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LIVING MARINE RESOURCES OF THE WESTERN MEDITERRANEAN (Statistical divisions 37.1.1-Balearic and 37.1.2-Gulf of Lions)

STOCK ASSESSMENT AND SCIENTIFIC RECOMMENDATIONS FOR MANAGEMENT

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1. INTRODUCTION

The traditional description of Mediterranean fisheries as artisanal with a great variety of species and the conspicuous absence of the large monospecific stocks found in other parts of the world requires some additional detail.

Concerning CATCH COMPOSITION, and despite the inherent complexity of multi-species landings in Mediterranean ports, there is an identifiable series of target species which, in biomass or in economic terms, constitute the basis of production. These are sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicholus*) among the small pelagics; hake (*Merluccius merluccius*), red mullets (*Mullus spp.*), blue whiting (*Micromesistius poutasou*), anglerfishes (*Lophius spp.*), *Pagellus spp*., *Octopus spp*., squid (*Loligo spp*.), and red shrimp (*Aristeus antennatus*) among the demersals; and, prominent among the large pelagics, bluefin tuna (*Thunnus thynnus*) and swordfish (*Xiphias gladius*) with other species of local interest in specific sites (Stamatopoulos 1993; STCF 1991; Oliver 1991; FAO 1993). These species represent 70-80 percent of all landings, at least eight of them over 2

percent of the total catch, and two over 15 percent. This situation is not unlike that of European Atlantic fisheries, for example, and of some other areas as well, where the validity of stock assessments for fisheries management is fully accepted.

Concerning FLEETS, except for a very few concrete and recent examples of specific industrial fleets fishing large pelagics, most Mediterranean fleets are artisanal. "Artisanal" is used to describe low-capital ventures where the fisherman is often the owner of the vessel, a contrast to industrial fisheries involving major investments by companies or financial groups. Artisanal fisheries are also linked to the notion of "coastal fisheriesn, by which is meant fleets operating near their home port and employing large numbers of people for short fishing trips over the shelf which can be reached in a few hours. Mediterranean fishing gears are also enormously diversified, with many fleets based all along the coast in a great many ports. Trawlers and purse seiners are clearly more relevant given the volume and value of their catches.

These characteristics of Mediterranean fishing fleets, though undeniably distinguishing features, fail to justify the view that Mediterranean fisheries are unapproachable for stock assessment and problematic in terms of effective management.

ADDITIONAL ASPECTS are needed to round out this brief description of Mediterranean fisheries.

First of all, fisheries administrators (and it is they who are supposed to be responsible for fisheries management) sometimes fail to set clear MANAGEMENT OBJECTIVES with clear priorities (e.g. increasing the extracted biomass, maintaining specific fish sizes in the market, increasing the economic value of catches, maintaining or raising employment levels, etc.), which makes it very hard for fisheries scientists and technicians to formulate scientific management criteria.

Fishery scientists and technical advisers have interpreted this lack in various ways, and priority has been given by omission to resource protection. This choice on the part of the technical people is unlikely to coincide with the priorities of either administrators or the fisheries sector itself. The result is "artificial" fisheries regulations and scant compliance and enforcement.

This clearly points to the urgent need for clearly formulated and specific management objectives and the involvement of the fisheries sector. At the same time, the assessment criteria prepared by the technical people must match management objectives and the sector must respect the fishing regulations produced by this joint effort.

Also, whereas stock assessment has until now relied almost exclusively on species biology and the population dynamics of fished resources, there is an increasingly clear and imperious need to evolve towards a consideration of FISHING as: "A social practice which generates an economic process in which people (with all the

implicit social and economic complexities) prey upon (exploit) a self-renewable natural resource evolving in an unstable environment" or, put in a more "ecological" and less "bio-economical" way, fishing is: "The interaction of two behaviours: the biological behaviour of the system exploited (recourse/catch within the environmental context) and the socio- economic behaviour of the exploiter (predator)".

Until now, stock assessment has disregarded the socio-economic and even the technical aspects of fishing, as well as the influence of environmental and climate change on the resource, and the prevailing inter-specific relations within the system exploited, even though all evidence points to the need to observe the system as a unit.

The conclusion of this general "analysis" is that we need to insist on the near or total incapacity of current stock assessments and management systems to avert resource depletion.

This is not meant to imply a total failure of stock assessment as a base for fisheries management, but rather the need to recognize, as does the International Commission for the Exploration of the Sea (ICES) in a recent report, that hitherto underestimated external factors do alter: "both the perception and the evaluation of the real situation of resources and of their ability to sustain stable exploitation, as well as the efficiency of current management models".

The implicit need is for intensified research on the ecosystems that support exploited stocks, and for more integrated studies of the system, incorporating socio-economic considerations. More effective research designed to also evaluate the implications of the application of regulatory measures is needed.

This would imply a tighter collaboration between fisheries biologists, oceanographers and marine biologists and the economic and social scientists, based on management objectives clearly defined by fisheries administrators.

The point of the foregoing would be to embody the concept of "responsible fishing" defined more than one year ago at the Cancun and Rio de Janeiro meetings and the "Code of Conduct" proposed by the 102nd Session of the Council of FAO in Rome in November 1992, the purpose of responsible fishing being to achieve "sustainable yields" based on rational fishing and the conservation of fishery resources.

2. FISHERIES RESEARCH IN THE MEDITERRANEAN

Fishing in the Mediterranean dates back to antiquity, as does the interest of Mediterranean peoples in methodical and systematic knowledge about the sector (Margalef, 1989).

A clearly documented and early precursor of fisheries research in the Mediterranean is found in Aristotle's studies of tuna migration (384-322 BC), although this branch of modern marine science really dates from the close of the 18th century (Farrugio et al, 1993).

The first descriptive studies of fisheries, fleets, fishing methods and fish biology in the Mediterranean appear in the 19th century (Farrugio et al, 1993). Typically, these studies reflect neither the modern pressure on stock assessment in response to resource depletion nor the demand for immediate results, which, in the 20th century, would galvanize fisheries research in general and stock assessment in particular. This lack of pressure on the part of the fisheries administrators explains why the species which captured the attention of the Mediterranean scientists of that time were not necessarily the most important ones from a fisheries standpoint.

In this connection, Umberto D'Ancona's observations on Mediterranean fisheries and variations in fish populations as a result of changing fishing patterns after World War I allowed Lotka and Volterra to establish the mathematical foundations of population dynamics in the 1920s (Margalef, 1974).

The application of POPULATION DYNAMICS to exploited stocks developed in the temperate waters of the North Atlantic in the modelling of industrial fisheries with a single gear on a single species. The scarcity of monospecies industrial fisheries in the Mediterranean has hindered the use of population dynamics as a tool. The first applications of population dynamics in the Mediterranean date from the 1970s, and are in very limited use even today. These concerned north-western Mediterranean fisheries, the sub-sector which has seen the greatest application of population dynamics to exploited stocks.

These early applications, promoted by the scientific working groups of the General Fisheries Council for the Mediterranean (GFCM) were GLOBAL MODELS, also called production models (GFCM, 1972; Pereiro and Fernandez, 1974). These models result, in principle, not very useful for the analysis of Mediterranean fisheries given their severe theoretical restrictions, nonetheless they clearly showed the state of full or overexploitation of demersal stocks.

The models have a sort of "black box" vision of the fisheries in which only one data entry, the fishing effort and only one data output, the catch, are observable. Moreover, they require long data series and a calibrated measure of the fishing effort, which must present a certain range of variation to facilitate the analysis of catch variation. This being so, and given the characteristics of Mediterranean fisheries and the available data bases, production models are considered to have limited applicability for evaluation in this case.

