FARWEST: An international research programme (1990-93) for the Northwestern Mediterranean demersal fisheries

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FARWEST : AN INTERNATIONAL RESEARCH PROGRAMME (1990-93) FOR THE NORTHWESTERN MEDITERRANEAN DEMERSAL FISHERIES

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INTRODUCTION

In the northwestern mediterranean countries, research works have been done at a national level during several years in the field of assessment and management of mediterranean resources. During the last decade it has be noted a general tendency to implement "analytical" methods of modelling of the exploited stocks, mainly cohort or virtual population analysis (VPA) and yield per recruit models. The techniques of computerized simulation of the fisheries'evolution under various hypothetical scenarii of exploitation also appeared recently in the Mediterranean area. These techniques can allow to cancel part of the handicaps linked so far to the multispecificity of the stocks and the interactions between fisheries and their use was recently recommended at a regional level (Griffiths, 1990).

Moreover, the mediterranean scientists have learned from the Atlantic experience that if some biological or exploitation parameters are often not precisely known, this should not be considered as an insuperable obstacle to assess a stock or to study a fishery. The sensitivity analysis techniques allow to study the impact of such uncertainties and their quantification, in order to evaluate the variance of the results. Also, the lack of long historical series of annual catches and length frequencies data should not be considered as a major problem for applying the analytical techniques and to reach to a fairly good idea of the mediterranean fisheries dynamics. These analyses can be runned starting from "pseudo-cohorts" which need only few - or at least only one - year of demographic sampling of the catches. Finally it appeared that it was possible to perform VPA on ages or length demographic structures of some mediterranean stocks exploited with several gears and to analyse the transition situations.

Some methodological works on mediterranean fisheries sampling strategies where also been done previously. The results of such works demonstrated that it was possible to obtain, via a sustained action in time, good data about the fishing activities in the western mediterranean.

This conceptual evolution have led in 1989 to the setting up of a multicountries project as an attempt to solve the question of the standardization of the data collecting and processing at a regional level. From 1990 to 1993, a European Community FAR research programme which partners where France, Spain and Italy gathered 35 scientists belonging to 8 different laboratories of the northwestern coast of the Mediterranean, from Gibraltar strait to the Tuscan archipelago (fig 1).

This 4 years programme (known under the code name "FARWEST" for FAR, WESTern *Mediterranean*) was aimed at the working out of a common methodology for the study of some of the most important topics in the French, Spanish and Italian demersal fisheries.The following works where achieved during the 4 years of the project:

- the setting up of a common data base on catches, efforts and biological information,
- the improvement of the knowledge of demographic and biological characteristics of some demersal and pelagic fish stocks of major economic value,
- a general reflexion about the methods and technics to be created and adapted for future common assessments and managements of the western mediterranean fisheries.

– *an improvement of the knowledge on biological parameters, fleets dynamics, fishing efforts and capacities,*

– *an approach of the modelling of some of the most characteristic problems regarding the demersal fisheries of the countries associated in the project,*

– *some preliminary predictive studies about the effects of changes in fishing patterns (assessment of stocks, sensitivity analysis, simulation of selectivity).*

– *an improvement of the knowledge about economical characteristics of the fisheries sector.*

SYNTHESIS OF THE WORKS

The objective of the present paper is to give a general overview of the analyses and results which details appear in the EEC reports on the Farwest programme (Farrugio *et al.*,1991,1994) and in various publications (see bibliography).

1. THE DATABASE AND ASSOCIATED PROCEDURES

The structures of the different computer files which constitute the common database have been defined in details and the processes for the preparation, codification and stocking of the information have been established and adopted previously. The final organigram includes two main kinds of files :

– reference files, that contain a common coded alphanumeric vocabulary for fleets, species, gears, sectors and fishing areas. These files can also control the realisation of the sorting, selection and aggregation procedures for data processing.

– Data files, that contain informations about landings, fishing efforts and biological samplings. Some of them are "exhaustive data files" aimed at the stocking of the global catches and fishing efforts, and of the aggregated regional demographic structures issued from the various sets of rough samplings of lenght–frequencies data. Another series of "sampling data files" are aimed at the stocking of non extrapolated field sampling data on the characteristics and equipments of the boats, catch samples or fishing effort samples.

The various files of the database are built in DBASE 3+ (an Ashton–Tate program) usable on IBM PC and compatible computers under the MS–DOS operating system. The organizational scheme of the interfacing between the various files of the base has been built using the fundamental concepts of the so–called relational–data–bases operating systems.

The project has used this tool as a basis for stocking and processing the information about biological and exploitation aspects.

