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IMPROVING THE UTILITY AND DIFFUSION OF FISHERIES STATISTICAL DATA AMONG RECOFI MEMBERS

Regional Commission for Fisheries (RECOFI)

Desk study

Improving the utility and diffusion of fisheries statistical data among RECOFI Members

by

C. Stamatopoulos
FAO Consultant

Food and Agriculture Organization of the United Nations
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1. Executive Summary

1.1 Background

The fourth session of the Regional Commission for Fisheries (RECOFI) which was held during 7–9 May 2007 in Jeddah, Kingdom of Saudi Arabia, decided the establishment of a Working Group on Fisheries Management (WGF), the terms of reference of which will include statistical functions aiming at the enhancement of national fisheries statistical programmes and the promotion of harmonization and integration of fisheries statistical data at regional level. The Commission further recommended that Member countries continue their efforts to improve the cost-effectiveness and reliability of their national statistical programmes and that in this respect effective use be made of related reference material and expertise available from the FAO. Regarding issues relating to harmonization of national data for establishing regional statistical data sets, the Commission agreed that this would mainly concern naming and classification practices for species, boat types and fishing gears.

Acting upon these recommendations the RECOFI Secretariat initiated a series of follow-up actions, one of them being the undertaking of a desk study and the preparation of a technical document concerning fisheries statistics to be presented at the second meeting of the RECOFI Working Group on Fisheries Management (WGFM - formerly the Working Group on Fishery Statistics) scheduled for October 2008. The terms of reference of the desk study are given in Annex A. This document summarizes the work carried out during May-June 2008 and contains a general review of current methods of data collection adopted by RECOFI member countries, specific proposals and related analytical tools aiming at improving the utility of the RECOFI capture database, and formulation of conceptual approaches for data harmonization and integration.

During the course of the desk study the author contacted several FAO HQ experts from whom he obtained much valuable information and advice. He also had the chance to attend meetings at which issues of relevance to the desk study were presented and debated. Of particular assistance were his technical discussions with Mr. Luca Garibaldi, FIES[1] Statistician, Dr. Richard Grainger, Chief FIES, Dr. J.F. Caddy, Marine Resources Consultant, Dr. Matthew Camilleri, GFCM[2] Bio-statistician, and Ms. Monica Barone, Bio-statistician of the MedFisis[3] project. Mr. Garibaldi provided material relating to the RECOFI capture database (the new release of the RECOFI capture production database with data for 1986-2006), as well as statistical documents presented at RECOFI Sessions. Dr. Grainger provided information on the FI Technical Paper “Chronicles of marine fishery landings (1950-1994), whereas Dr. Caddy did the same for the FAO Review Paper “Long- and short-term trends of Mediterranean Fishery Resources”. Dr. Camilleri made available for my consultation PowerPoint presentations and technical documents that were prepared for GFCM but are also of relevance to data harmonization and integration issues concerning other fisheries commissions, including RECOFI. Ms. Barone explained the structure and use of a new procedure proposed for the analysis of GFCM time series. This particular analytical instrument is adaptable to RECOFI data format and would provide users with additional insight with regards to status and trends of landings[4].

In concluding, the desk study discusses existing difficulties in fisheries statistics, presents simple methodological procedures that increase the utility of existing databases, underlines the need for

[1] Fishery Information, Data and Statistics Unit of the FAO Fisheries Department
[2] General Fisheries Commission for the Mediterranean
[3] Mediterranean Fishery Statistics and Information System
[4] Throughout this paper the terms “catches” and “landings” will be mentioned interchangeably as, at least with regards to RECOFI fisheries statistical data, there is no distinction made between the two in the main data source used (RECOFI capture production database).

feedback information on statistical quality to be provided by members and, proposes short-term follow-up actions to be considered by the WGF and the Commission for the general improvement of national and regional data and the promotion of cooperation and synergy in fisheries statistical activities in the RECOFI region.

1.2 Brief review of RECOFI data collection systems

The Commission has in the past made several requests for a systematic evaluation exercise on the fisheries statistical programmes of its members. This evaluation, the results of which would first be communicated directly to the national authorities concerned, it has not yet taken place for a variety of reasons of which the primary ones were two: (i) the long vacancy of the RECOFI Secretary position and the consequent lack of follow-up[5] and, (ii) the insufficient RECOFI regular funds for such missions to be undertaken with effective duration and regional coverage.

Therefore the brief review contained in this document is limited to issues relating to the feasibility of RECOFI Members to participate in a second phase of data integration[6], this time involving variables on fleet capacity and fishing effort. Consequently, the views expressed here do not constitute any criticism, positive or negative, of the performance of the ongoing national systems and the quality of obtained results, as such knowledge is still to be derived from *in situ* investigations and systematic formulation of performance and quality indicators and diagnostics. In Section 1.3 a number of short-term technical support activities are proposed and specific provision is made for a statistical evaluation approach extended to all RECOFI Members, with the understanding that its results would first be communicated to those that are directly responsible and primarily concerned, i.e. the national authorities themselves.

It is nevertheless known (from past technical consultations on fisheries statistics[7]) that RECOFI countries are at present using a variety of methods for data collection and processing, involving both census-based and sample-based schemes. The first scheme applies primarily to industrial and semi-industrial fisheries and data are directly obtained from the operators themselves, usually as part of the licensing process. The sampling approach is used for the small-scale fisheries which are generally characterized by high dispersion combined with large numbers, thus making impossible the collection of information on a complete enumeration basis.

RECOFI Members in general operate sample-based systems which function regularly and cover basic variables on catch, effort, CPUE, prices, fish size, market prices, etc. The most recent source of information with regards to principal functions (specifically concerning the national systems of Bahrain[8], Oman and UAE), are the presentations made by these three RECOFI Members at the RNE statistical workshop of November 2006. An interesting common element of the RECOFI fisheries statistical systems that are sample-based is that there are instances of intense and frequent sampling which would potentially become less demanding in data collection effort while maintaining present levels of reliability and accuracy. On the other hand there are cases where sampling approaches ought to be upgraded using methodological and operational standards recently published by FAO (see Section 3.3).

[5] The position of the Senior Regional Fisheries Officer for the Near East and RECOFI Secretary was finally filled in February 2008.
[6] The integration of RECOFI capture time series was accomplished in 2003.
[7] The most recent being the RNE regional workshop on latest developments in fishery survey tools and integrated databases, Cairo, 20-22 November 2006, which was attended by seven RECOFI Members (see also References).
[8] These presentations involve Excel worksheets, MS Word documents and PowerPoint slides and can be made available by the RECOFI Secretariat.

With regards to complete enumeration approaches these involve direct reporting (i.e. landing declarations, logbooks) as well as indirect (i.e. sales receipts, market research). One problem with the direct methods concerns statistical coverage of different fleet sectors and completeness of data collected within each sector. Concerning indirect methods (which are useful for periodic cross-checking purposes), the problem is that they are at times used as a substitute to direct ones thus resulting in difficulties in obtaining data on the type and intensity of fishing operations.

There are also cases that RECOFI national administrations with limited human resources cannot sustain census-based operations for the whole fishing fleet, with the result that there are always gaps in their catch reports. This difficulty might perhaps be resolved by switching from census-based to sample-based approaches, at least for important fishery sectors for which serious coverage difficulties seem to constitute a chronic problem.

Finally, another problem is the lack of coordination and synergy between different institutions that are charged with data collection tasks, a situation that at times causes duplication of data collection effort and generates estimates that are not comparable.

On the other hand, there is a general improvement in data collection and reporting at both national and international levels. Species identification for instance has gained in precision; this can be confirmed by comparing the proportions of catches of unidentified fish before and after 2001 (see Section 2.2). In both RECOFI sub-areas 51.2.0 (Gulf) and 51.3.1 (Sea of Oman) the reported catches of *Marine fish nei*[9] has declined significantly and this is an indication of improved statistical reporting and that much less catch is now lumped under *Marine fish nei*.

The main question at this point is whether RECOFI Members will be able (using their ongoing systems as these stand at present) to proceed successfully to the next integration phase through which current annual catch statistics will be split by gear and be accompanied by fleet and effort information. Some first questions can be answered by examining feedback information provided from RECOFI national authorities and the desk study prepared a number of questionnaires to serve this purpose (Section 3.2).

1.3 Data harmonization and integration

Looking at the RECOFI fisheries statistics in a regional perspective requires that each national fisheries statistical programme becomes a component of a logical network comprising not only data but also processes and methodology. Such integration of different systems (each created through national programmes), is in general feasible when member countries use a regional set of statistical standards and apply regionally agreed definitions and classifications.

There are some important issues that affect the quality of integrated fishery statistics. The first concerns data coverage. In several cases available national data are incomplete in terms of range of variables and sectors covered. Consequently, records in a regional dataset contain gaps for which estimates are required; the latter however should be based on good assumptions if they are to provide a reliable substitute to directly collected figures. A second issue relates to differences in statistical concepts and methodologies used by countries for assessing the accuracy of collected data.[10]

[9] nei: not elsewhere indicated

[10] An example of a non-standard statistical indicator is the sampling proportion of landings to be collected (i.e. 10%, 15%, etc.) in order to achieve a commonly accepted level of accuracy. This conception is not altogether statistically

Methodological variations often make comparability of statistics a difficult task, especially when the degree of accuracy among national data is uneven. And a third point concerns the timeliness of national data, that is the time required for primary data to be processed into officially authorized statistical figures.

Although the aforementioned issues constitute a national responsibility they nevertheless have strong impact on the overall utility of regional statistics. Thus, improving data quality and timeliness and protecting the credibility of regional statistics requires interaction with countries and human effort and financial inputs invested in regional cooperation at both technical and operational levels. RECOFI has always recognized the importance of political willingness for cooperation in all fisheries issues, including fisheries information and statistics, and has been encouraging its members to pay due attention to both national and regional fisheries statistical programmes.