The impossibility of distributing the effort among the different species to which the model - is simultaneously applied is an additional problem. To solve it, there have been various attempts to apply the so-called "composite production models"

(GFCM, 1972; GFCM, 1979; Garcia, 1983; Caddy and Garcia, 1984; Chavance and Girardin, 1985; GFCM, 1988).

In the late 1980s and early 1990s, the limitations of production models induced a group of north-western Mediterranean fisheries scientists to adapt VIRTUAL POPULATION ANALYSIS (VPA) techniques to Mediterranean fisheries.

The LENGTH COHORT ANALYSIS (LCA) is a simplification of the Virtual Population Analysis (VPA) which assumes that the stock is in a state of equilibrium, is currently the most widely used method in the western Mediterranean. It requires knowledge of catch distribution by size classes and by gear and some estimation of the biological parameters of the species, and currently represents a clear line of progress for population dynamics in the Mediterranean.

Lastly, we shall cite the YIELD PER RECRUIT (Y/R) ANALYSIS used on various occasions in the western Mediterranean throughout the 1980s. It utilizes simple estimates of the dynamic and biological parameters (Oliver, 1983). It can also use the more solid estimates of fishing mortality provided by VPAs and LCAs, together with length/weight and length/age relationships, estimating the yield (in biomass) of each recruit brought into the fishery for different vectors of mortality. Y/R curves can thus be built by varying effort (fishing mortality) or gear selectivity (length at first capture), providing an enormously useful overview of the state of the stock.

The application of these techniques to the Mediterranean has been limited. The development of a programme package based on LCA and Y/R analysis adapted to Mediterranean fisheries (Lleonart and Salat, 1992) and designed to analyse the enormously important competitive gear situation in the Mediterranean has facilitated research on the population dynamics of many western Mediterranean stocks (Lleonart, 1993; Farrugio et al, 1994). The sampling effort of the 1980s has also enabled conventional VPAs to be applied to some stocks (Oliver, 1993; Aldebert et al, 1994).

These analyses are highly sensitive to the estimates and biological parameters used. The uncertainty about the Von Bertalanfy Growth Function parameters, and particularly natural mortality (Caddy, 1991), hinders correct stock assessment.

Special efforts have therefore been made to improve the accuracy of these estimates (Lleonart, 1993; Farrugio et al, 1994; Djabali et al 1993).

The above methods analyse stocks alone, ignoring INTERSPECIES RELATIONSHIPS and the ENVIRONMENT, even though the need for analytical systems to describe these interactions is increasingly evident. Such systems would introduce new data into the findings of monospecies analyses, which ignore the limits imposed by the carrying capacity of the system. Likewise, the existence of marked fluctuations in captures apparently independent of exploitation (Astudillo and Caddy, 1988; Oliver, 1993), and which point to the concept of recruitment

windows (Pauly, 1987), further complicate the situation, stressing the need to observe marine systems as a whole and pointing up the limitations of "conventional" population dynamics. Meanwhile, some scientists, critical of these indirect evaluation methods (based on fishing data) are opting for the application in the Mediterranean of DIRECT METHODS of evaluation such as biomass hydro-acoustical surveys, abundance indexes for demersal populations from swept-area surveys and ichthyoplankton surveys applying the Daily Egg Production Method to evaluate the Spawning Stock Biomass of fish stocks (GFCM 1982; Oliver and Pastor 1986; Charance and Girardin, 1986; Lazar et al., 1986; Miquel and Alvarez 1990; Miquel et al. 1991; Abad et al 1991; Abad et al 1992; Rubin et al 1992; Garcia 1992; Palomera and Pertierra 1993; Campillo et al. 1989, Gil de Sola 1990).

While it may be difficult to understand resource behaviour prior to exploitation, using monospecific methods and ignoring the environmental factors, it is equally difficult to comprehend the fishery system as a whole if we leave out the SOCIO-ECONOMIC factors of exploitation. This is why we are trying to progress towards an overview of the "MEDITERRANEAN FISHERIES SYSTEM" and its web of relationships.

On the other hand, substantial progress in resource evaluation and analysis is in direct proportion to the current extent of INTERNATIONAL COOPERATION. Recent research efforts by the European Union (EU) in the western Mediterranean have supplemented earlier GFCM research, fostering the creation of fisheries research networks. These researchers plan to pursue activities under the International Commission for the Scientific Exploration of the Mediterranean (CIESM), with the collaboration of the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM), to facilitate the incorporation of researchers from countries other than the European Union and to take up the analysis of fishery science problems in the Mediterranean without the pressure inherent in stock assessment.

The “GFCM expressed its support for this initiative at the Council's meeting held in Malta in July 1993. This initiative would allow the GFCM Technical Consultations and Working Groups access to the earlier work necessary for more efficient stock assessment”.

Mention should also be made of the collaboration begun in Bari in June 1992 between GFCM and the International Commission for the Conservation of Atlantic Tuna ICCAT), which should improve knowledge and evaluation of stocks of large pelagic fishes in the Mediterranean. GFCM is thus becoming involved in the issue of managing these stocks which, lying as they do outside the jurisdiction of the coastal States and with ICCAT's priority to Atlantic problems, had received little attention.

Thus began a new coordination between various efforts by organizations with clear and complementary spheres of interest and action, paving the way for concrete and truly efficient management action by GFCM in the Mediterranean.

3. WESTERN MEDITERRANEAN FISHERIES

Mediterranean fisheries, particularly western Mediterranean fisheries, are influenced by the sea's oft-described oceanographic characteristics (e.g. Margalef, 1989), summarily: a semi-enclosed sea, poor in living resources with a narrow continental shelf.

Consulting the scientific literature for a more concrete view of the physical oceanography of the western Mediterranean (e.g. Le Vourch et al, 1992) we see how different areas can be marked off in terms of their oceanographic features.

The Sea of Alboran with its strong Atlantic influence, the Algerian coast, the Gulf of Lions and the central area known as the Balearic Sea are clearly marked zones. They correspond to the GFCM statistical divisions established in 1980: 37.1.1.5/7, 37.1.1.8, 37.1.2 and 37.1.1.112131416 (Figure 1).

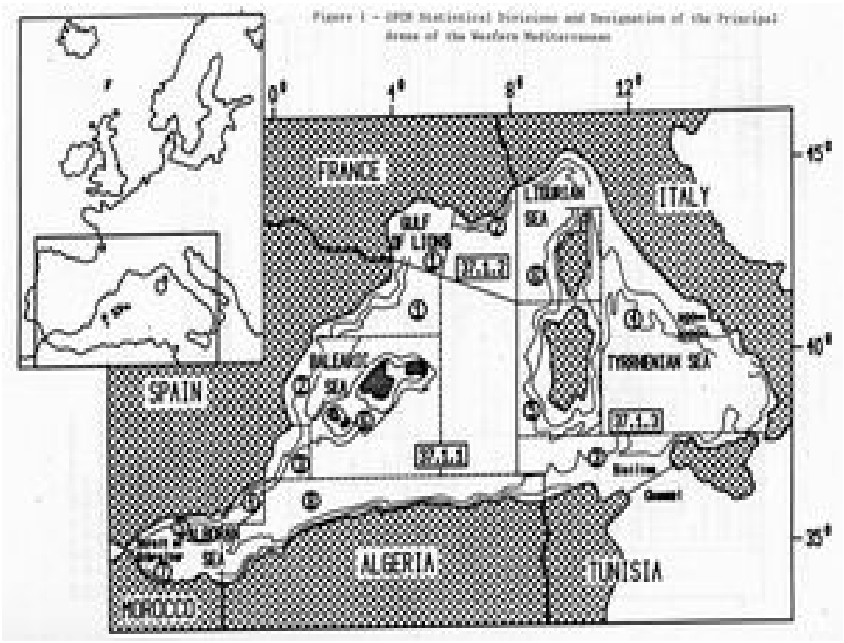

Figure 1. GFCM statistical divisions and designation of the principal areas of the western Mediterranean.