The collection of biological data comes from sampling at landings and from purchased fish caught by the demersal western mediterranean fleets for hake (*Merluccius merluccius*), sole (*Solea vulgaris*), sea bass (*Dicentrarchus labrax*), gilthead sea bream (*Sparus auratus*) and "gamba" shrimp *Aristeus antennatus*. The sampling have been emphasized for hake, as it is one of the most important target species of the demersal fishery in the three partners countries.

The sampling operations directed at the biological and demographic studies have been done regularly from the begining of 1990 to the end of 1993. According to the seasons and the species, the biological monthly samplings took place in various landing places and fish auctions or on board commercial boats of the area studied. Some Italian frequencies distributions for the Tyrrhenian and Ligurian waters also come from several experimental trawl survey cruises at sea which where carried on in the framework of national programmes during the period of the FARWEST studies.

The data base has been also fed with several "extra" series (contemporaneous or not) of biometric measurements previously available in the various participant laboratories. In order to ensure the processing of data regarding fisheries dynamics, the data base has also been fed with historical and contemporaneous series of catches and efforts corresponding to the fleets exploiting the target species mentioned above.

The basic data can allow several types of stock assessments, essentially by using for example the VIT (LLEONART and SALAT, 1992) and ANACO (MESNIL, 1988) models for cohort and virtual populations analyses of exploited stocks, or the classical computer programs aimed at the fishing efforts standardization processings.