In discussing harmonization aspects at regional level it is perhaps worth clarifying a point which has been frequently debated at technical consultations and regional meetings. Countries have at times expressed concern that a regional harmonization exercise might hamper the operations of their respective national systems and cause disruption to historical data and time series. The present document advocates that the term "harmonization" does not imply the introduction of a single and uniform statistical system across RECOFI member countries. It rather means the stepwise introduction of commonly agreed classifications with the view of making nationally-produced statistics comparable at regional level. RECOFI has in fact been able to accomplish a first level of harmonization through the establishment of a capture database[11]. It is further pointed out that the introduction of methodological standards on a when/where-needed basis (particularly in sample-based data collection systems), will in fact benefit both RECOFI and its members, since the integrated datasets would contain data of known quality and completeness.

It should be noted here that harmonization of nationally-collected fisheries statistics at regional level can be achieved only progressively and only in those sectors where data are available at the required level of detail. It was mentioned earlier that the integration of annual catch data has already been achieved and that the integration process should expand to include other variables. At this stage, however, it would not be very practical to propose an all-at-once implementation of integrated databases containing monthly data on fleet, catch, effort, prices, fish size, fuel costs, etc., when it is yet not known if all RECOFI Members are in a position to participate in this exercise. This means that data types and variables on which information is to be integrated should be tailored to the capacity and structure of national fisheries and not be dependent on drastic changes to data collection operations that are being regularly operated by member countries.

It is on the basis of these observations that the present desk study suggests that with regards to data harmonization and integration only two further steps be taken in the short- and medium-term, with the twofold purpose of:

(I) Expanding harmonization to include boat/gear classifications so as to integrate fleet capacity and annual effort at regional level;
(II) Introduce commonly used international standards in sample-based data collection operations, in order to set-up a minimum target for accuracy with regards to catch and effort estimates.

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sound and can mislead users with regards to the accuracy of estimates. Section 3.3 provides some indications on standard criteria used for measuring sampling accuracy.

[11] The RECOFI capture database contains catch time series organized by country, species and sub-area (Gulf and Sea of Oman). The last release, issued by FAO-FIES in May 2008, contains catches covering the period 1986-2006.

Approach (I) takes stock of the achieved integration of catch data and provides some first findings relating to the commonly used species classification for reporting to FAO. It then suggests a practical tool to expand harmonization to include fleet capacity and fishing effort. In doing this emphasis is placed on taking maximum advantage of existing estimates directly deriving from ongoing national fisheries statistical programmes.

Approach (II) concerns the introduction of basic concepts relating to sample-based fisheries statistical programmes. The related section is not dealing with theoretical sampling aspects; it simply highlights some of the commonest problems and attempts to provide a set of practical guidelines that would hopefully assist RECOFI Members to improve the cost effectiveness of their national statistical programmes.

1.4 Proposal for short- and medium-term actions

The desk study identified two major activities relating to fisheries statistical development in RECOFI. The first concerns the long overdue review of national fisheries statistical programmes. The second activity is envisaged under the assumption that there will be favourable conditions for initiating a new integration exercise including annual catch and fishing effort data. Table 1.4.1 provides a breakdown of the overall cost (US$ 70,000) without making suggestions as to the source(s) of supporting funds.

Table 1.4.1. Summary of short- and medium-term actions in relation to fisheries statistics

Type of activity	Person months	Cost in US$	
		Travel	Honorarium
(A) Review of national fisheries statistical programmes. US$ 40,000. All RECOFI countries will be visited for an average duration of 7-10 days each. Missions will be fielded in two round trips. The output will be a mission report and eight technical documents containing diagnostics, conclusions and recommendations to be addressed to each national authority for consideration and follow-up.	2	25,000 (incl. tickets and DSA)	15,000
(B) Integrating annual catch, effort and fleet data. US$ 30,000. Depending on the outcome of the survey relating to the feasibility of an expanded data integration, and upon receiving of first inputs from RECOFI Members a new database will be implemented and made available on the web for general access and consultation.	4	(FAO HQ)	30,000
TOTAL COST IN US$			70,000

1.5 Desk study questionnaires

Upon conclusion of the 2nd WGFM Session, the RECOFI Secretariat will distribute the electronic folder "RECOFI DESKSTUDY" containing:

- The desk study technical report (present document);
- An Excel workbook entitled RECOFI_CATCH_FLEET_EFFORT;
- An electronic questionnaire relating to sample-based statistical standards;
- A series of Excel application programs relating to two methods developed by the desk study and are proposed for use by RECOFI Members.

The RECOFI_CATCH_FLEET_EFFORT worksheet (Annex E) will be used by RECOFI Members solely for indicating whether catch can be split into boat/gear components following the proposed classification scheme of three boat and eleven gear groups. Users are also invited to indicate the feasibility of supplying figures on active vessels and estimates of individual annual vessel effort. No real data need to be returned at this stage. The purpose of the exercise is for the RECOFI Secretariat to obtain feedback information on the feasibility of the approach and report on its first findings at the 1st Session of the RECOFI WGF in October 2008.

The electronic questionnaire with sample-based statistical standards (Annex F) will contain a number of simple questions with the purpose of obtaining a general picture of RECOFI sample-based national statistical programmes with respect to:

- Extent to which registers of fishing vessels are used for statistical purposes and for the generation of spatial extrapolating factors for estimating total fishing effort;
- Whether frame surveys are also conducted for statistical purposes;
- How sampling accuracy is measured and monitored;
- Common problems in data collection (multiple use of gears, seasonal migration of fishing units).

The Excel workbooks PATTERNS and SPECIES_RANKING (a detailed description of which is given in Chapter 2), can be used by RECOFI users either as standalone applications (i.e. limited to the data they have been set-up with), or applied to new datasets generated by FISHSTAT+ using the guidelines given in Sections 2.1.3 and 2.2.4.

Chapter 2

Improving the utility of existing data by RECOFI Members

Section 2.1: Desk study Method 1: Patterns of time series

The Code of Conduct for Responsible Fisheries (FAO, 1995) clearly indicates that reliable and timely data are required for the promotion and implementation of sustainable fisheries. The collection, analysis and accessibility of basic data, such as landing statistics, are the basis for monitoring the structure, production and performance of the fishery sector, and for analysing trends over time. The Strategy for Improving Information on Status and Trends of Capture Fisheries begins by stating that "Knowledge of the status and trends of capture fisheries and fishery resources, including socio-economic aspects, is a key to sound policy-making and responsible fisheries management" (FAO, 2003).

The advantage of examining RECOFI landings as a long time series is that it provides a broad picture of the dynamic nature of the Gulf and Sea of Oman fisheries. The observed patterns highlight temporal changes between different fisheries. Such changes are most probably caused by four factors: market demand, environment/ecosystem variability, prolonged exploitation, and abrupt changes of data collection/recording schemes (the last factor having a statistical rather than exploitation meaning).

There is a general consensus that the monitoring of the state of fisheries and their resources must be substantially strengthened for better informed and improved governance as well as for more transparency and better publicizing of information (Garcia and de Leiva Moreno, 2001).

In analyzing time series there is a clear distinction between the terms "trend" and "pattern" or "shape". The term "trend" is generally associated with a mathematical model that describes a relationship between the independent variable t (=time) and the observed variable (catch, value, etc.). This relationship, when established, permits the prediction of values of the observed variable in-between known values (this is commonly referred to as interpolation), or outside the range of observations (extrapolation to the left or to the right). A typical example of such a model is the simple linear regression:

$$\mathbf{C_t = a_0 + a_1 t}$$

which predicts catch $\mathbf{C_t}$ at a time t, provided that there are N observations:

t_1	C_1
t_2	C_2
.....	
.....	
T_N	C_N

used by the method of least squares to calculate parameters a_0 and a_1.

Another example is the quadratic model:

$$\mathbf{C_t = a_0 + a_1 t + a_2 t^2}$$

describing a time series in which time and catch follow a parabolic relationship and where a linear model would fail to provide reliable estimates.

In general it is rather rare that all time series in a dataset can be described by a single mathematical model. Some time series may be closely linear, others may obey an exponential law of rise or decline; for others a dome- or U-shaped relationship would prove to be more suitable. In all cases there are special statistical diagnostics qualifying the goodness of fit (such as the coefficient of determination R^2) so as for users to assess whether prediction of values is reliable, risky or not feasible at all. It would thus seem reasonable to partition any dataset of time series into groups of similar shapes before deploying fitting functions; this would mean that each separate group would subsequently be fitted by a specific model that is most likely to produce satisfactory results.

This partitioning of time series into subsets of homogeneous shapes can be done in various ways and there is a considerably large chapter in statistical theory dealing with this very problem. Broadly speaking the options are choosing between a statistical process that would result in a yet unknown number of groups (this means that partitioning a set of 1000 time series might end up with four, fifty, or four hundred groups), or rather set-up a pre-determined number of shapes and identify the time series that fall into each of these categories. It is the latter option that was used in the present study and the following paragraphs describe the methodological steps taken.

2.1.1 Normalization of a time series

The first step is to transform time series to become normalized with all their elements varying between a minimum of 0 and a maximum of 1. Given a time series (t_i , C_i) i=1,2,…, N , with C_{min} and C_{max} being minimum and maximum elements respectively and $C_{min} \neq C_{max}$, the transformation formula:

$$\mathbf{U_i = \frac{C_i - C_{min}}{C_{max} - C_{min}} \quad , 0 \leq U_i \leq 1}$$

converts a time series C into a normalized time series U with all of its elements having values between (or equal to) 0 and 1.

