Fish stocks of the Northeastern Mediterranean, like other stocks in the other coasts of Turkey, have not been regulated on a scientific basis, as already underlined in the sixth Development Plan of the Turkish Government (20). Immediate managing applications are outdated and not relevant to the present state of the fishery, and urgent renewal of the management policy is required. The main reason is the lack of basic work in periodical and continuous collection of the necessary biological and production statistics. Individual attempts are being made by several university groups; however, the proceedings are scarcely used for manaement purpose. The university sector is not considered in fishery policy making.

What are the stock regulation strategies applied for the region? Basically, there are three different regulation strategies applied by the Ministry of Agriculture and Rural Affairs. Those are fishing season limitation, mesh size limitation and minimum size limitation. In a general sense, trawling is not allowed within the 3-mile zone from the coast line, but this restriction is

legally disregarded by the fishermen. Legally, because by law it is possible to use shrimp trawls within the coastal zone, which, in fact, are not different from bottom trawls.

There are many other restrictions for the fishing types and fishing equipment used which are not listed here.

The following suggestions can be made to control fishing effort by simply improving ongoing regulation measures.

1) License control: The Ministry should put a limitation on licensing newly constructed boats so that construction of new fishing boats, and hence the increase in the fishing effort, may be paused until a desired level is reached. Thereafter, introduction of new boats may be permitted under the control of the governmental institutions.

2) Fishing season: From the reasons discussed above, it is evident that the existing fishing effort on the stocks is too highly demanding and regulation is urgently needed. The introduction of new boats and a further increase of the fishing power may be stopped by license control, but reducing the effort to a desired level cannot be done by preventing the fishing activities of some fishing boats and allowing others to continue. The best solution could be by keeping the size of the fishing fleet as it is and reducing the duration of the fishing season. In this case, the purpose of a fishing season regulation would be not only to protect fish spawning, but also to limit the stress of fishery on the fish stocks.

3) Relaxation of the stocks: Periodically, different fishing grounds may be closed to all kinds of fishing activities for one or two years depending on the average maturity age of the species involved. In that way, if the stocks are depleted to a level of recruitment overfishing, by leaving them unfished, the yearly spawn may grow to adulthood, spawn, fertilize eggs, and eventually sustain the future of the stock during that prohibited fishing period.

Generally, the females of most fish species produce several thousand eggs. To a certain extent, this high fecundity has misled policy makers to assume that a very limited number of adult females is sufficient to replenish the number of recruits that eventually become available to the fishery. Opposed to this assumption, it was undoubtedly proven that there is a relationship between parent stock and recruitment (21), and the recruitment overfishing, where the parent stock is reduced to the extent that not enough young fish are produced to ensure that the stock will maintain itself; this is the most dangerous stage for the fate of a fish stock that can be reached by a fishery.

4) Mesh size and minimum size limitations: Fish assemblages of the region should be considered to be multispecies stocks, not only from faunal aspects but also from an economical point of view. There is no single mesh size which will simultaneously catch a desired fish size since species vary in length. Bingel (7) estimated the minimum allowable size of various species such as 12 cm for *Mullus barbatus*, 25 cm for *Saurida undosquamis*, 23 cm for *Solea vulgaris*, and 10 cm for *Upeneus moluccensis*. Similarly, Gucu and Bingel (22) studied *Mullus barbatus*, which is the most important commercial teleost fish for the trawl fishery, and recommended a 35 mm mesh size (mesh to mesh) for eumetric fishing. As an example to stress the contradiction in the mesh-size application, if 35 mm is applied to the other species simultaneously captured by the trawl net, according to the above given estimates, with a rough estimation, the stocks of *Solea vulgaris* will be grossly overfished and the stocks of *Upeneus moluccensis* will be slightly underfished. Thus, only one species can be fished eumetrically, but not all.

As a result, both size and mesh size regulations are not appropriate measures for the protection of the stocks. Ideally, quota application to all species, would be best which, nowadays is, beyond the capability of the Ministry of Agriculture and Rural Affairs due to many reasons. Among them, lack of proper information about the stocks, lack of monitoring surveys, diffused organization of the fishery such as dispersed landing ports, lack of control on landing ports, and many others can be listed.

5) New fishing grounds: The fishing fleet of the region focuses its activity on the continental shelf; however, as already stressed by Israeli scientists (10), one of the deep sea fishing grounds (between 100-500 m isobaths) for trawl fishery is concentrated between the North coast of Cyprus and the Southeast coast of Turkey (Figure 1). To direct a certain part of the fishing fleet to this quite virgin area under institutional guidance and governmental control would reduce the fishing pressure on the coastal area and increase the total landings from the region. Actually, nowadays, there is already such a tendency among the fishermen to fish the deeper part of the usual fishing grounds, especially during off seasons when fishing is totaly prohibited within the national waters. The crucial fear here is the invasion of the Black Sea fishing

fleet. Today, the Black Sea fishing fleet is over-capitalized and has reached a level that the Black Sea fish stocks can no longer carry. The Black Sea fishermen, therefore, are seeking new fish resources all over the Turkish coasts. Although most of them are purse seiners, some others are multipurpose boats (23). Even the exclusive purse seiners can be operated as trawlers with slight modifications (23). This is a widely used application in the Black Sea; while they catch anchovy and other pelagics in the first half of the fishing season (October-February), they switch to the trawl mode and catch demersals during the rest of the season. Consequently, if these new fishing grounds call the attention of the Black sea fishing fleet, fishing pressure on the stocks may increase suddenly by their intrusion. Similarly, when local fishermen discover relatively rich resources along the deep sea fishing grounds, the investment to the fishery will automatically increase, as in the Black Sea anchovy case, and in turn, fishing effort, which is already higher than it should be for an eumetric fishery, will grow accordingly.

There is nearly no specific fishery for the cephalopods. They are caught as by-products in the coastal waters (24). However, there is some evidence of a remarkable cephalopod population in the offshore regions (25, 26), more likely within the upwelling zone of the Rhodes gyre. Therefore, cephalopod stocks of the productive areas may be an alternative to deep sea trawling grounds for enlarging the fishing grounds.

6) Grid-based management system: Most of the measures given above necessitate a grid-based management system in which the Turkish coast is divided into grids systematically and the measures are set grid-wise and applied individually. To prevent the intrusion from different regions, together with license control, a region based fishing allowance should be set, or rather, each boat should be licensed to fish only within a certain region, not all. Namely, a boat licensed to the Black Sea should not be allowed to fish in the Mediterranean. By this way, controlling the fishing power on a region will be easier, and equally, license control will be enhanced in effect by preventing an unexpected invasion of alien boats to a region.

Conclusion

The stocks of the Turkish Mediterranean Waters have apparently reached full exploitation and the total amount of fishery from these stocks should not be greatly increased. While this conclusion should promote caution in plans to further develop the Turkish Mediterranean fishery, much more information about the stocks and the fishing is required in order to realize the actual position. It must be emphasized here that the MSY values obtained in this study can only be used as a relative indicator of the exploitation level. Estimation of the absolute value of MSY can only be possible if the amount of ablosute landing due to trawl fishery is available.

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