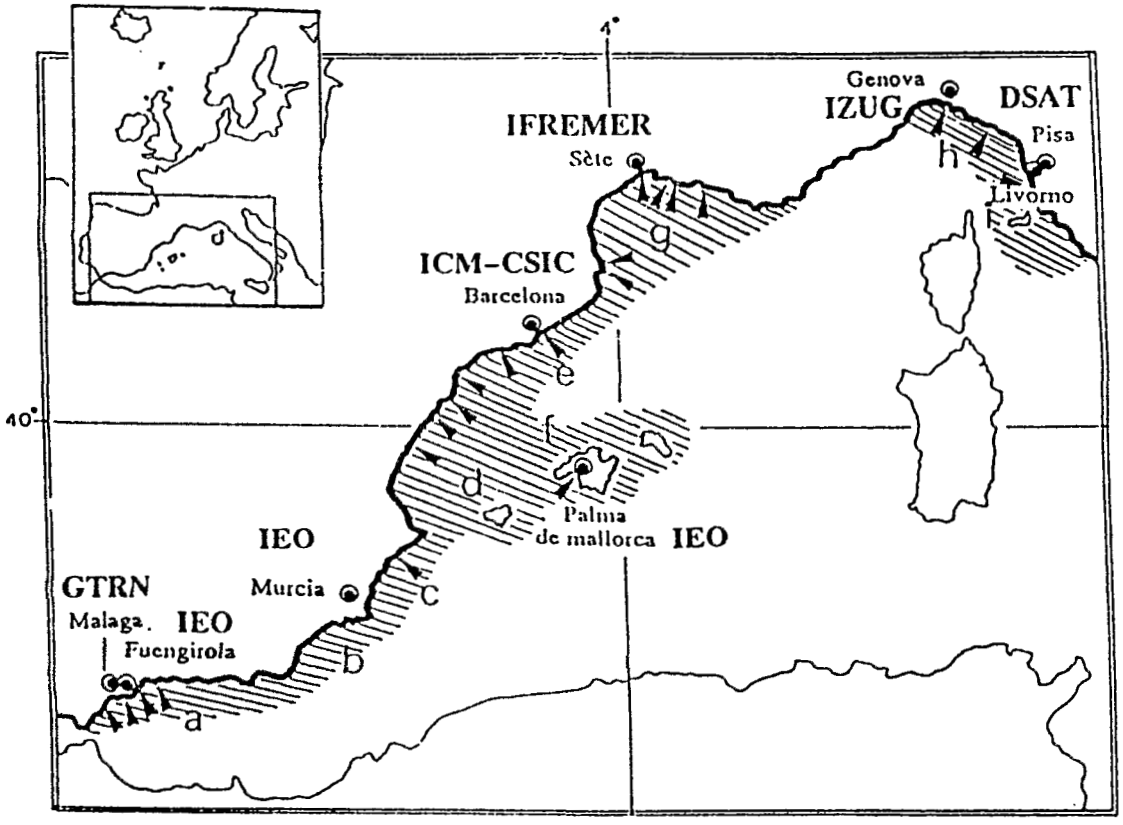


Fig. 1. FARWEST programme geographic coverage

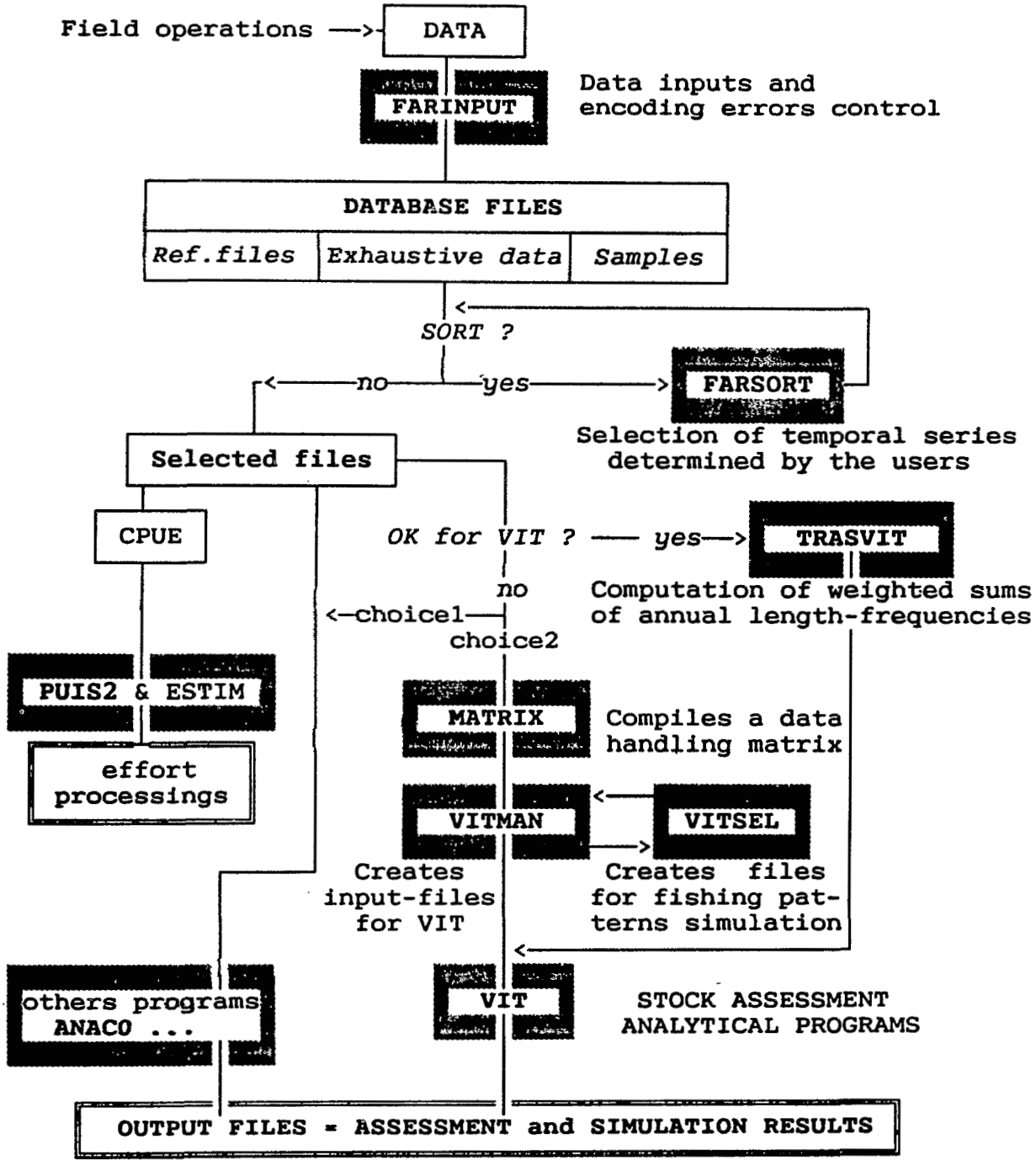
Distribution of the various fisheries studied.
Main sampling points
Partner laboratories:

DSAT: Dipartimento di Scienze dell'Ambiente e del Territorio dell'Università di Pisa
GTRN: Grupo de Trabajo de Recursos Naturales, Univ.Malaga
ICM-CSIC: Instituto de Ciencias del Mar
IEO: Instituto Espanol de Oceanografia
IFREMER: Institut Français de Recherche pour l'Exploitation de la Mer
IZUG: Istituto di Zoologia dell'Università di Genova

Areas cited in the text : a: Alboran sea b: gulf of Vera c: Alicante d: Valencia e: Cataluña f: Balearic sea g: gulf of Lions h: Ligurian sea i: Tyrrhenian sea.

Several computer programs have been set up, aimed firstly at the facilitation of stocking and sorting operations and secondly at the interfacing between the data base and the assessment modelling programs (mainly the VIT one).