In each of these areas, the fisheries can be typified in accordance with the classic division of MARINE SYSTEMS into demersal, coastal pelagic and ocean pelagic (a fourth lagoon system should also be considered). Each of these systems has clearly definable groups of species which are the target of exploitation as defined in the introductory chapter.

As to the existing information on the delimitation of STOCK UNITS, what data there are do confirm a strong influence of Atlantic spawning grounds on the populations of the Sea of Alboran (Rubin et al, 1992) and the genetic delimitation of these stocks compared to those further north (Suau 1959; Larrañeta 1968; Alemany and Alvarez 1993; Vila et al 1990; Pla et al., 1991; Pla 1994).

Lastly, we shall consider the different fishing GEAR used in the western Mediterranean, again using the conventional classifications of: trawl, purse seine,

small-scale gear (gillnets, bottom lines, etc.) and gears for large pelagics (long lines, tuna seines and drift nets), each specialized in the exploitation of different species or groups of species.

This will allow a quantitative classification of the different western Mediterranean fisheries, not forgetting that these fisheries may overlap at certain times and places, a perfect example of which is hake in the Gulf of Lions, where different gears are working in sequence on successive size groups of the hake population (Figure 2).

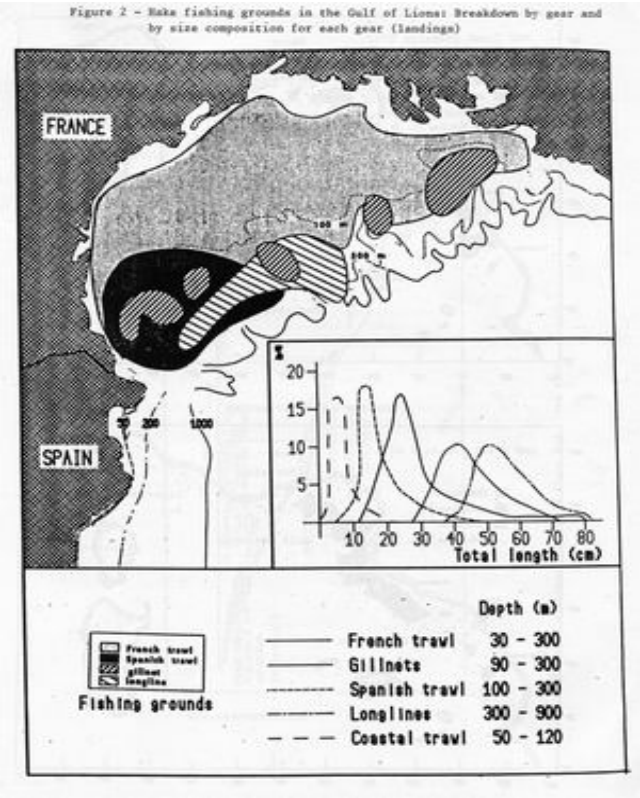

Figure 2. Hake fishing grounds in the Gulf of Lions: breakdown by gear and by size composition for each gear (landings).

For the sole purpose of providing an overview of western Mediterranean fisheries, Table 1 includes an approximate quantification of fleets by areas and countries with reference to average characteristics and to the volume of pelagic and demersal catches landed by each. Capture does not include the substantial bivalve catch by dredges in some areas. For example, in the north Alboran Sea, a fleet of some 260 units (2-5 GRT and 15-50 kw of landing power) landed 3 500 MT in 1987, primarily *Acanthocardia tuberculata*, plus *Callista chione* and *Venerupis rhomboides*, although in 1990 the catch, basically *Callista chione* (Baro et al, 1992), dropped to 975 MT.

TABLE 1. Fishing fleets operating in the western Mediterranean, their characteristics, landings and (indicative) numbers

FLEETS	TOTAL		1 088			7 773			1 986		
	Algeria		540		180	716	(80)	80	305		300
	Alboran Sea	Mor.	122	55		(6) 1 900			(5) 40	47	
		Spa.	159	20	123	(1) (1 021)	7	30	183	35	135
	Spain		290	30	180	2 480	5	5	1 049	50	280
	Gulf of Lions	Spa.	(14)			(9) 16			13		
		Fra.	(3) 45+	21		(2) 2 146	3.6	32	177		340
	Characteristics		n	GRT	KW	n	GRT	KW	n	GRT	KW
Fishing Gear			Purse seine			Small gears			Trawl		
			Pelagics (13)			Demersals					
CATCHES	Gulf of Lions	Fra.	(4) 30 000			9 300			9 900		
		Spa.	(10) 3 000			1 200			1 100		
	Spain North		45 000			46 500			23 000		
	Alboran Sea	Spa.	(12) 3 000			3 000			5 000		
		Mor.	(7) 27 000			5 000			6 000		
	Algeria		70 000 (11)			10 000			5 000		
	TOTAL		178 000			75 000			50 000		

Table 1. Fishing fleets operating in the western Mediterranean, their characteristics, landings and (indicative) numbers.

4. DATABASE AND RESOURCE EVALUATION

Incontestably, the failure to develop marine population dynamics for exploited stock in the Mediterranean is mainly due to the lack of reliable fishery STATISTICS and DATABASES with at least minimal coverage.

More than 20 years ago, Gulland (1970) pointed out the priority need for better Mediterranean fishery statistics. There has been little progress to date, however, and only in very specific areas where research teams have concentrated on compiling a database for the evaluation of a specific stock. Sadly, when the project

in question terminates, the database runs into continuity problems, and is normally interrupted.

Aside from the GFCM statistical bulletins, which give us a time-series of the reported catches of the Mediterranean coastal countries since 1964, there is no sufficiently reliable Mediterranean database with sufficient coverage for stock assessment. However, quite independently of the reliability of the GFCM statistics, they have led to highly revealing analyses of trends in catches and landings (Caddy and Griffiths, 1991; Stamatopoulos, 1993).

The most ambitious exercise of this sort in the Mediterranean is the FARWEST database (Farrugio et al, 1992; Farrugio et al, 1994) on the French and Spanish demersal fisheries in the Mediterranean, and those of Italy in the Ligurian and upper Tyrrhenian. This database, designed to absorb catch information by port and by species including demographic structure, inventory and fleet activity, is combined with the VIT programme package (Lleonart and Salat, 1992) of fisheries analyses based on LCA and Y/R analyses. With this system, using FARWEST or data from other databases analysing multi-gear fisheries, not only future projections, but also YIR evaluations outside the situation of equilibrium can be made, once modifications in the existing exploitation pattern have been established.

POPDYN, another database currently in an advanced state of preparation by FAO, records data on biological parameters, population dynamics, and the characteristics of the exploitation they support, broken down by geographical area for stocks or populations of species of interest to fisheries.

A series of initiatives are also under way to introduce Geographical Information Systems (GIS) into fisheries research and stock assessment, but concrete results have not yet been reported.

As mentioned, up to the 1970s there were few if any fisheries analyses based on the specific methods of "exploited population dynamics, despite the very many studies then available on the biology of specific species of interest to fisheries. The findings of these studies were later recompiled (Dremiere, 1979; Oliver, 1983; Quesada, 1992; Campillo, 1992), which was very useful for current analyses. Some of these studies established quite detailed descriptions of the life cycle of commercial species (Suau and Vives, 1964), which were very helpful in designing technical measures for fisheries management (Figure 4).