Further three arithmetic means A_1, A_2, A_3 are calculated, each corresponding to three time periods determined dynamically so as for the sum of their individual variations to be minimum[12]. Since averaging is based on normalized values between and including 0 and 1, it follows that the three means will also be within that range.

Lastly the range 0-1 is partitioned to three zones of the same width, each representing low, medium and high values respectively. Low values are those that are greater than or equal to zero and smaller

[12] Repeated experiments involving other criteria, such as linear correlation, proved to be less robust and consistent than the selected variation-based approach.

than 0.33. Medium values are between and including 0.33 and 0.66, whereas high values are greater than 0.66 and less than or equal to 1.

Subsequently three pointers P_1, P_2, P_3 are generated in a manner that each of them takes three possible values: 1, 2, or 3. Pointer values are determined by associating each of the three averages to one of the three zones determined as above. For instance, if A_2 is 0.8 then P_2 is equal to 3; if A_2 is 0.45 then P_2 becomes 2; if A_2 is 0.15 then P_2 becomes 1, and so on. Because of the way these three pointers are formulated there are evidently $3^3 = 27$ different paths of 1-2-3 elements, each describing a pattern. All 27 patterns are independent of each other and are not further grouped into more general categories. Table 2.1.1 provides a description of these 27 independent patterns, including a 28th that represents a case where there is no identifiable pattern or shape in the time series (case of $C_{min} = C_{max}$).

2.1.2 Application of the method to RECOFI sub-areas

RECOFI sub-area 51.2.0 (Gulf)

Access was made to the RECOFI capture database containing catches for the period (1986-2006), which was released by FIES in May 2008. Using the FISHSTAT+ standard functions of filtering, data grouping, ranking, sorting and exporting to Excel format, it was easy to extract data for area 51.2.0 (Gulf) and apply the pattern-finding algorithm described earlier, the summary results of which are given below.

Please use the PLOTS worksheet to verify statistics on landing patterns

Capture time series: Statistics on general shapes and landing patterns

Developed by C. Stamatopoulos
FAO Consultant
Fisheries Resources Monitoring and Assessment

RECOFI: Gulf

Number of series processed: 163

	Basic shape	Frequency	% of total landings	% CUMUL.	Shape accur. (%)
16	Rising from medium to high level, then declining to low level	11	34.26	34.26	87
8	Rising from low to high level, then declining to medium level	33	20.43	54.69	87
6	Rising (all along, or eventually)	31	18.69	73.38	92
3	Around low level, then rising to high level	24	11.29	84.67	90
12	Declining from medium to low level, then rising to high level	2	4.63	89.3	76
7	Rising from low to high level, then declining back to low level	34	4.19	93.49	89
25	Around high level, then declining to low level	4	3.38	96.87	96
9	Rising from low to high level, then around high level	11	2.01	98.88	98
21	Declining from high to low level, then rising back to high level	1	0.8	99.68	67
22	Declining (all along or eventually)	2	0.14	99.81	72
19	Declining from high to low level, then around low level	1	0.09	99.9	84
4	Rising from low to medium level, then declining back to low level	1	0.04	99.95	58
20	Declining from high to low level, then rising to medium level	2	0.04	99.98	54
2	Around low level, then rising to medium level	2	0.01	99.99	67
28	*** NO IDENTIFIABLE PATTERN ***	4	0	99.99	0

Figure 2.1.2.1. Summary of time series patterns detected for RECOFI sub-area 51.2.0 (Gulf)

A sub-set of 163 time series was examined. Reading the summary statistics of Figure 2.1.2.1 it is concluded that about 85% of the total landings have the following four patterns:

(a) About 34% of landings (11 time series) first show a rise from medium to high level and then a decline from high level to low level. This corresponds to pointer values 2-3-1. An example of such a pattern is given by Figure 2.1.2.3.
(b) About 20% (33 time series) first show a rise from low to high level, followed by a decline toward medium level (see example in Figure 2.1.2.4). This corresponds to pointer values 1-3-2.
(c) About 19% (31 time series) first show a steady or eventual (i.e. after a certain stability period) rise from low level toward high level (see two examples in Figures 2.1.2.5a/b). This corresponds to pointer values 1-2-3.
(d) About 11% (24 time series) stay around low level and then rise to high level, a pattern similar to the one examined above (eventual rise from low to high level), only that here the pointer values are 1-1-3. An example is provided by Figure 2.1.2.6.

There are also two interesting modal patterns, though of relatively small proportion in terms of landings:

(e) About 4% of landings (34 time series) first show a rise from low to high level, followed by a decline back to low level (pointer values 1-3-1). An example of such a pattern is given in Figure 2.1.2.7.
(f) About 2% (11 time series) first show a rise from low to high level; then they stay around high level. This corresponds to pointer values 1-3-3 (see Figure 2.1.2.8).

It should again be pointed out (see second paragraph of this Section) that the significance of a detected pattern might be of statistical, rather than exploitation nature. For instance, if data for a species started being submitted only in 1995 due to a split of a species group into more detailed species breakdown, this will be reflected by zeroes for the period 1986-1994 and a rise toward medium or high level. Parallel to that, the pattern of the grouped species will show a decline from 1995 onwards.

Users also have access to the PLOT worksheet of the PATTERNS program which provides detailed information on a record-by-record basis. In there they find species names (according to the way data were extracted from FISHSTAT+), the name of the fishing area and all landings reported to FAO for the period 1986-2006. This is followed by a description of the time series pattern, a statistical indicator scoring the relationship between actual data and detected pattern and finally the three variable periods corresponding to the three averages and pointers described earlier.

By clicking on any record and pressing CTL+p a plot will be produced allowing users to verify visibly the consistency of the pattern-finding approach. Each plot must be followed by (i) selecting and deleting the image, and (ii) pressing CTL+r to return to the time series list.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1			*RECOFI: Basic patterns of FISHSTAT capture time series 1986 - 2006*														
2			**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
66	Indian oil sardine	Gulf	6000	6497	6810	7114	7114	6900	7100	2953	6085	3455	3491	10637	11680	8827	11139
67	Indian pompano	Gulf	0	0	0	0	0	0	0	0	0	0	0	32	25	30	14
68	Indian scad	Gulf	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1106
69	Indo-Pacific king mackerel	Gulf	336	614	510	1089	1378	1737	1842	1306	1253	1826	3297	2109	3700	2856	4290
70	Indo-Pacific sailfish	Gulf	0	0	0	0	0	51	48	50	5	22	23	382	832	1231	446
71	Jack and horse mackerels nei	Gulf	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	Jacks, crevalles nei	Gulf	0	5510	5770	6060	6060	5800	5974	6000	6682	6833	6905	7379	7403	7588	3107
73	Japanese threadfin bream	Gulf	0	0	0	0	0	0	0	0	0	0	0	1854	1998	1713	1936
74	Javelin grunter	Gulf	0	0	0	0	0	0	0	0	0	0	0	2372	2724	2317	2276
75	Jellyfishes	Gulf	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76	John's snapper	Gulf	0	0	0	0	0	0	0	0	0	0	0	1166	1231	943	1193
77	Karanteen seabream	Gulf	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	Kawakawa	Gulf	1994	2315	2953	2707	2400	2523	2593	1770	3406	3169	4233	9860	10547	12731	13873

20	21	22	23	24	25	26	27	28	29	30	31	
						Patttern code and description		Score	With 3 forming averages based on:			
003	2004	2005	2006									
1102	12620	11843	14096			12	Declining from medium to low level, then rising to high level	76.82	1986-1992	1993-1996	1997-2006	
19	12	267	22			2	Around low level, then rising to medium level	53.34	1986-1996	1997-2004	2005-2006	
113	921	1119	1389			9	Rising from low to high level, then around high level	99.06	1986-1999	2000-2005	2006-2006	
3427	4215	3345	4152			3	Around low level, then rising to high level	77.9	1986-1988	1989-1995	1996-2006	
230	169	121	110			7	Rising from low to high level, then declining back to low level	85.3	1986-1997	1998-1999	2000-2006	
0	107	541	204			3	Around low level, then rising to high level	81.54	1986-2003	2004-2004	2005-2006	
740	1638	1985	2019			8	Rising from low to high level, then declining to medium level	87.08	1986-1986	1987-1999	2000-2006	
3337	3916	5483	6363			6	Rising (all along, or eventually)	93.35	1986-1996	1997-2004	2005-2006	
1574	2100	2759	2793			9	Rising from low to high level, then around high level	97.88	1986-1996	1997-2004	2005-2006	
0	312	358	43			7	Rising from low to high level, then declining back to low level	99.48	1986-2003	2004-2005	2006-2006	
375	1557	1510	1747			6	Rising (all along, or eventually)	97.64	1986-1996	1997-2002	2003-2006	
0	100	0	0			7	Rising from low to high level, then declining back to low level	98.08	1986-2001	2002-2002	2003-2006	
211	11842	13097	14001			6	Rising (all along, or eventually)	96.9	1986-1996	1997-1998	1999-2006	

Figure 2.1.2.2. List of time series and their patterns for RECOFI sub-area 51.2.0 (Gulf)

Table 2.1.1. The 27 different paths of 1-2-3 values of the pointers P_1, P_2, P_3. The 28th element signifies that there is no identifiable pattern (when for instance all time series values are equal to each other).