The complete process, from basic data to assessment results can be schematized as shown in fig. 2 below :



2. DATA PROCESSINGS AND RESULTS

2.1 Growth of HAKE (*Merluccius merluccius*)

2.1.1. Materials and methods

It is well known that for eco-biological reasons the growth rates of the hake are very difficult to establish and age-reading of otoliths of this species (which are the only anatomic usable pieces) is far from easy. This situation raises an important problem when using population dynamics models like cohort analyses, because of their very high sensitivity to the values of the biological input parameters. A special working group was created within the FARWEST programme, the objective of which was to reach an agreement about a common methodology to use for growth data processing and for the evaluation of the growth curves to be used for our stock assessments. The work of this group has been centered on the application of the various existing computation models to the available sets of data and to compare the results, discuss them and adopt consensually the more plausible fittings. Two kinds of analyses have been done:

- comparison between the results obtained with several models for the same set of data (same area),
- comparison between the results obtained with the same model applied to different sets of data (various areas).

The data processings where based on length-fequencies distributions, splitted by sexes, sampled at landing or during experimental cruises. They consisted in the following operations:

- Splitting in normal curves of quarterly 2cm lenght histograms, after a smoothing on three consecutive classes, using the Bhattacharya method included in the routine MPA of the ELEPHAN computer program package (GAYANILO *et al.*, 1988). Evaluation of the growth parameters via the FISHPARM computer program (SAILA *et al.*, 1988), using as inputs these results (modal lenghts) associated to ages allowing to take into account two successive annual recruitments.

Computations have been performed on single cohorts, on the trimestral averages for 2 or more years and on the averages of the best quarter for 2 or more years.

- Assessment of the growth parameters for the same sets of data, but using the routine ELEPHAN 1 of the ELEFAN computer program package.
- MULTIFAN likehood-based method computer program (FOURNIER *et al.*, 1990) application trials on the 1991 data.
- FISPARM (SAILA *et al.*, 1988) computer program has also been used for the growth parameters evaluations.

Regarding hake in the Gulf of Lions, the methods based on length frequency analysis were used for estimating growth parameters. Another part of the work on hake in this area have concerned the growth rates of this species during the first year of life.

A growth model for the Balearic hake has also been established, taking into account sizes of some 20 cms for 1 year old individuals, around 40 cm for the second year, and a little more than 50 cms for the third year of life for females, and maximum sizes greater than 110 cms, discounting the concept of the existence of a 'dwarf' race in comparision with the north Atlantic hake.

Length-frequency analysis has also been applied to the hake from Santa Pola Bay (Alicante, Spain). The starting data were obtained by samplig the catches from the commercial vessels of Santa Pola Port during 1991-92, using the BHATTACHARYA method following an application of the ELEFAN Program, with a monitoring of cohorts and quarterly means by the FISHPARM packet and the application of MULTIFAN packet on length frequency files, obtaining several estimations of the VBGF parameters.

For the Northern thyrrhenian sea hake, a study was also performed in the framework of the FARWEST programme, as part of a wider Italian research project aimed to clarify the growth pattern of Mediterranean hake. Length frequency distributions from commercial landings and experimental trawl surveys have been processed with the ELEFAN, Bhattacharya and MIX (Mc. Donald & Pitcher, 1979) methods for the analysis of distribution mixtures. This work emphasized on the identification of the first winter annual ring, which is a primary goal to understand the pattern of otolith rings formation.

2.1.2. Results and discussion

For the Gulf of Lions, the results lead to consider that hake growth rate is faster than one could think according to otoliths readings. They quite agree with those obtained for the other areas in which the same methods were used. Furthermore, there is a rather good agreement with hake growth in Atlantic ICES areas.

For the same area, analyses on age, growth rates and birth distribution throughout the year have shown that the daily increment, despite its shortcomings for Mediterranean hake, confirm that mean size is 16 cm at the end of the first year of life. The birthdate distribution determined from otolith microstructure showed births throughout the year with a main season between autumn and winter. The monthly growth rate of 1.18 cm obtained by means of modal length–frequency progression confirms the rate obtained from otolith interpretation.

For the Santa Pola Bay, the results are homogeneus when comparing different years, different areas and different statistics packets, obtaining high K estimates, showing the growth rates for this hake are higher than the formerly accepted ones.

The interpretation of these results presented have been discussed by the whole group. Finally, a set of parameters has been choosen taking into account the regional biological characteristics of the species, the fitting of the growth parameters to the statistical working conditions of the various models and the fitting of the first year lenght to the readings of the daily growth increment otoliths rings, according to the previous Mediterranean studies.