In terms of the biological parameters, it is worth mentioning the earlier trend, based on very partial studies, whereby Mediterranean species were considered to have short life cycles, like those of dwarf species, compared to Atlantic populations of the same species. The intensification of such biological studies in the Mediterranean now shows that these differences owed more to methodological questions (basically sampling) than to actual species biology, considerably modifying our view of the dynamics of these populations. For western

Mediterranean hake, for example, Von Bertalanfy Growth Function parameters are now being assigned values of some 100 cm for Linfinite and from 1.5-2 for K (Aldebert and Recasens, 1994; Alemany et al, 1994), which would have seemed unacceptably high only a few years ago (Oliver et al, 1992). Like on sardine were values for K of 0.6-0.8 are being found (Alemany and Alvarez, 1993).

Works of this type, purely descriptive of the biology of the main species of interest to fisheries in the Gulf of Valencia, inspired the 1962 "Experimental Trawl Fisheries Plan for the Province of Castellon" (Suau 1964). The demersal populations exploited in this area began to exhibit overfishing in the early 1960s. This analysis, based on empirical observations, was similar to that attributed to resources in other areas of the Mediterranean at that time (Gulland, 1970). Suau (1964) estimated the fishing effort to be above optimum, and recommended its reduction, increasing cod-end mesh size to 40 mm, closing areas under 50 m to trawl fishing and banning the trawl fleet from April to June, which would allow the fishery to recover. The experimental plan developed between 1961 and 1965 produced the expected recovery of the fishery, but once it was over the controls disappeared, and with them, particularly the participation of the fishery sector in the experience: what progress had been achieved was soon dissipated. Despite this, the findings of the "Plan Castellon" served as the basis for the current regulation of the trawl fishery in Spain (Oliver, 1990) and were widely projected to other areas of the Mediterranean Sea via GFCM.

During the 1970s, as mentioned above, GFCM introduced the application of population dynamics in the Mediterranean. The application focused on production models using short and fairly unreliable data series, and on Y/R models using preliminary estimates of biological and dynamic parameters. These analyses, whose results were summarized by Oliver (1983), diagnosed over- exploitation of demersal resources and under-exploitation of coastal pelagic resources in the western Mediterranean.

Perhaps the fullest exercise on stock assessment during this period was carried out by the GFCM Ad Hoc Working Party on Western Mediterranean Stock Assessment, whose two meetings in 1986 in Rome and in 1987 in Sete used a global production model to assess the demersal resources of the Gulf of Lions, estimating the catch and effort of all fleets in the Gulf of Lions based in French and Spanish ports (GFCM, 1988). The Working Party recommended a reduction in the fishing effort, which was adopted by the GFCM Committee on Resource Management, but later given a negative vote by the Council due to the possible adverse socio-economic consequences inherent in a measure of this sort (GFCM, 1989).

Going on from the approaches in use up to the mid-eighties, we shall attempt to give some idea of current activities in western Mediterranean resource evaluation and what has been learned by summarizing the findings of the most recently reported analyses of western Mediterranean fisheries, focusing on the species of greatest interest.

SARDINE (*Sardina pilchardus*)

The purse seine fishery (and in some sectors the trawl fishery) for sardines caught some 124 453 MT in 1991 (Stamatopoulos, 1993), for an estimated value of 85 million ECU (STCF, 1991). The Spanish Institute of Oceanography (IEO) has been doing hydro-acoustical surveys since 1982 to evaluate coastal pelagics in the Spanish Mediterranean. Since 1990, the survey which covers Gibraltar to Marseilles (but only the northern half of the Sea of Alboran) is carried out every year at the same time, Oct-Nov. It is fully standardized, and has therefore produced a time-series of sardine abundances comparable over a four-year period. The results are as follows (Abad et al, 1991; Abad et al, 1992).

	1988	1989	1990	1991	1992	1993
BIOMASS	210(1)		240	252(2)	708	(3)
Catches (4)	56	59	53			
1 000 Mt						

1) Surveyed in May-June (Miquel and Alvarez, 90).
2) Underestimated, the Gulf of Lions partially covered.
3) Earlier trend continues maintaining the figures of 1992 (Abad, pers. com.).
4) FAO (1993).

These data indicate the lack of pressure on this stock, which is probably due to low market demand and an increase in the biomass. Lleonart (1990) analysed sardine fishing in Catalonia and Valencia (37.1.1.1+2). An LCA was applied to pseudo-cohorts in 1988 and 1989, and a Y/R as well, both of which indicated under-exploitation, although as anchovy was the target species the results are considered relative. Sardine is trawled as well as purse seined in this area, which means the smaller specimens are caught. Pertierra and Perrotta (1993) made a new evaluation applying the same method with data from 1988-1991, and their conclusions were: of a stable biomass, a situation of under-exploitation, and adequate gear selectivity.

The catch in the Sea of Alboran is mainly length classes 9-14 cm. An LCA puts average fishing mortality at 0.8-2.5 times above the estimated Fmax, and Y/R at a value 13 percent below MSY (STCF, 1991).

We are not aware of any evaluations for the southern part of the Sea of Alboran (Morocco) subsequent to an acoustical survey done nearly 20 years ago, which gave an estimated coastal biomass of 80 000 MT (Lamboeuf, 1974). Catches in the sector in 1991 were some 18 822 MT (FAO, 1993). Some acoustical surveys were done off the coasts of Algeria: R/V Fridjof Nansen of Norway in April 1981 gave an estimate of 326 000 MT of coastal pelagics, and R/V Thalassa, France, gave a July- August 1982 estimate of 191 000 MT, including 47 750 MT of sardine (Ferhaoui, 1986). The 1991 catch was about 52 464 MT (FAO, 1993), about 50% above the 1982 figure.

ANCHOVY (*Engraulis encrasicolus*)

Anchovy is caught by purse seiners, although with increasing competition from trawlers using below-regulation mesh sizes, giving them a competitive advantage. Catches in the Balearic and Gulf of Lions divisions in 1992 were about 31 572 MT (Stamatopoulos, 1993) valued at over 75 million ECU (STCF, 1991).

The IEO evaluation from Gibraltar to Marseille gave the following results for anchovy:

	1988	1989	1990	1991	1992	1993
BIOMASS	61(1)		42	32(2)	38	(3)
Catch(4)	26	37	34	29		
1 000 MT						

1) Evaluated in May-June (Miquel and Alvarez, 1990; Miquel et al, 1991)
2) Underestimated. Gulf of Lions not surveyed.
3) Confirmation of biomass decline observed since 1988
4) FAO (1993).

Lleonart (1990) evaluated anchovy stocks in the Gulf of Lions, Catalonia and Valencia applying an LCA to pseudo-cohorts in 1988 and 1989, using a length-age key obtained by age readings of otoliths. The analysis showed a trend towards over-exploitation. This agrees with the findings of the acoustical survey and is a logical consequence of exploitation patterns in recent years.