CODE	Pointers			PATTERN		
1	1	1	1	Mostly around low level		
2	1	1	2	Around low level, then rising to medium level		
3	1	1	3	Around low level, then rising to high level		
4	1	2	1	Rising from low to medium level, then declining back to low level		
5	1	2	2	Rising from low to medium level, then around medium level		
6	1	2	3	Rising (all along, or eventually)		
7	1	3	1	Rising from low to high level, then declining back to low level		
8	1	3	2	Rising from low to high level, then declining to medium level		
9	1	3	3	Rising from low to high level, then around high level		
10	2	1	1	Declining from medium to low level, then around low level		
11	2	1	2	Declining from medium to low level, then rising back to medium level		
12	2	1	3	Declining from medium to low level, then rising to high level		
13	2	2	1	Around medium level, then declining to low level		
14	2	2	2	Mostly around medium level		
15	2	2	3	Around medium level, then rising to high level		
16	2	3	1	Rising from medium to high level, then declining to low level		
17	2	3	2	Rising from medium to high level, then declining back to medium level		
18	2	3	3	Rising from medium to high level, then around high level		
19	3	1	1	Declining from high to low level, then around low level		
20	3	1	2	Declining from high to low level, then rising to medium level		
21	3	1	3	Declining from high to low level, then rising back to high level		
22	3	2	1	Declining (all along or eventually)		
23	3	2	2	Declining from high to medium level, then around medium level		
24	3	2	3	Declining from high to medium level, then rising back to high level		
25	3	3	1	Around high level, then declining to low level		
26	3	3	2	Around high level, then declining to medium level		
27	3	3	3	Mostly around high level		
					?	?
28	0	0	0	*** NO IDENTIFIABLE SHAPE ***	?	?

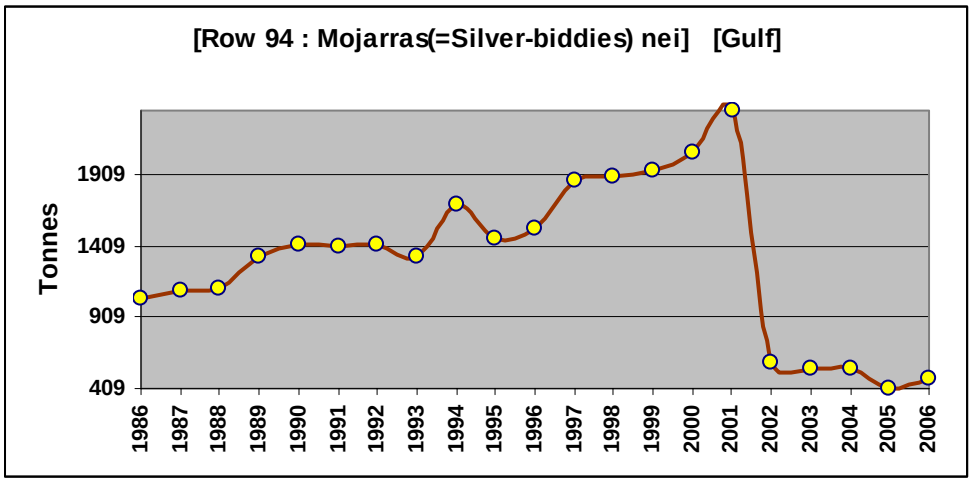

Figure 2.1.2.3. Rising from medium level to high level, and then declining toward low level