For the parameters calculated with ELEFAN 1, Rn indexes greater than 0.4 have been considered as convenient; for the global stock assessments it has been recommended to use the growth curves fitted on both sexes; for the Gulf of Lions it is considered that the best parameters are those which fit better with the real sex–ratio observed and it was decided to discard the Linf, k and to values which do not verify a suitable inverse relationship.

Based on these considerations, the group agreed on the following parameters of the Von Bertalanffy's growth–in–length equation, to be used as "standard" inputs for the further population dynamics analyses on the demography of the hake stocks in the western Mediterranean area (tab.1).

	both sexes			*females*			*males*		
Area	**Linf**	**k**	**to**	**Linf**	**k**	**to**	**Linf**	**k**	**to**
Span.Med	94.7	.131	-.122						
G. Lions				100.7	.124	-.35	72.8	.149	-.383
Ligur.P	33.2	.48	.051						
Ligur.S				82.0	.180	.121	62.0	.320	.328
Ligur.T	49.8	.28	-.332						
Tyrrhen.	110.0	.11	-.044	111.0	.109		55.0	.250	
	85.0	.163	-.044						

Tab. 1.- Hake growth parameters . *Span.Med* = Mediterranean Spanish waters, *G.Lions* = Gulf of Lions, *Ligur.P* = Ligurian sea continental shelf, *Ligur.S* = Ligurian sea continental slope, *Ligur.T* = total, *Tyrrhen.* = Tyrrhenian waters.

2.2. Growth of GAMBA SHRIMP (*Aristeus antennatus*)

2.2.1. Materials and methods

The determination of growth parameters of crusteceans by direct methods (examination of calcareous structures) is generally very difficult, due to the change of shell at each periodical moulting. So the gamba growth has been studied using the length frequencies analyses techniques to monitor the evolution of the cohorts and the relationship between average sizes and ages. Size frequencies distributions obtained from regular samplings on the catches have been splitted by sex and weighted by the corresponding total catches in each fishing area.

At the same time, biological samplings have been done, aimed at the laboratory determination of the relative growth parameters (lenght–weight relationship, maturation stage ...). These data where processed with FISHPARM, ELEPHAN and MULTIFAN computer programs for growth evaluation.

2.2.2. Results

The different results produced by these analyses where compared and a consensus have been met on a set of Von Bertalanffy's growth curve parameters to be used as the "standard" one for the further stock assessments on this species (tab. 2).

		Linf	k	to
BALEARS	*Females*	74.0	0.38	0.071
	Males	56.0	0.24	-1.061
CATALUNA	*Females*	74.4	0.40	0.020
	Males	52.0	0.23	-0.940
IBIZA CHANNEL	*Females*	75.0	0.25	-0.330
	Males	44.0	0.24	-1.210
GULF OF GENOA	*Females*	61.74	0.78	-0.06

Tab. 2.– *Aristeus antennatus* growth parameters

2.3 STOCK ASSESSMENTS AND MODELLING OF THE INTERACTIONS BETWEEN GEARS WITHIN SINGLE FISHERIES OR BETWEEN FLEETS IN THE CASE OF SHARED STOCKS.

This work has been particularly developped to attempt the modelling of the western mediterranean areas where interactive fisheries exist.

2.3.1. Materials and methods

As in general the available series of demographic data where not long enough to achieve classic cohort analyses, the use of pseudocohorts has been adopted for the case–studies performed during the project. So the use of the VIT model (LLEONART and SALAT, 1992) has been adopted. This model was specially built by the ICM/CSIC laboratory in Barcelona to analyse exploited marine populations based on catch data, structured by ages or sizes, from one or several gears. The main assumption is the steady state because it works on pseudocohorts, so that it is not suitable for historical studies (but very few of these are available in the western Mediterranean at the moment).

From the catch data with some auxiliary parameters, the program rebuilds the population and mortality vectors, using Virtual Population Analysis (VPA) tecniques. After this first step, the user has several tools of analysis and data presentation available: he can obtain results from VPA *in extenso*, Yield per Recruit (Y/R) based on the fishing mortality (F) vector, sensitivity analysis of the parameters and study the transition (away of the equilibrium) between two steady states, the initial and that after a change of the exploitation pattern or due to changes in recruitment. All these analyses are applicable to the study of competition between different kinds of gears.

The VIT program also includes several interactive options in the sense that partial results can be visualized, parameters may be changed and primary data can be converted from size to age structure. The outputs of the analyses are included in an ASCII file ready to be entered onto a worksheet.

The source code has been written in FORTRAN and the executable is prepared for use on IBM PC computers and compatibles under MS-DOS Operating System.

The current available sets of data have been used in the framework of our programme to perform some stock assessments and other computation trials such as comparisons between the results obtained using small historical or geographical series or using average demographic structures, comparisons between the results of assessments based on lenght or age frequencies and studies on interactive multigears fisheries; the various assessment computations that have been done are listed in table 2.