There has been a gradual intensification of exploitation and a spectacular increase in the catch since 1980. In the Gulf of Lions and northern part of Spain in 1980 the catch was under 300 MT compared to 600 MT in 1985, 3000 MT in 1986-87 and 8000 MT in 1989. It then fell to about 5000 MT in subsequent years, and to less than 2000 MT in 1993. In 1985 fleets moved in from the southern part of Spain where the anchovy catch had fallen off. In the Sea of Alboran, where catches of over 25000 MT were recorded in the early 1980s, the figure has dropped below 1000 MT (Giraldez and Abad, 1991). A transfer of effort from south to north was observed in spring and summer in the past years and, the fishing season was also extended from May-September to open season on a target population of 24 years (12.5-18 cm). The average 1988 catch size was 16 cm. In 1990 it was 10 cm, close to the first year size class of 10.5 cm and lower than the 11 cm length at first maturity. Effort was also increased in the Gulf of Lions as a number of Italian purse seiners joined the fishery, some 40 of them in 1991 (ten with Ligurian home ports, and mainly some 30 vessels with a GRT of 500-1 000 from the Neapolitan area. For all these reasons, a return to the fishing pattern prior to 1988 is recommended. This would imply a reduction of the fishing effort and, above all, a moratorium on fishing during the winter in hopes of seeing an anchovy recovery.

This being the situation, in 1992 the EU Fisheries Aquaculture Research (FAR) project began a survey of north-western Mediterranean anchovy with the participation of Italian, French and Spanish institutions (Garcia 1992). Spawning areas were located in 1992 with a ichthyoplancton survey running from the Gulf of Valencia to the Upper Tyrrhenian (Figure 3), with two direct surveys in 1993 to evaluate the stock and the spawning stock biomass (SSB) using two independent methods (biomass acoustical evaluation and Daily Egg Production).

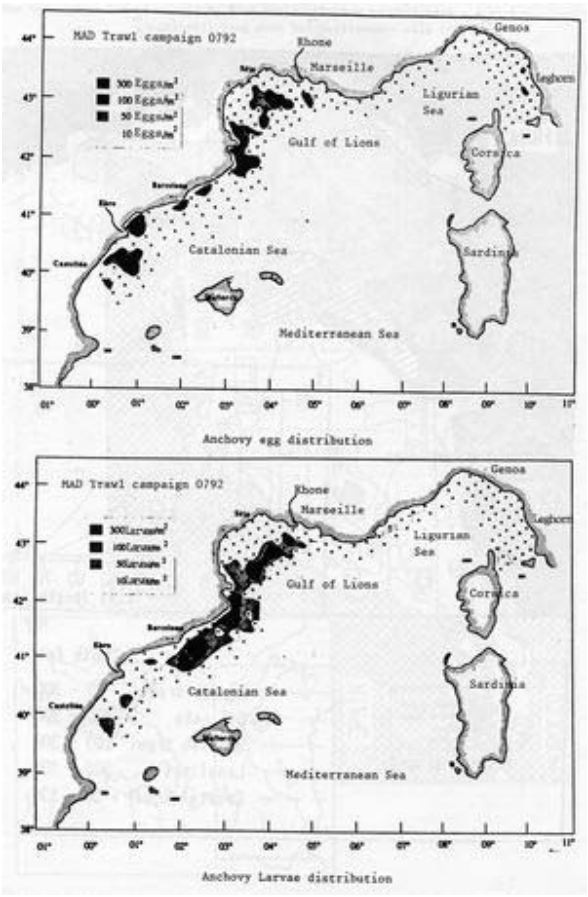

Figure 3. Anchovy spawning grounds in the North-western Mediterranean July 1992 (Garcia 1992).

Palomera and Pertierra (1993) applied the Daily Egg Production Method (DEPM) in the summer of 1990 to the anchovy stock in the southern part of the Catalonian coast, obtaining a biomass estimation within the range of the results of the other evaluations based on hydro-acoustic surveys and LCAs.

The 1992 stock assessment over the Algerian shelf gave an anchovy biomass estimate of 95500 MT (Ferhaoui, 1986). This would imply under-exploitation and could be maintained if the catch were held to under 3000 MT (FAO, 1993). A direct anchovy survey project off the Algerian coast led by the “Institut des Sciences de la Mer et de l'Amenagement du Littoral” (ISMAL) with Algerian, Spanish and Italian participation and the support of the Inter-governmental Oceanographic Commission (IOC) is currently blocked for lack of financing.

RED MULLET (*Mullus barbatus* and *Mullus surmuletus*)

Red mullet, a platform trawl-fishery target species is also important in some small-scale fisheries such as trammel nets. We can take it as a key species of the species on which the current trawl-fishing regulations are based. Concentrations of recruits and juveniles appear in areas near the coast (less than 3 nautical miles off the coast or less than 50 metres deep). They have a low Linf and L at first maturity (Figure 4) compared to other groups of species, e.g. hake, whose concentrations of recruits are found in deeper areas (Figure 5).

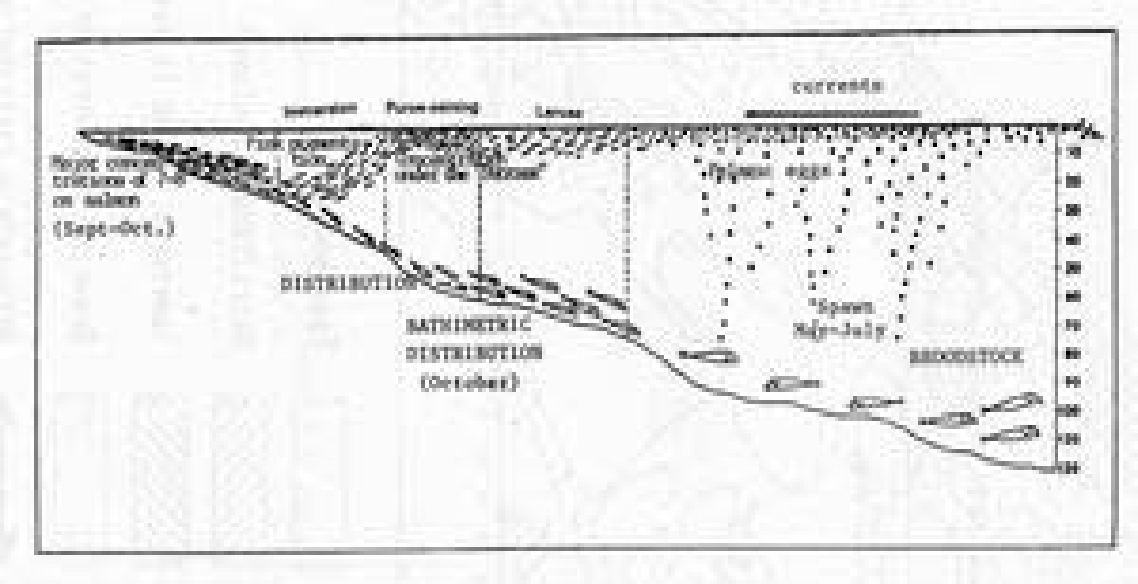

Figure 4. Red mullet life cycle (Suau and Vives 1964).

The catch for the two red mullet species *Mullus surmuletus* and *Mullus barbatus* in the Balearic and Gulf of Lions divisions was somewhere between two (probably not comparable) estimates of 4720 MT in 1989 (FAO 1993; STCF 1991) and 3546 MT in 1991 (Stamatopoulos 1993), a value somewhere between 29 and 22 million ECU (STCF 1991).

The biology (Morales-Nin 1991) and dynamics (Sanchez et al., 1983; Martín and Sanchez 1992; Oliver 1993) of this species in Catalonia and in the Balearic division are receiving some attention. In any case, overexploitation is clearly on the rise, necessitating a recommendation of reduction of effort and modification of the current pattern of exploitation.

SOLE, SEA BREAM AND SEA BASS (*Solea vulgaris, Sparus aurata* and *Dicentrarchus labrax*).