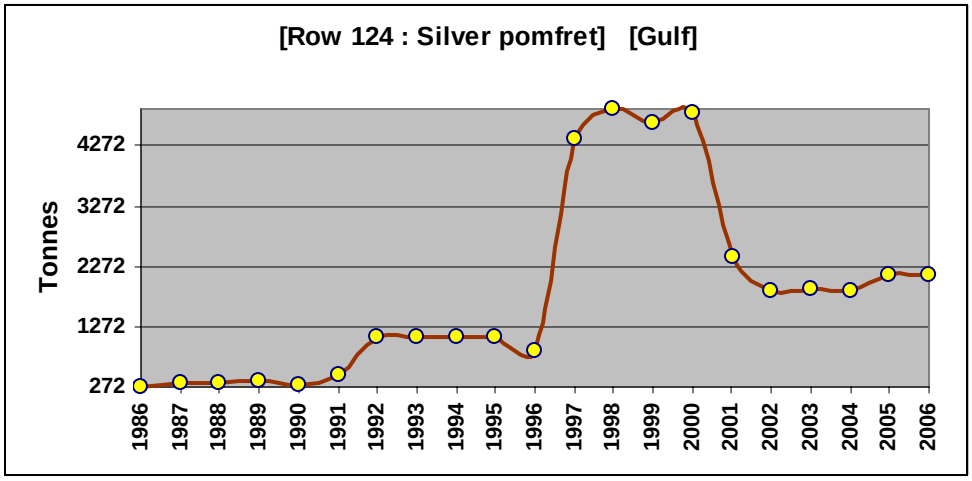

Figure 2.1.2.4. Rising from low to high level, then declining to medium level

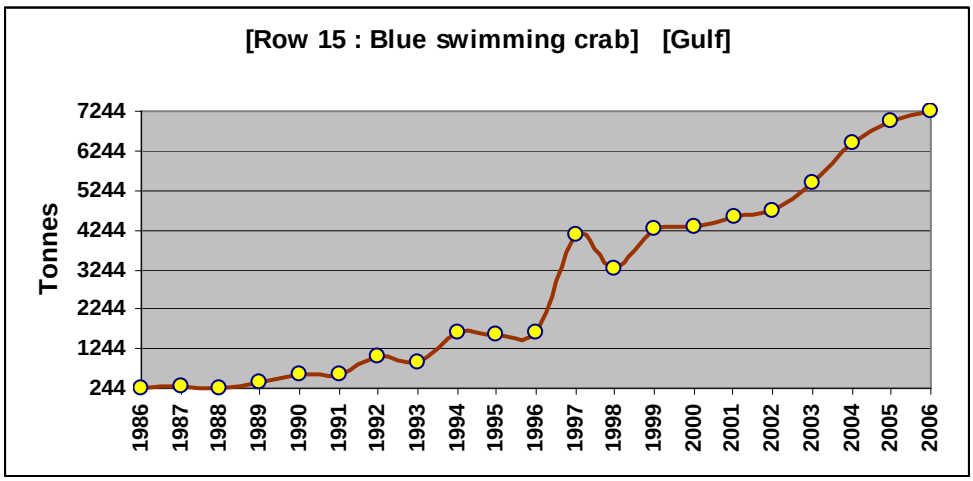

Figure 2.1.2.5a. Rising all along from low to high level

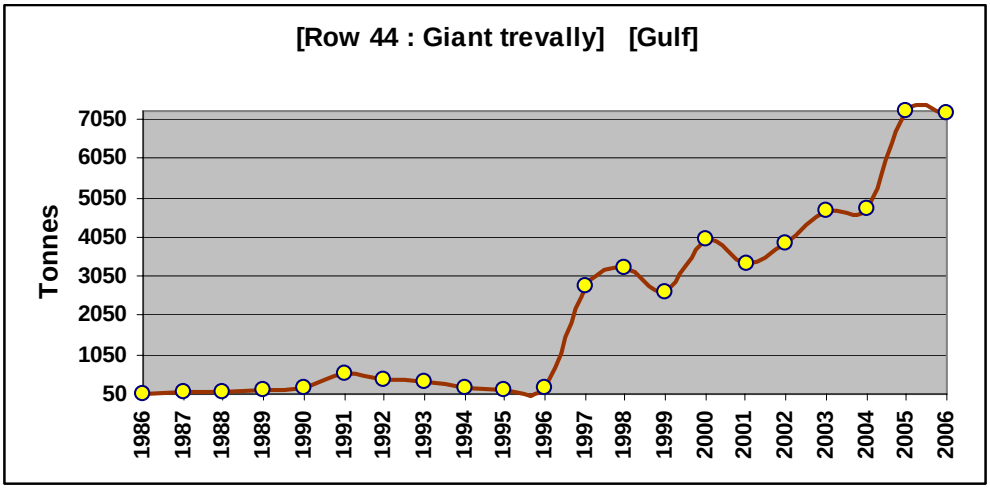

Figure 2.1.2.5b. Rising eventually from low to high level

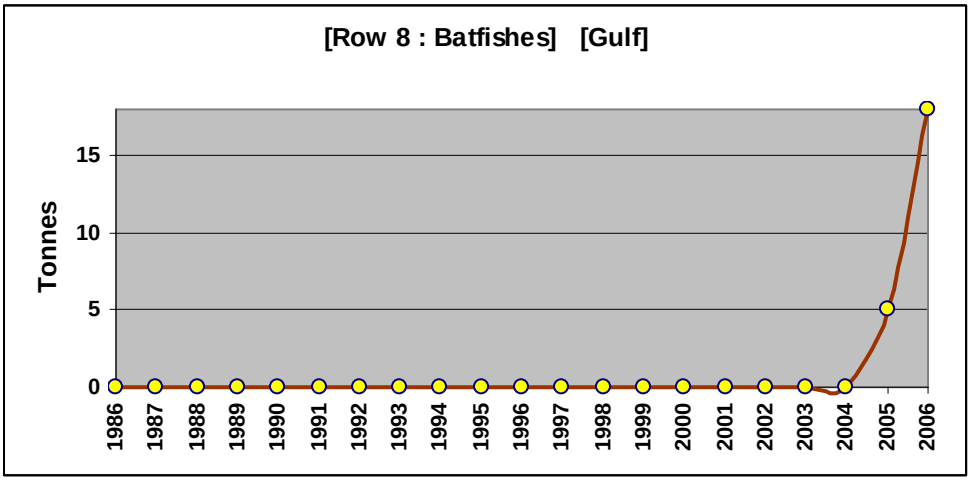

Figure 2.1.2.6. Around low level, then rising to high level

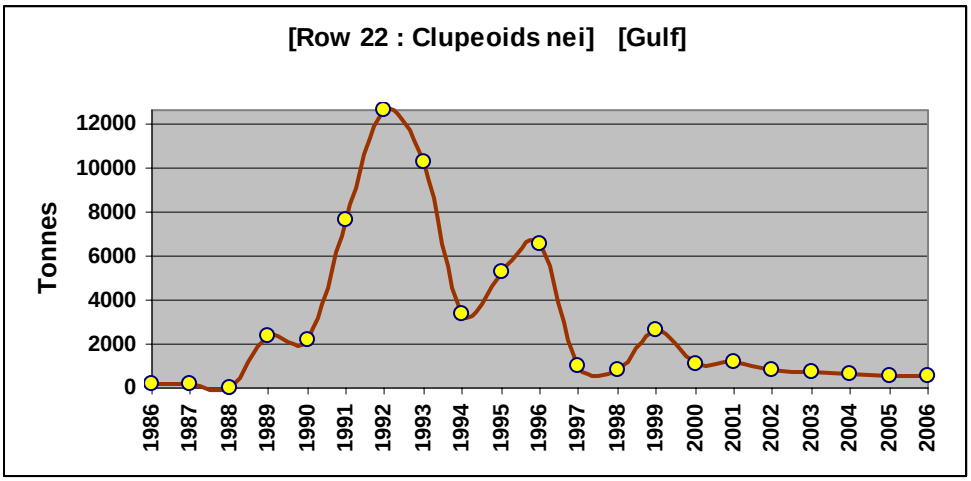

Figure 2.1.2.7. Rising from low to high level, then declining back to low level

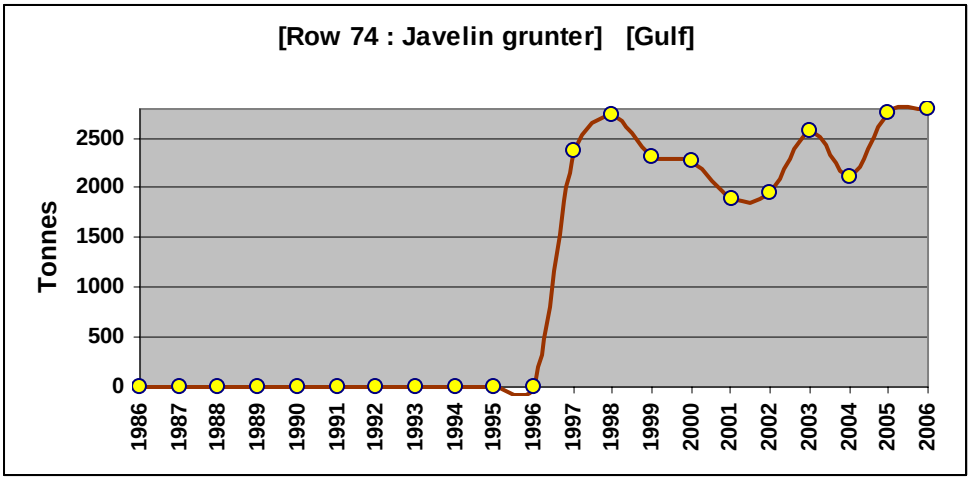

Figure 2.1.2.8. Rising from low to high level, then staying around high level

RECOFI sub-area 51.3.1 (Sea of Oman)

The second application of the PATTERNS program concerns the Sea of Oman, for which FISHSTAT+ furnished 88 time series representing landings by Iran and Oman. Figure 2.1.2.9 illustrates the summary statistics of the landing patterns detected.

Please use the PLOTS worksheet to verify statistics on landing patterns

Capture time series: Statistics on general shapes and landing patterns

Developed by C. Stamatopoulos
FAO Consultant
Fisheries Resources Monitoring and Assessment

RECOFI: Sea of Oman

Number of series processed: 88

	Basic shape	Frequency	% of total landings	% CUMUL.	Shape accur. (%)
6	Rising (all along, or eventually)	22	45.81	45.81	79
16	Rising from medium to high level, then declining to low level	2	20.27	66.08	88
25	Around high level, then declining to low level	1	6.78	72.86	95
12	Declining from medium to low level, then rising to high level	1	6.61	79.47	68
8	Rising from low to high level, then declining to medium level	13	6.1	85.57	79
20	Declining from high to low level, then rising to medium level	2	4.87	90.44	55
7	Rising from low to high level, then declining back to low level	25	4.82	95.26	80
3	Around low level, then rising to high level	1	1.44	96.7	92
4	Rising from low to medium level, then declining back to low level	3	1.09	97.79	80
9	Rising from low to high level, then around high level	2	0.75	98.54	96
22	Declining (all along or eventually)	1	0.49	99.03	59
19	Declining from high to low level, then around low level	1	0.33	99.36	94
2	Around low level, then rising to medium level	4	0.32	99.68	53
5	Rising from low to medium level, then around medium level	2	0.31	99.99	72
28	*** NO IDENTIFIABLE PATTERN ***	8	0	99.99	0

Figure 2.1.2.9. Summary of time series patterns detected for RECOFI sub-area 51.3.1 (Sea of Oman)

Here about 80% of the landings contain records of which about half show a rising pattern (22 and 1 time series respectively) and the other half show a declining one. Figures 2.1.2.10-2.1.2.13 each provide examples of those four landing patterns. The other two cases of interest relate to modal patterns with 13 and 25 records respectively, examples of which are illustrated by Figures 2.1.2.14 and 2.1.2.15.