SPECIES	FISHERIES	COUNTRIES
HAKE	*Murcia and Valencia*	Spain
HAKE	*Balearic islands*	Spain
HAKE	*Catalonia,Levante,Baleare*	Spain
HAKE	*Gulf of Lions*	France + Spain
HAKE	*Ligurian sea*	Italy
HAKE	*Tyrrhenian sea*	Italy
HAKE	*Catalonia & Tyrrenian sea*	Spain + Italy
SHRIMP	*Catalonia,Baleares,Ibiza*	Spain
SEA BASS	*Gulf of Lions*	France
SEA BREAM	*Gulf of Lions*	France
SOLE	*Gulf of Lions*	France

Tab.2.- Species and areas for which assessments have been performed

2.3.2. Results

2.3.2.1. Hake stocks

Using the sampling data on commercial catches for the period 1988-1992, an analysis (VPA and Y/R) of the Spanish "Levant" area (Murcia and Valencia regions) has been done in order to obtain an overview of the current state of this stock to be compared with others areas. The biomasses and yield per recruit values obtained from the VPA show an exploitation scheme quite different from the biological optimum, with an acute overfishing as the exploitation starts with younger classes, subsisting on the recruitment and showing a high turnover.

The Balearic stock of hake has been assessed for the period 1980-1992. This work is oriented towards the comparison of the Y/R values obtained when using an unique average pseudocohort established for the whole period and three annual pseudocohorts corrfesponding to years in which recruitment was low (1991), medium (1981) and high (1984). The results show that the years of relatively good recruitment can be considered as those which reflect more accurately the average situation of this stock.

Another methodological trial has been done on the same Balearic set of hake data, aimed at the comparison of the results obtained using the cohort or pseudocohort assessment methods. ANACO and VIT models have been applied respectively to this 13 years series, showing significant differences between the F's and recruitment values produced by the two methods.

For the Balearic waters, another work taking into account about the catch fluctuations of hake and red mullet (*Mullus surmuletus*) in the trawl fishery has been done, applying Length Cohort Analysis (LCA). Monthly length sampling of hake and red mullet, for the period 1980 - 1991, have been used for this purpose. They have been converted in two specific pseudocohorts on which VPA and Yield per Recruit analyses were performed with the VIT software.

The results have shown, for both species, a high level of fishing effort and an inadequacy of the exploitation pattern which is currently applied. A transition analysis has also shown that using a larger mesh size (60mm) will result in a significant improvement of both species yields and biomasses.

About Spanish hake fisheries in general, a comparison of the exploitation patterns and populations status has been done using the VIT model for VPA and Y/R calculations. This work used the data regarding bottom-trawl catches on Catalonia, Levante and Balearic islands. Exploitation pattern resulted as lightly different one from another. The mean lengths and ages are smaller in the Levante area than in the other regions, whereas fishing mortality level is higher. For Catalonia and Balears these values are similar. Y/R assessments have shown a biological overexploitation trend for all the areas studied.

A VPA was run on the Italian Ligurian sea hake stock, using length frequencies distributions coming both from 13 trawl surveys carried out from 1990 to 1993 and samplings at landing. VIT model was applied separately on three consecutive years (1990,91,92) and on an average pseudocohort for this period. The two trials reach to the same general conclusions about the state of this stock (i.e. very heavy exploitation). It was shown that the interpretation of the VPA results can be considerably improved by taking into account the bio-ecological observations which have been done on the Ligurian hake populations during the last 25 years.

For the Northern Tyrrhenian basin (Italy), the 1992 samples regarding the exploitation of hake by two different types of trawls used by the Italian fishermen in this region have been used to perform some VPA and Y/R VIT runs on two pseudocohorts, each one corresponding to one gear. The results have shown a heavily biological overexploitation, with a very low average age and a very high turnover. Differences between the current Y/R values of the two gears have been shown, but in both cases these values are very low if compared to the theoretical maximums.

A comparative analysis of the trawling exploitation of hake in two non-adjacent areas of the Western Mediterranean (Tyrrhenian sea, Italy and Cataluna, Spain) has been performed using the 1990-1992 samples available in our database for these two areas. VPA and Y/R computations have been done both on lengths and ages frequencies, and using three different sets of growth and mortality parameters obtained from the biological studies achieved in the framework of our project (see previous chapters). The analyses have reach to very similar characteristics for the Tyrrhenian and Catalan populations, clearly showing that the hake can be considered as biologically overexploited in the two areas.