A Y/R analysis based on a LCA for a 1986-1992 data base was applied to three small-scale fisheries target species in the Gulf of Lions (Farrugio et al, 1994). The 1989 catches for the Gulf of Lions were 460, 190 and 731 MT and the values 5,2 and 10,5 million ECU (STCF, 1991). The three species, worked by trawl and artisanal gears in lagoons (trap nets and lines), and by bottom nets in coastal waters in the sea, appear to be heavily exploited. They have proved highly sensitive to simulations of redistribution of effort, which appear to indicate significant increase of yields and biomass in the medium and long term.

HAKE (*Merluccius merluccius*)

Hake is basically a target of the trawl fishery, although it is also caught with gill nets and long-lines (Figure 2) in the Gulf of Lions. Catches in the area in 1991 were 8405 MT (Stamatopoulos, 1993) for a possible value of 60 million ECU (STCF, 1991). Hake and anchovy are among the Mediterranean species now receiving the greatest attention from researchers, and work done in the last five years in the northwestern Mediterranean has produced a series of results.

First of all, the workshop on hake and sardine age readings organized by FAO and the IEO in Palma de Mallorca in 1989 (Oliver et al, 1991). Progress was made in estimating the growth parameters needed for the study of population dynamics. The growth parameters adopted for the Balearic and Gulf of Lions are: Linf.=94.7 and 100.7 cm and k=0.13 and 0.13, respectively (Farrugio et al, 1994). Some later analyses based on the monitoring of two annual cohorts are also estimating a more rapid growth (Linf. = 110 and k=0.2) (Alemany et al, 1994), which, if confirmed, would have major implications for our understanding of hake population dynamics.

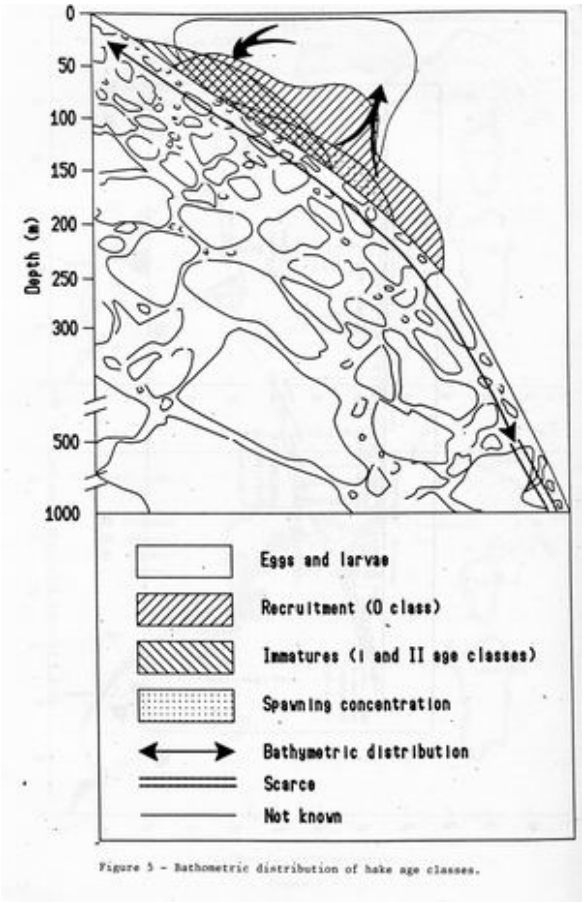

Figure 5 - Bathometric distribution of hake age classes.

Lleonart (1990) did a preliminary analysis of hake stocks in the Gulf of Lions based on the Spanish trawl and long-line catches. The European Union Scientific and Technical Committee for Fisheries (STCF 1991) did a similar analysis on the French trawl and gill-net fleets, and on the trawl fishery in Catalonia and Valencia. In all cases an LCA was applied, for the two gears in the Gulf of Lions, and a Y/R analysis, the result was a situation of overexploitation, with an effort double the MSY. In the Gulf of Lions, the analysis showed that trawling the smaller fish in the stock (Figure 5) had a much greater effect on long-line yields than the other way around. Simulations which increased the length at first capture to 18 cm showed that this would produce lower than current yields in the first years but long-term gains of some 50 percent.

These works have resulted in recommendations to freeze effort, apply the 40 mm mesh size regulation, and observe a minimum catch length of 18 cm. The European Union FAR programme for the evaluation of north-western Mediterranean fisheries later repeated the

analysis with data from both the French and Spanish fleets (Recasens, 1993; Aldebert et al, 1993), paying particular attention to gear interaction. Another analysis made on Balearic stocks (Catalonia, Valencia, and the Balearic Islands) (Recasens et al, 1994) produced very similar results, again clearly revealing an unsuitable pattern of exploitation and recommending the protection of recruits and the reduction of effort in order to improve both the state of stocks and yields. An example was given in the form of an estimate of possible trends in hake fishery yields in Catalonia over a 15-year period if the effort were reduced by 30 percent. This simulation, based on the above-mentioned Y/R analysis, is considered perfectly representative of the situation in other nearby areas (Figure 6).

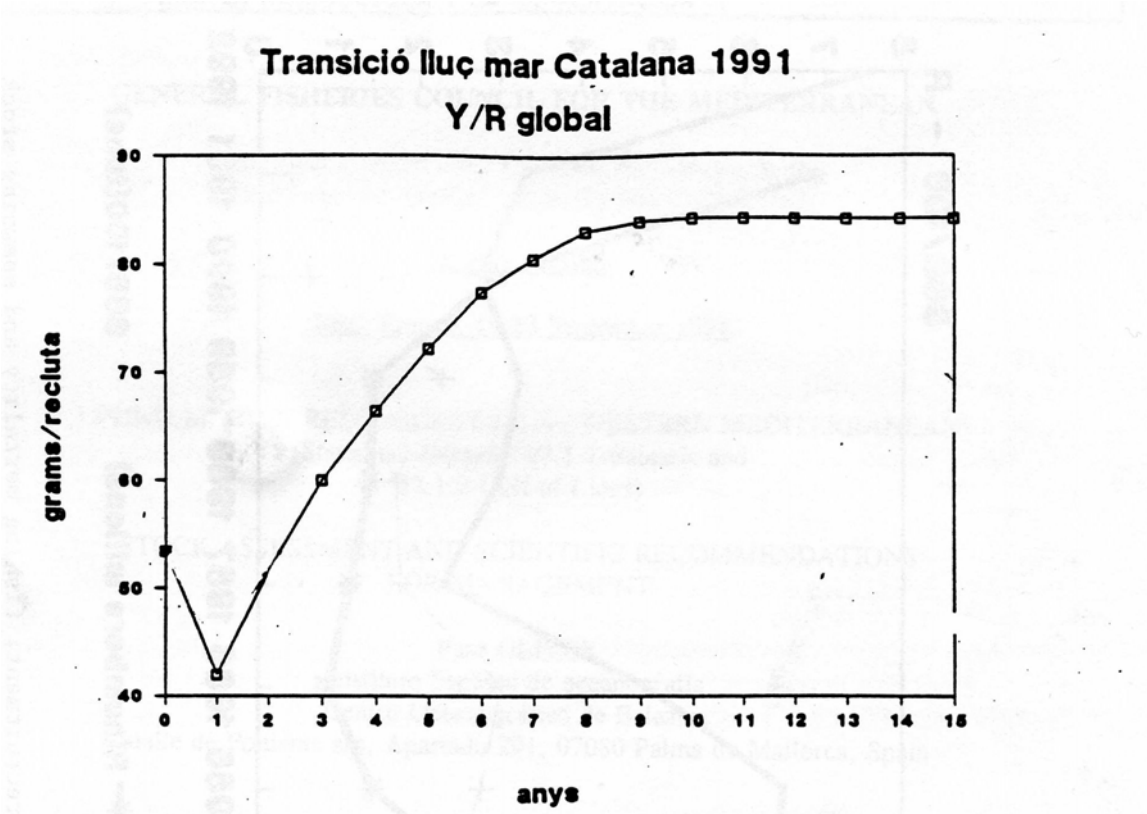

Figure 6 - Fifteen year simulation on the effect of a 30 percent reduction in the trawl fleet in terms of hake Y/R (Recasens 1993)