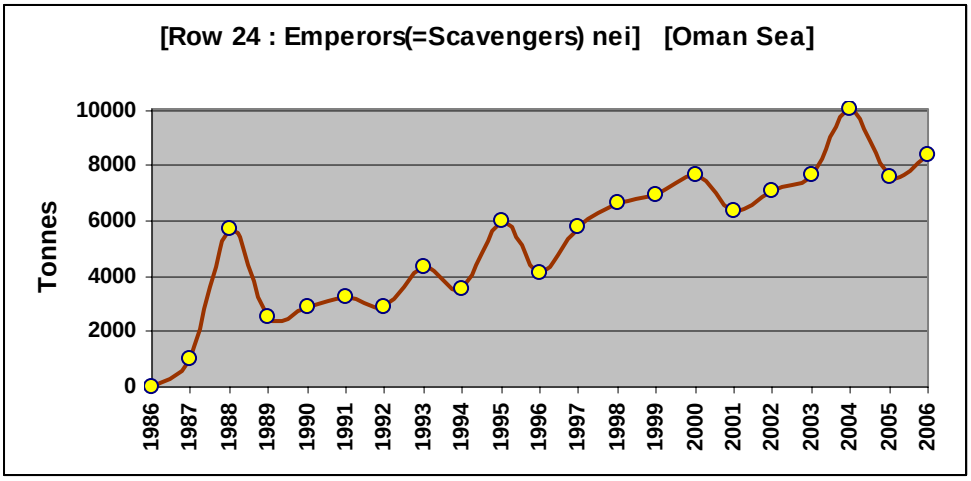

Figure 2.1.2.10. Rising all along

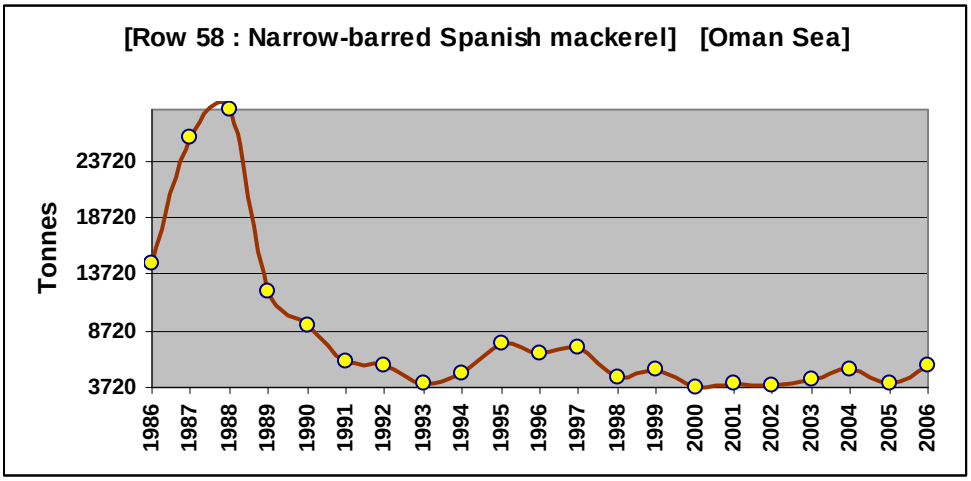

Figure 2.1.2.11. Rising from medium to high level, then declining to low level

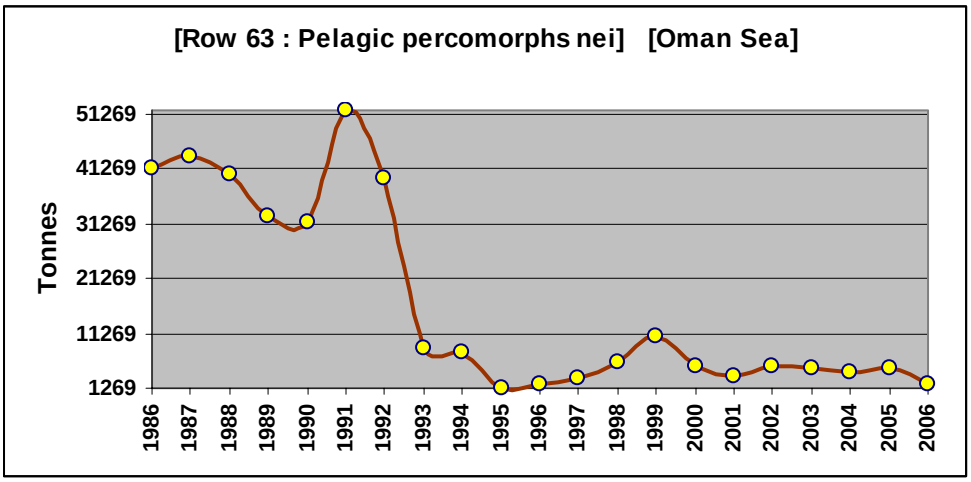

Figure 2.1.2.12. Around high level, then declining to low level

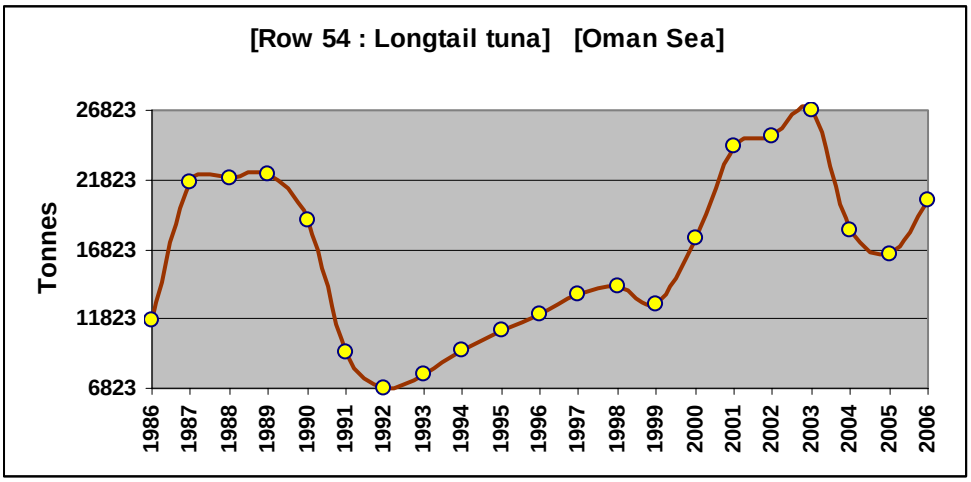

Figure 2.1.2.13. Declining from medium to low level, then rising to high level

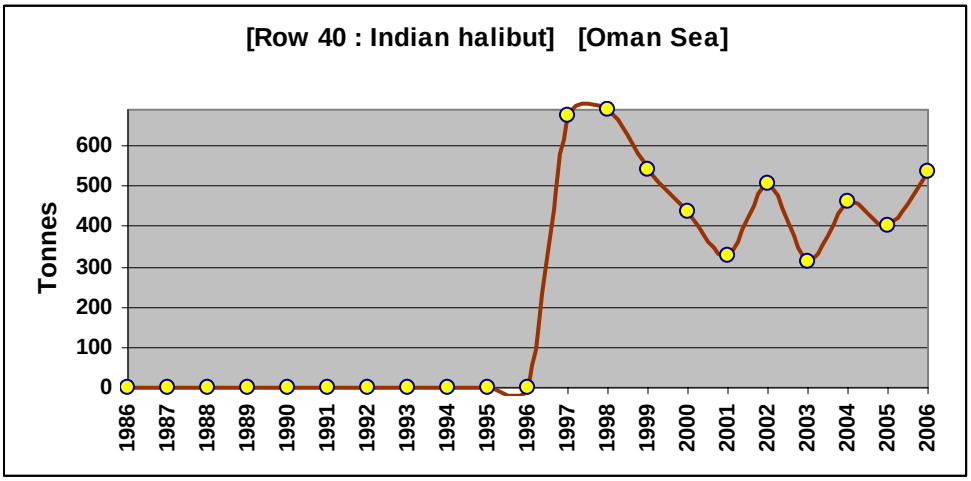

Figure 2.1.2.14. Rising from low to high level, then declining to medium level

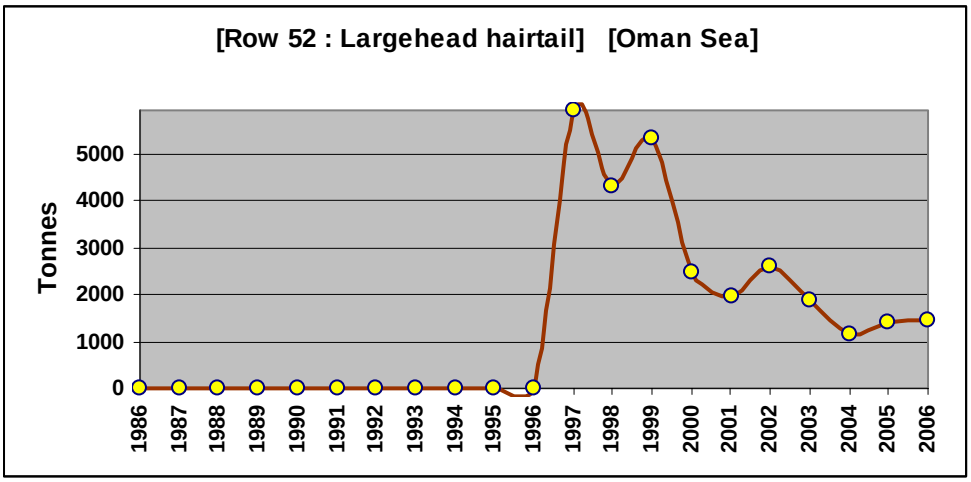

Figure 2.1.2.15. Rising from low to high level, then declining back to low level

2.1.3 The Excel workbook: PATTERNS

The desk study produced an Excel program (PATTERNS.XLS) in order to assist the application of the methodology described in the earlier paragraphs. The program first imports data from FISHSTAT+ and then elaborates them for each of the two RECOFI sub-areas. Following are the instructions on how to extract data from the RECOFI capture database and then analyse them using the PATTERNS.XLS program. .

Step 1: Create a folder on the C: drive with name "C:\AAA_RECOFI_DESKSTUDY and place in it the two generic Excel workbooks PATTERNS.XLS and SPECIES_RANKING.XLS.

Step 2: Access FISHSTAT+ and load RECOFI CAPTURE DATABASE.

Step 3: Use the "FILTER" function in order to select "GULF" (or "SEA OF OMAN") and produce separate results for each of the two sub-areas.

Step 4: Use the "AGGREGATE" function to aggregate countries, leaving areas and species at full detail.

Step 5: Use the "OUTPUT" function to produce a "Simple Report" in SYLK format (spreadsheet-like) written on file "FISHSTAT_WORK" under C:\AAA_RECOFI_DESKSTUDY. This file is the standard input source for both Excel programs.

Step 6: Access PATTERNS.XLS and press CTL+x. The program will automatically import the FISHSTAT+ time series and apply to each record the pattern-finding methodology. The first worksheet provides summary statistics regarding records read, frequencies of time series falling under specific shape categories and percentages of landings for the same shape category.

The worksheet "PLOTS" displays graphs of time series in the species order determined by FISHSTAT+. Each time series has on its right a description of the shape that most fits its data. Placing the cursor anywhere on a record and pressing CTL+p, will produce plots such as those illustrated in the earlier examples. To produce a new plot, the current graphics must be removed, followed by CTL+r to return to the tome series list. The cursor is then returned to its previous position pointing to the last time series plotted.

It is worth mentioning at this point that the principal output of this program is the summary statistics of landing time series patterns. Plotting of individual records is of course useful when used selectively and in this case the pattern is visible and does not need verbal interpretation. But when the dataset of time series is large and involves hundreds or thousands of records, individual screening and manual categorization of patterns becomes impractical and it is then that the summary pattern statistics really becomes useful.

It is advisable that the workbook PATTERNS.XLS is then saved under a different name (i.e. PATTERNS_GULF.XLS) for easy reference and to avoid repetition of all steps for its generation.

Likewise another Excel workbook with name:

PATTERNS_SEA_OF_OMAN.XLS

can be generated using the same approach described above, the only difference being that in Step 3 the Sea of Oman will be selected for inclusion.

Section 2.2. Desk study Method 2: Ranking of species

In analyzing catch time series it is often useful to compare the level of production of species of high importance over two different periods of time. Usually the second period is shorter than the first since emphasis is placed on spotting significant and/or unexpected evolutions of catches over the last 4-5 years, or even ten years in the case of long-lived species whose population consists of several age classes (cohorts).

Methodologically, the process described here is rather simple. Each species time series is split into two periods and then each period is sorted in descending order, usually applying the arithmetic mean (or the total catch) as sort criterion. In this manner two columns are produced showing species in two different ranking orders. It might then occur that some formerly top species has been replaced by another emerging species, or the contrary: a species that showed low catch in the past now it figures amongst the top of the list. And there might be others that maintain their position.

In some cases the change in ranking has a statistical, rather than exploitation meaning. For instance, when *Marine fish nei* shows a drastic drop, this is usually a good sign since it shows that species identification has improved and fewer species are lumped into this category. In other instances the downward shifting of commercially important species might indicate that because of continuing exploitation and reduced abundance, catch of these species is replaced by other species of lower economic value.

Species ranking is perhaps more meaningful when applied within a species group or a combination of relatively similar species groups. In the last example of the three presented here (2.2.1; 2.2.2; and 2.2.3), ranking concerns both RECOFI areas (Gulf and Sea of Oman) and two ISSCAAP[13] species groups: coastal fishes and demersal fishes.

2.2.1 Ranking example 1: RECOFI sub-area 51.2.0 (Gulf)

The RECOFI capture database containing catches for the period (1986-2006) was used in order to apply species ranking (all species) from area 51.2.0 (Gulf). A dataset of 163 species time series was examined and the results are given in Figure 2.2.1.1.