In the Gulf of Lions, the exploitation of the hake stock is shared between French and Spanish fishermen using four types of gears. Some analyses of its dynamics have been performed. Both VPA and Y/R assessments where done and the sensitivity to the biological parameters was studied, as well as the interactions between gears. These analyses have shown that, from a biological point of view, this stock can be considered as heavily exploited. Another general result is the evidence that the gears fishing mainly small individuals (i.e. trawls) have a great influence on the others gears - such as gillnets and longlines - scores.

An assessment of the same stock has been carried on for the period 1988-1991, using two methods of virtual population analysis based respectively on mean pseudocohorts and on cohorts.

The results of these VPA have been analysed and compared from a methodolgical point of view. General results confirm previous ones with regards to the level of exploitation of hake. The two methods give quite similar results for fishing mortality rates and for mean biomass. The trawlers fishing mortality rate on juveniles is important. Rather high values encountered for turnover and for the ratio maximal biomass/mean biomass are significant from an important level of exploitation but not so high to be dangerous for the stock.

2.3.2.2. Other species

After the hake -which is only fished at sea- the sea bass, the sea bream, and the sole are three of the main target species of the french trawlers, small-scale coastal marine and lagunar fleets in the Gulf of Lions. The analyses were done on the 1986, 1987, 1991 and 1992 catch samples corresponding to these activities to build a diagnosis on the demographic evolution of

the stocks of the three species during this period, on their current status and on the possible results of an hypothetic new distribution of the ratios of fishing power of the three fleets.

The results have shown that the three stocks can be considered as biologically heavily exploited. They stay at low biomass levels but their demography is very sensitive to any variation of the fishing effort. The most important part of the mortality rates are due to the trawling, which interact heavily on the small-scale fishery scores; simulating increases or decreases of the trawlers effort resulted in significant corresponding losses or gains in yield for the two others fleets.

The evolution of the fishing of *Aristeus antennatus* during the last 15 years on the Catalan coast has also been analyzed. Major components of catches are mature individuals. The exploited length frequency distribution, as well as the mean size of catches remained stable during 1984-1991; the fishing effort directed to this species has undergone slight variations. Catches showed marked seasonality, with maximum values in spring-summer, during the reproduction period. Annual natural mortality rates M of 0.5 for females and 0.8 for males are proposed, values much lower than those estimated for other penaeids. This work shows that the fishing strategy on this species is close to the optimum.

A demographic analysis of *A. antennatus* for Catalonia and Valencia has also been done. An annual series of length frequencies by sex were analysed over a 6 year period (1984-1989) using LCA and VPA. Some Y/R analyses were performed in order to get a general view of the status of the stock. Sensitivity of LCA on demographic parameters K (growth rate) and M (natural mortality) were studied in order to evaluate the effect of estimation errors. The stocks studied appeared not to be far from the steady state and presented a fairly stable fishery pattern, hence it was possible to use LCA. The Y/R vs effort curves show an exploitation level close to the biological optimum. Fishing effort changes did not appreciably improve they yield.

The current status of Gamba shrimp stocks exploited by the Spanish fisheries in three adjacent zones (Baleares, Catalunia and Ibiza Channel) have been compared, after being assessed using VPA and Y/R analyses. The results have shown that the exploitation pattern is close to the biological optimum for these stocks, which do not show evidence of overexploitation.

2.3.2.3. General comments about the status of the stocks

The population dynamics studies performed during this programme where essentially aimed at the demonstration of the feasibility of a complete chain from data sampling to analytical stock assessments in the region.

However, beyond this methodological demonstration, some general practical conclusions about the status of some stocks and fisheries can be drawn from these analyses: from a biological point of view we can state that for the fish species we have considered in this programme, diagnoses of biological full exploitation, or even overexploitation have been obtained. This situation seems to be the result of both the conditions of the exploited populations and the exploitation patterns which are traditionally applied to them. It limitates today's catches approximately to their recent levels. The prospective simulation trials we have performed foretell that if the general tendency to a growing fishing effort (and especially the trawlers one) was carried on according to the pattern prevailing during the recent past, such an increment will rapidly result into a general state of biological overfishing of these resources. The situation seems to be different for the gamba shrimp resource which seems to be correctly exploited at the moment.

2.4. Studies on gear selectivity

Some studies on gears selectivity have also been achieved to obtain additional data which will allow future studies on the possible effects of changes in mesh sizes and fishing patterns on the production and age composition of the stocks. The data of several experimental cruises at sea have been processed under this topic

The demersal fisheries of the western Mediterranean and the Adriatic sea have some common characteristics among which have to be noticed the use of small meshsizes for the trawls codends and an obvious importance of the mixed gears exploitations. In these mixed fisheries it can be expected that any change in the meshsize will result in important quantitative

and qualitative effects on the catches. In the last decades a certain amount of experimental studies on trawl selectivity where done by the partners countries.