A VPA was applied to catch by age class for 1988-1991 (Aldebert and Recasens 1993) in the Gulf of Lions, and to a 13-year data series in the Balearic Islands (Oliver et al, 1994). The analysis shows fishery trends (yields and fishing mortality)

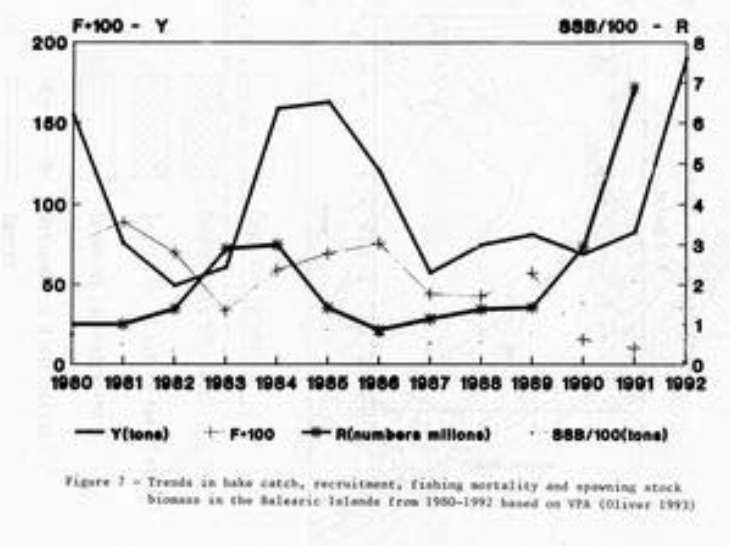

Figure 7 - Trends in hake catch, recruitment, fishing mortality and spawning stock biomass in the Balearic Islands from 1980-1992 based on VPA (Oliver 1993)

in terms of recruitment (Figure 7), trends undoubtedly similar to what must be happening in other stocks and areas of the western Mediterranean.

We have no reports on work done on hake stocks in the Sea of Alboran and the Algerian coast.

BLUE WHITING (*Micromesistius poutassou*)

It was fished by the shelf trawl fleet and accounted for a catch of 3818 MT (Stamatopoulos, 1993) and a value of over 7.3 million ECU (STCF 1991). This was evaluated in Catalonia and Valencia using an LCA-supported Y/R analysis with data for 1988 and 1989 (Lleonart 1990). The analysis revealed a situation at the boundary between under-exploitation and overexploitation with a possible 15 percent yield increase with a larger mesh size, provided the effort were held to current levels. It also showed that an increase in the fishing effort would not improve yields. We also have no reports on the hake situation in the southern part of statistical division 37.1.1.

RED SHRIMP (*Aristeus antennatus*)

Red shrimp is exploited by slope trawlers: the 1989 catch was 2 886 MT (FAO, 1993; STCF, 1991) for a value of some 60 million ECU (STCF, 1991). An evaluation made for Catalonia and Valencia (Lleonart 1990) applying an LCA-based Y/R analysis for 1988 and 1989 found a situation very close to MSY. The current exploitation pattern was found adequate; there should be no increase in effort. A later analysis included the Balearic fisheries and those between the Balearic Islands and mainland Spain, applying the same methodology for 1991 and 1992 (Demestre et al, 1994). This analysis confirms the results of the earlier study while stressing the influence of M values on the results and the rise in exploitation compared to 1988-89. Though red shrimp was widely exploited on the Algerian slope and in the Sea of Alboran, there were still no evaluations of southern stocks of this species.

NORWAY LOBSTER (*Nephrops norvegicus*)

This species, exploited by shelf trawlers and with a 1991 catch of 813 MT valued at over 18 million ECU (Stamatopoulos l983), was studied in a relatively small fishing grounds in Catalonia, but the results are probably representative of the general

situation of the stock in other areas of Catalonia, Valencia and even the Gulf of Lions, where the pattern of exploitation is very similar.

An LCA-supported Y/R analysis for 1991 combined with density estimates from swept-area surveys revealed no signs of overexploitation (Sarda and Lleonart 1993).

DEMERSALS

As the Mediterranean demersal fisheries are highly multi-specific, there have been some attempts to make global analyses in the Mediterranean covering all demersal stocks. In Algeria, a global production model was applied to demersals (Chavance and Girardin 1987). Overexploitation in the western part of the country was the finding, whereas the more productive area west of that, and less suitable for trawling, was underexploited. A comparable recent analysis made for the demersal fisheries of the Beni-Saf area (Djabali et al 1991) in the western part of the country showed overexploitation, and recommended a reduction of effort. The same work estimated exploitation rates from the demographic structure of the catch of the main fishery species: it produced fairly high estimates for this parameter (>0.5).

Another global production model applied to the demersal fishery was used in the Gulf of Lions in 1987. This evaluation by the GFCM Ad Hoc Working Party, using a data basis for French and Spanish fleets for 1959-1985, showed a situation slightly above MSY and recommended a 30 percent reduction of the effort to achieve substantial economic improvement with no major production losses (GFCM 1988).

As can be seen, increasingly complete and reliable evaluations are available, but the conclusions and recommendations are substantially the same as those put forth 20 years ago. Generally, DEMERSAL STOCKS are subjected to heavy exploitation on recruits and juveniles, mainly by trawler fleets, with an upward trend towards overexploitation everywhere. A series of measures to control (and often to reduce) fishing effort is therefore recommended, as are systems to control access to the resource, primarily to boost juvenile survival and protect brood-stock. Except for the experimental cases above, the degree of enforcement of such measures is quite tiny and so the situation is getting progressively worse as over-fishing spirals.

COASTAL PELAGICS

Coastal pelagic stocks vary greatly at different times and places as recruitment fluctuates for biotic or abiotic reasons. This makes it extremely difficult if not impossible to predict either the biomass or the recruitment of coastal pelagics. Information on the minimum level of spawning stock needed to ensure an acceptable level of recruitment and to avert the collapse of these stocks is currently the only data useful in assessing coastal pelagic resource management. The information can be obtained through surveys, independently of data from the fisheries. Sadly, safeguarding these minimum levels has not been possible to date,

and the result has been the crash of the anchovy fisheries in southern Spain and the alarming situation of anchovy in the Gulf of Lions.

LARGE PELAGICS

Concerning large pelagics, the first thing to note is the virtual absence of a database even minimally adapted to the stock assessment of large pelagics. The ICCAT recommendations, such as a minimum size of 6.4 kg for bluefin tuna, are not respected in the Mediterranean, and 50 percent or more of the bluefin catch is made up of undersized specimens. The same is true of the recommendation that fishing mortality be held at 1975 levels, a level exceeded in the case of bluefin tuna by nearly 50 percent. For swordfish, the second most important species, some 60-70 percent of the catch is reportedly under the minimum recommended 125 cm ICCAT size for North Atlantic swordfish, a good indication of severe fishing pressure and a need for conservation measures, although there is not really enough data for a proper evaluation.