The first column gives the ranking order of each species in the period 1986-2001, followed by the species name and the average annual catch. Next column indicates the ranking order of the same species in the period 2002-2006. If the species has "gained" rank its name is printed in green, if it has lost rank it is displayed in red, if it maintains its position it is shown in blue. Likewise there are ranking order columns for the period 2001-2006, using the same logic as before. Users can also obtain a graphical representation of the evolution of catches for any pair of species (replaced and replacing) by simply clicking on a record and pressing CTL+p.

In this first example *Marine fishes nei* dropped from first position in 1986-2001 to second position in 2002-2006, while *Emperors(=Scavengers) nei* became first. As was mentioned earlier this has a statistical rather than exploitation meaning and indicates that over the last years reporting of catches in the Gulf sub-area gained precision in terms of species details.

[13] International Standard Statistical Classification of Aquatic Animals and Plants (ISSCAAP)

Please select a line and use CTL+p to plot a pair of species in old and new ranks respectively

Capture time series: Changes of top species landings
(stable, increased rank, decreased rank)
Developed by C. Stamatopoulos
FAO Consultant
Fisheries Resources Monitoring and Assessment

RECOFI area: Gulf

Rank	Top species in: 1986- 2001	Aver: 1986- 2001	New rank in: 2002- 2006	Top species in: 2002- 2006	Aver: 2002- 2006	Old rank in: 1986- 2001
1	Marine fishes nei	83257	2	Emperors(=Scavengers) nei	28346	2
2	Emperors(=Scavengers) nei	16822	1	Marine fishes nei	25849	1
3	Longtail tuna	14059	6	Groupers, seabasses nei	18058	5
4	Narrow-barred Spanish mackerel				15572	4
5	Groupers, seabasses nei				13826	11
6	Natantian decapods nei				13387	3
7	Sardinellas nei				10999	10
8	Stolephorus anchovies				8190	6
9	Carangids nei				8001	18
10	Indian oil sardine				7211	21
11	Kawakawa				6498	15
12	Jacks, crevalles nei				6292	31
13	Indian mackerel				6177	25
14	Snappers, jobfishes nei				5574	40
15	Spinefeet(=Rabbitfishes) nei				5366	23
16	Clupeoids nei				5296	41
17	Penaeus shrimps nei				5141	13
18	King soldier bream				5046	53
19	Grunts, sweetlips nei				4942	19
20	Barracudas nei	2696	30	Stolephorus anchovies	4712	8
21	Green tiger prawn	2174	10	Whitefin wolf-herring	4627	34
22	Groupers nei	2077	31	Sardinellas nei	4540	7

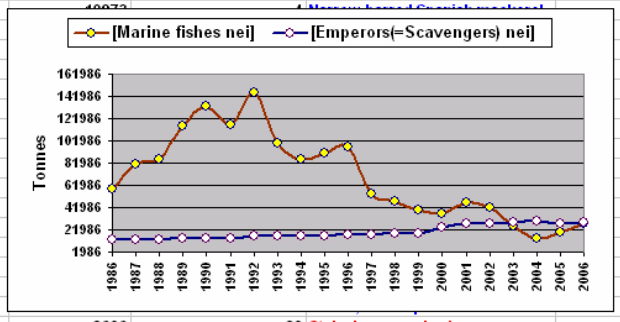

Figure 2.2.1.1: Species ranking in RECOFI sub-area 51.2.0 (Gulf)

2.2.2 Ranking example 2: RECOFI sub-area 51.3.1 (Sea of Oman)

The RECOFI capture database containing catches for the period (1986-2006) was used in order to apply species ranking (all species) from area 51.3.1 (Sea of Oman). A dataset of 88 species time series was examined and the results are given in Figure 2.2.2.1. In this second example *Pelagic percomorphs nei*, ranking third in 1986-2001, dropped to the 18th position in 2002-2006, replaced by *Indian oil sardine* which was 4th in 1986-2001. Notice that *Yellowfin tuna* maintained its second place despite doubling its catch.

Then select a line and use CTL+p to plot a pair of species in old and new ranks respectively

Capture time series: Changes of top species landings
(stable, increased rank, decreased rank)
Developed by C. Stamatopoulos
FAO Consultant
Fisheries Resources Monitoring and Assessment

RECOFI area: Sea of Oman

Rank	Top species in: 1986- 2001	Aver: 1986- 2001	New rank in: 2002- 2006	Top species in: 2002- 2006	Aver: 2002- 2006
1	Marine fishes nei	51446	6	Skipjack tuna	60608
2	Yellowfin tuna	28053	2	Yellowfin tuna	54525
3	Pelagic percomorphs nei	20603	18	Indian oil sardine	41001
4	Indian oil sardine	1			21381
5	Longtail tuna	1			11736
6	Narrow-barred Spanish mackerel				10737
7	Demersal percomorphs nei				9456
8	Skipjack tuna				8170
9	Sharks, rays, skates, etc. nei				7629
10	Emperors(=Scavengers) nei				7082
11	Hairtails, scabbardfishes nei				6974
12	Porgies, seabreams nei				5881
13	Cuttlefish, bobtail squids nei				5840
14	Groupers nei				5134
15	Clupeoids nei				4715
16	Croakers, drums nei				4660
17	Anchovies, etc. nei				4627
18	Kawakawa	2701	21	Pelagic percomorphs nei	4305
19	Barracudas nei	2207	17	Groupers nei	4287
20	Carangids nei	2185	20	Carangids nei	3434
21	Jacks, crevalles nei	2004	24	Kawakawa	3070
22	Indo-Pacific sailfish	1701	7	Common dolphinfish	3050

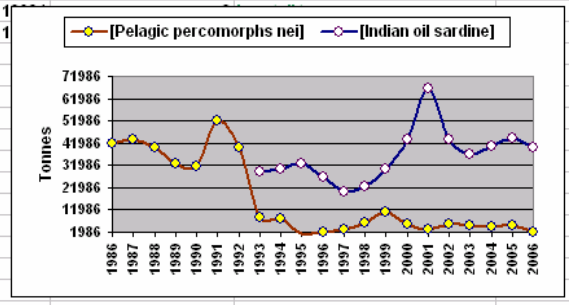

Figure 2.2.2.1. Species ranking in RECOFI sub-area 51.3.1 (Sea of Oman)

2.2.3 Ranking example 3: Coastal and demersal fish in both RECOFI sub-areas

The RECOFI capture database containing catches for the period (1986-2006) was used in order to apply species ranking for the combined ISSCAAP groups Coastal fishes and Demersal fishes from areas 51.2.0 (Gulf) and 51.3.1 (Sea of Oman). A dataset of 84 species time series was examined and the results are given in Figure 2.2.3.1. Here, the two top species in the period 1986-2001, emperors [=scavengers] nei and groupers, seabasses nei, maintained their top positions. The third top species (demersal percomorphs nei) fell from the third to the sixth position, its place taken by croakers, drums nei, which was ranked 6th in the earlier period.

Please select a line and use CTL+p to plot a pair of species in old and new ranks respectively

Capture time series: Changes of top species landings
(stable, increased rank, decreased rank)
Developed by C. Stamatopoulos
FAO Consultant
Fisheries Resources Monitoring and Assessment

RECOFI area: Gulf

Rank	Top species in: 1986- 2001	Aver: 1986- 2001	New rank in: 2002- 2006	Top species in: 2002- 2006	Aver: 2002- 2006	Old rank in: 1986- 2001
1	Emperors(=Scavengers) nei	21174	1	Emperors(=Scavengers) nei	36516	1
2	Groupers, seabasses nei	10329	2	Groupers, seabasses nei	18058	2
3	Demersal percomorphs nei	6754	6	Croakers, drums nei	9194	6
4	Porgies, seabreams nei				8001	11
5	Groupers nei				7780	4
6	Croakers, drums nei				7700	3
7	Hairtails, scabbardfishes nei				7422	9
8	Snappers, jobfishes nei				6957	5
9	Spinefeet(=Rabbitfishes) nei				6259	17
10	Grunts, sweetlips nei				6237	12
11	King soldier bream				6143	14
12	Tigertooth croaker				5962	7
13	Largehead hairtail				5819	10
14	Sea catfishes nei				5296	20
15	Mullets nei				3991	19
16	Mojarras(=Silver-biddies) nei				3672	18
17	Japanese threadfin bream				3031	26
18	Greater lizardfish				2962	13
19	Javelin grunter				2452	22
20	Klunzinger's mullet	1090	14	Pink ear emperor	2349	33
21	Bluespot mullet	1079	26	Snappers, jobfishes nei	2309	8
22	Orange-spotted grouper	1069	19	Spangled emperor	2249	35

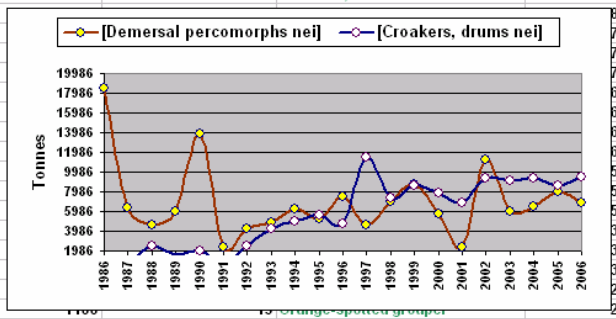

Figure 2.2.3.1. Species ranking in RECOFI sub-areas 51.3.1 (Sea of Oman) and 51.2.0 (Gulf) including species of two ISSCAAP groups (Coastal fishes and Demersal fishes)

2.2.4 The Excel workbook: SPECIES_RANKING

The desk study produced a second program in order to assist the application of the ranking process described in the earlier paragraphs. The workbook first imports data from FISHSTAT+ which are then passed on to the Excel workbook for ranking and plotting. Following are the instructions on how to extract data and run the Excel macros.