Several new cruises, particulraly aimed at trawl selectivity evaluations by the "cover-end" method, took place on board professional local fishing boats in the Tuscan Arcipelago waters (Italy) and in the Alboran sea (Spain) between 1991 and 1993. The data collected, especially on hake, where analyzed in the framework of the FARWEST programme and the selectivity factors and curves parameters have been assessed.

Furthermore, one of the tasks achieved during the programme has been to compile all these informations and to discuss about the methodologies, the precision and interpretation of the results and the usefulness of carrying on further standardized experiments.

3. SOCIO-ECONOMICS

The southern part of the Spanish western Mediterranean coast has been choosen as an experimental working zone to develop an approach in the economical field related to fisheries. This work has been done stating that the general methodological fundaments of the firms administration are totally applicable to the fisheries.

The basic objective of this part of the research was not to perform analyses but to imagine the structure of a database which will contain the elements to establish the management strategies aimed at the main efficiency for all the actors of the "fishery system". In fact, it appears as necessary to consider this system as a whole, because fishing is linked to numerous complementary activities where economics take an important place.

Complementary to the main part of the database which includes mainly eco-biological and catch-effort data, the structure of the files which could permit the economical part of the mediterranean fisheries system analyses has been defined. They consist mainly in two types of data: technical information about boats and fleets and socio-economical data. Part of this information (especially the technical one) was yet included in the structure of our previous common database but at a further step of the mediterranean research this redundancy should easily be eliminated, as the interfacing between the various files do not poses any hard technical computation problem.

furthermore, this work produced a sampling strategy and the corresponding encoding frames aimed at the realisation of the inquiries oriented towards the collection of the socio-economical information. This methodology has been tested on the Andaluz fishing ports, the files have been fed with the corresponding 1991,92 and 93 data and some examples of processings have been performed.

4. OTHER TOPICS

Two series of catches and efforts data available have been use to analyze the variations of the hake catch per unit of effort of trawlers in two different areas of the northwestern Mediterranean: the Gulf of Lions and the eastern Tyrrhenian basin. The variations observed in the hake cpue (kg/day) have been considered to be the result of the combination of the following factors: vessel horsepower (hp), fishing gear, fishing zone and time of the year (month). With respect to the fishing gear, a distinction was done, according to the vertical opening of the mouth, into two trawlers types, ("traditional" and "french" gears). In order to determine the factors affecting the monthly variation of the cpue a multiple linear regression model has been used.

The daily mean catch, per vessel and month, showed a high variability with respect to the factors considered determining the cpue changes.

According to the results of this study, the expected hake yield per vessel mainly depends on the time of the year and fishing zone and, to a lesser extent, on the vessel horsepower and type of fishing gear.

Related with the Alboran sea hake stock analyses previously mentionned, the distribution of hake in this area has been studied using the data collected during five Spanish experimental trawl surveys (IEO "MERSEL" cruises) in 1991, 1992 and 1993.

Stratified abundance indices have been computed and the results shown that the levels of abundance of the hake were stables during the considered period.

GENERAL DISCUSSION

As a global result of the FARWEST programme, it can be underlined here some general conclusions, that can serve as guidelines for the future mediterranean fisheries science research:

In the Mediterranean, as in other regions of the world, the works carried out up to now, essentially directed towards biological studies of the dynamics of exploited populations, does not allows to respond to the various needs of the national and international decision–making bodies. Fisheries management should therefore be based on full knowledge of the system and should grow out of the oversimplified resource/catch concept.

Given the topical preoccupations of fisheries science in all the coastal countries one of the main line in future research in this field concerns the study of the typology of the ressources and trades which lead to the definition of well individualized units of exploitation and management.

The realization of these analyses and their generalization requires an improving of the quality of the statistics in general. It requires also particularly, for a certain number of species, an improving of the knowledge on the biological parameters (age, growth, fecondity), on the biogeographical characteristics (migrations, distribution, spawning areas, nurseries). Studies on interspecific and trophical relationships seem also to be primordial, as well as the understanding of the mechanisms of biomasses fluctuations in space and time. Still at the fundamental level, the works allowing to explain the determinism of recruitement linked to the environnement and those of the fleets' dynamics become of paramount importance too.

In such a perspective, the building of mediterranean Geographical Information Systems databases will be of a great help for the understanding of the situation as a whole.

From a socio–economic point of view, the regular survey of several indicators like the evolution of the investments and the capital, of employment and salaries, seems indispensable. The future research should also start dealing with – or extending – the studies about the price of the production factors and the profitability of fishing in the Mediterranean about which only sketchy knowledge is available.

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