To conclude this chapter, we wish to highlight the importance of ENVIRONMENTAL CHANGES due to both to climate and oceanographic factors and to pollution caused by excessive costal runoff of nutrients accompanied by toxic wastes (Caddy 1993). Some observers suggest the existence of a 10-12 year productivity cycle in the Mediterranean system and point out that there was a virtually universal increase in landings by the Mediterranean fishing fleet in the 1980s (Caddy and Griffiths 1990). This increase in catch could have been partly triggered by water enrichment from the discharge of land-based nutrients which raised biological and fishing productivity (FAO, 1992). However, we should not ignore the possible role of improved statistical coverage and greater fishing capacity in the higher catch levels reported in official statistics. In the western Mediterranean, the phenomenon is becoming increasingly clear in the area of influence of the Rhone delta. Research projects combining the joint efforts of fishery scientists, marine biologists and physical oceanographers are thus needed to evaluate the implications with respect to stock assessment.

5. MANAGEMENT OPTIONS

European Communities Council Regulation 3760/92 establishes in Title I (Rules of access to waters and resources) Article 4 that: "These measures shall be drawn in the light of the available biological, socio-economic and technical analyses."

Assuming this to be the correct stance, there is an obvious need for fisheries research and stock assessment on which to base scientific management criteria adapted to the demands of fishery administrators.

Despite this, the Common Fisheries Policy (CFP) done by the European Union (U.E.) rated as one of the most complete fisheries management experiments in recent years, has been rated by the E.U. itself a "failure@ in terms of resource conservation and management (CEC 1992). The conclusions of this report (among

which we stress the need to tailor fleet capacity to resource availability and to the search for better economic performance with less socio-economic disruption), can be considered perfectly valid for the situation of Mediterranean fisheries, however.

In any case, Mediterranean fisheries scientists are increasingly critical of quantitative assessments as the sole management tool, aware of their limited usefulness to managers, who would probably value a complementary qualitative understanding of the functions of the fishery system as more useful and less expensive.

FISHERIES REGULATIONS currently in force in the western Mediterranean apply to the 12 territorial miles of the coastal States and the fishing fleets belonging to these states. This implies that fleets from other countries harvesting outside the territorial limit, usually exploiting large pelagics, are either not subject to or do not respect any fishery regulations whatsoever. Concerning continental shelf stocks, particularly demersals, the General Fisheries Council of the Mediterranean (GFCM) has been calling attention since 1951 to the overexploitation of some resources considered to be of very limited potential, producing recommendations intended to improve the conservation and exploitation of these species. The need to establish mesh-size regulations for the trawl fishery, plus closed-to-trawling areas and closed seasons which will actually be enforced, has been insistently but unsuccessfully stressed for over 40 years (Caddy 1993). The need to reduce the coastal pelagic fishing effort continues to be, in GFCM and FAO's view, the top fisheries management priority. The reduction of effort, which should correct the situation of over-fishing, is a sine qua non for the successful introduction of other measures such as increasing the length at first capture or the protection of spawning stocks for better spawning recruitment prospects.

The current fisheries management situation in the western Mediterranean, apart from the gap concerning the zones outside the territorial waters of the coastal countries and their fleets, is basically fairly homogenous and generally dependent on the gear used: trawl, purse-seine or other. The various degrees of current enforcement and compliance for the different areas, gear and situations is another question.

The management of bottom trawling, which is the most intensive fishing method on demersal resources and the one with the most aggressive pattern of exploitation, would control the fishing effort through operational fleet censuses and the establishment of licensing systems (even reducing licences by limiting vessel characteristics and fishing time: i.e. about 500 kw maximum power, 12 fishing hours a day and five fishing days a week). At the same time, the improved exploitation pattern would lower the fishing pressure on the youngest age classes, prohibiting the use of small-sized meshes (i.e. stretched mesh less than 40 mm) and fleet activity near the coast (i.e. less than 50 m deep or three nautical miles from the coast). Reinforcement of these measures would include a ban on fish landings under the legal limit for the principal species (i.e. under 18-20 cm for hake and 11-12 cm for red mullet).

Coastal pelagics are basically exploited by purse-seines and pelagic trawls, the latter being unauthorized in some countries (Spain and Morocco). Purse-seining, involving resources which did not arouse concern until very recently has received less attention. The same is true for other gear, probably also because the fleets are highly diversified and difficult to monitor. In any case the regulatory measures have been quite similar to those for the trawl fishery (fleet censuses, licensing systems, vessel characteristics, gear size, mesh size, fishing times, closed areas and seasons, and minimum legal landing sizes).

Faced with this state of affairs, the European Union put forth a Proposal for a Council Regulation for Member States to harmonize certain technical measures in force in the Mediterranean. If approved, this regulation will be enforced in waters under the jurisdiction of the E.U. and its fleets harvesting in the Mediterranean. It is based on the premises we have just described, and its intent is to ensure the actual application of the proposed measures and to monitor their effectiveness. Aware of the importance of coordinating this action on the part of all coastal and some non-coastal states with major fishery interests in the Mediterranean, and as part of the approval process of this regulation, the European Union convened a seminar in May 1993 in Palma de Mallorca on the "analysis of the technical management measurements for shared stocks in the Mediterranean". Invitations to attend the seminar were extended to fisheries experts and administrators from 10 Mediterranean countries, including Morocco and Algeria, in addition to those from the European Union, as well as representatives from Japan, FAO and ICCAT. The proposed regulation was presented and analysed at this meeting (CEC 1993).

The Seminar took note of the common interest in the harmonization of fisheries management policies in the Mediterranean, calling attention to the twin problems that these policies cannot be implemented beyond the 12 miles of the territorial limit, and that there has been an increase in external fleets flying flags of convenience. There was agreement on the need for standardized rules on the measurement of vessels, fishing gears and catches landed, as well as standardized fishery statistics. A series of common management objectives were the Seminar's fundamental conc1usion:

1. Control of the fishing effort
2. Protection of the coastal zone
3. Protection of specimens of the youngest age classes based on:

    - Limitation or even prohibition of the use of gear harmful to
    - Juveniles and protection of spawning and recruitment areas.
    - Greater gear selectivity.
    - The establishment of legal minimum size limits.
    - The designation of areas closed to fishing.

Not to be ignored, however, is the scant level of compliance with fishery regulations in the Mediterranean an-d the general failure to comply with

management norms, which is to some extent a reflection of the lack of any real management will on the part of all sectors involved. This comment is justified by a wealth of examp1es, some of which have been cited in this paper. The impossibility of achieving a reduction of effort in the Gulf of Lions or of coming up with a successful GFCM recommendation requiring the enforcement of a minimum 40 mm mesh size for trawl nets; the fai1ure to respect ICCAT recommendations; the impossibility of effectively prohibiting the use of giant drift nets - these are all indications of the real situation of fisheries management in the Mediterranean.

A new attempt to stabilize and reduce fishing effort and to protect the coastal zone through technical measures to ensure the protection of juveniles is urgently needed. These measures must be truly applicable from a socio-economic standpoint; they must be based on stock assessments which take environmental factors into account; and they must be applied and their effectiveness monitored. Lastly, there is a need to stress the additional problem of the lack of jurisdiction of coastal countries beyond the 12 mile limit and the consequent lack of control over fleets fishing outside this limit, flying flags of convenience, and easily identifiable. In this context, GFCM would be the ideal basic international instrument to approach a solution to these problems in collaboration with the coastal and non-coastal countries involved in Mediterranean fisheries and the other relevant international organizations. The way ahead is clearly marked: how much progress can be made and how long it will take to achieve it is obviously very much a question of the will of all those involved.

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