Step 1:

Unless already created, set-up a new folder on the C: drive with name "C:\AAA_RECOFI_DESKSTUDY and place in it the two generic Excel workbooks PATTERNS and SPECIES_RANKING.

Step 2:

Access FISHSTAT+ and load RECOFI CAPTURE DATABASE.

Step 3:

Use the “FILTER” function in order to select “GULF” (or “SEA OF OMAN”) and produce separate results for each of the two sub-areas. The same filtering technique can be used to select species or combine ISSCAAP species groups.

Step 4:

Use the “AGGREGATE” function to aggregate countries and areas, leaving species at full detail.

Step 5:

Use the “OUTPUT” function to produce a “Simple Report” written on file “FISHSTAT_WORK” under C:\AAA_RECOFI_DESKSTUDY. This file is the standard input source for both Excel programs.

Step 6:

Access SPECIES_RANKING.XLS and press CTL+x. The program will automatically import the FISHSTAT+ time series and apply the ranking procedure.

The worksheet “TWO AVERAGES” illustrates the whole set of time series in the order determined by FISHSTAT+. Each time series is split into two periods and species landings are ranked separately in descending order for each period. Those “gaining” rank are marked in green, those “losing” are marked in red, and the ones that stay at same ranking level are marked in blue. Placing the cursor anywhere on a record and pressing CTL+p will produce a plot similar to those illustrated earlier but showing the two species that appear in the first and second ranking order. To produce a new plot, the current graphics must be removed, followed by CTL+r. The cursor is then returned to its original position pointing to the last time series selected.

It is advisable that the workbook SPECIES_RANKING.XLS is then saved under a different name (i.e. SPECIES_RANKING_GULF.XLS) for easy reference and to avoid repetition of all steps for its generation.

Section 2.3: Other methods for the analysis of catch time series that are adaptable to RECOFI data

2.3.1 FISHSTAT+

This is the cornerstone of all analytical approaches applied to the Global Catch Database. FISHSTAT+ was developed in the early 90's and underwent several upgrading phases before taking its present form. Its main characteristic is that each of its annual issues is preceded by several stages of checking and editing in which both FAO and reporting countries participate. Secondly, FISHSTAT+ responds immediately and effectively to requests as complex as: "Landings of crustaceans for the period 1990-2002 and only from the Gulf area, structured to also contain the averages of the periods 1990-1998 and 1999-2002, and including only the top 12 species of the second period".

All these requirements are immediately interpreted into FISHSTAT+ functionalities and the transformed data become available in a matter of seconds. These can then be passed on to other applications software (such as Excel, Access, Xcelcius, etc.) for further processing and analysis. All approaches used in the desk study and in the other time series applications described in the coming sections, made use of the FISHSTAT+ database and data processing engine.

FISHSTAT+ is available free-of-charge on the FAO web and can be easily downloaded and locally installed. It is fully documented and the operational guidelines cover the entire spectrum of its functions. Its learning curve is fast and can become faster if the system is demonstrated by means of live examples. In this respect the desk study proposes that the second meeting of the RECOFI Working Group on Fisheries Management (WGFM - formerly the Working Group on Fishery Statistics) includes a short presentation of FISHSTAT+ for the benefit of those participants who are not yet aware of its data management potential.

2.3.1 Trend analysis and fisheries potential

This method was developed by Grainger and Garcia in 1996. A full description is given in Fisheries Technical Paper FI/TP/359 entitled "Chronicles of marine fisheries landings" (1950-1994).

World fishery landing statistics as disseminated by FAO have been completely revised for the period 1950-1969 and time series in the database have been extended backwards by 20 years, so that the period covered by the study is 1950-1994. Through a preliminary analysis of trends, globally first and then by oceans, it was attempted to demonstrate that the extended time series can be very useful in interpreting developments in the world's fisheries and so help in assessing the present situation as well as for planning and policy-making for the future. Grouping the 200 most important resources into a few categories according to the shapes of their landing trends, reveals a variety of patterns which seem to form different segments of a generalized fishery development model comprising undeveloped, developing, mature and senescent phases. The analysis demonstrates strikingly the succession of the passage of the majority of the world's major resources through these phases, indicating the current general saturation of fisheries development and increasing overexploitation.

Fisheries potential was estimated by predicting at which point the relative rate of increase of landings is zero, using the same generalized fishery development model applied to total fishery production data for marine fish and shellfish. The analysis was applied using data aggregated to three different levels, namely (1) a total for all oceans, (2) totals for each ocean, and (3) individual FAO major fishing areas. Estimated fishery potential for the world's oceans increases as the level of aggregation of the data decreases, and the results indicate that marine fishery potential may be higher than has been assumed

up to now. The areas and resources which might provide potential increases in production are identified.

2.3.2 Long- and short-term trends of Mediterranean fishery resources

This method was developed in 1997 by Caddy, Fiorentini and de Leiva.

The study made use of the 1995 issue of FAO catch time series covering the period 1950-1994. The objective was to analyze long-term trends and separate them automatically in a number of categories using an expert system for data analysis. Landing time series of the most important commercial species and groups of species of both West (148 species) and East (137 species) Mediterranean have been processed with this program, in order to analyze and categorize long- and short-term trends in these fisheries. Species trends have been categorized following a description of the different stage a fishery could pass through in time (new, rising, stable, declining, recovering and collapsed fisheries). Species have been also arranged into ecological or biological categories (estuarine, benthic and coastal, pelagic, large pelagic, demersal and slope resources), and differences between West and East Mediterranean trends were sought for the same and different species. A ranking of the most important commercial species using 1992 catches, as well as by 1992 total value of landings, has been carried out, and a comparison between West and East Mediterranean fisheries has been provided.

2.3.3 GFCM priority species: a simple information tool for the visualization of the open-access capture fisheries landing data

The method described below is among the most adaptable to RECOFI data. It was developed in 2006 by Barone, De Rossi, Mannini and Marttin with the objective of analyzing landing time series contained in a database specifically created for the Mediterranean.

Introduction

The General Fisheries Commission for the Mediterranean (GFCM) database, maintained by the Fishery Information, Data and Statistics Unit of the FAO Fisheries Department, presents annual nominal catches allocated by countries or areas, by species and statistical divisions, and the capture production (catches expressed as live weight equivalent of landings) in the Mediterranean and the Black Sea region for calendar years starting with 1970 (FAO, 2006).

Notwithstanding the variable reliability of historical data series of catches in the Mediterranean, time series of fishery landings can provide important indication of changes in the past. The FAO data set of nominal catches has often been used with various empirical approaches based on the analysis of the landing patterns, in an attempt to evaluate the current state of the fisheries. Fiorentini, Caddy and de Leiva (1997), using the analysis of a large number of Mediterranean important commercial species, distinguished 11 types of catch trends categories. Garcia and de Leiva Moreno (2001) classified 441 stock items, for which there was some information on the state of the stock, as underexploited, moderately exploited, fully exploited, over-exploited, depleted or recovering.

The method presented in this section focuses on the species listed as of priority interest by the GFCM (also referred to as “GFCM priority species” and examples are given of the time series of landing data from the Mediterranean FAO statistical sub-areas and divisions and from the individual countries. For each species: an elementary statistical analysis (change relative to mean, trend of relative rate of increase, linear trend analysis over the last ten year period) was made and the percentage of missing values of the series in countries and statistical divisions was evaluated.

Furthermore, a simple tool for the easy and quick visualization and preliminary analysis of the priority species landings series is presented. This information tool can provide additional information for the stock assessment and fisheries appraisal work within the framework of the Scientific Advisory Committee of the GFCM.

The use of the information in Xcelsius, the data processing engine, is almost intuitive. The user can select a species from the list box, and select an area by clicking directly on the map. The name of the chosen species and area will be displayed, and the charts corresponding to the several analyses will change according to selection.

Materials and methods

Nominal landing data were extracted from the 1970-2004 GFCM capture production dataset using FISHSTAT+ (Version 2.31). Data were filtered for the 41 GFCM priority species and for the 30 countries in the 7 Mediterranean statistical divisions (Sardinia, Aegean, Balearic, Ionian, Gulf of Lions, Adriatic, and Levant). The series per sub-areas (Western, Central and Eastern) and for the whole Mediterranean were calculated. The landing series from the Black Sea and from tuna fisheries were not considered.

The tool analyses data only from complete data series, and calculates percentages of missing series, and missing values. The missing series percentages were calculated according to the formula:

Missing series % = {1 – ([Number of complete series per species]/[Total number of countries])}*100

Missing values were calculated according to:

Missing values % = {1 – ([Number of values per species]/([Number of countries(=27)]*[Number of years(=35)])} *100

In this context, the series from the eastern Adriatic countries (Yugoslavia SFR, Slovenia, Croatia and Montenegro) were compiled into a unique series.

The missing series percentage could be considered as an indicator of the occurrence of, and the reporting on, the selected species in the considered area. The missing values percentage could be considered an indicator of the quality of the series of data of the selected species.

For the series from 1970 to 2004 whose records were blank or filled with zeroes, the following statistics was produced:

Change relative to mean: $(L_t\text{-AVG})/AVG$[14]

Each time series was standardized by subtracting the mean and dividing it by its standard deviation. Standardization was done in order to compare the pattern of different series in the same statistical area.

Series standardised: Lt-AVG/STDEV

[14] Notation used refers to: L_t= annual total landing series; t=year; AVG= average; STDEV= standard deviation.

In addition, the series from 1995 to 2004 were selected in order to evaluate, through linear regression, whether a significant trend was present over the last ten years. Series whose records were blank or filled with zeroes were excluded from this analysis.

Analyses of all the landing series are available in a dynamic Excel file, and the user can scroll down and select the species from the species list and then clicking on a map to select country, division, sub-area, or the whole Mediterranean.

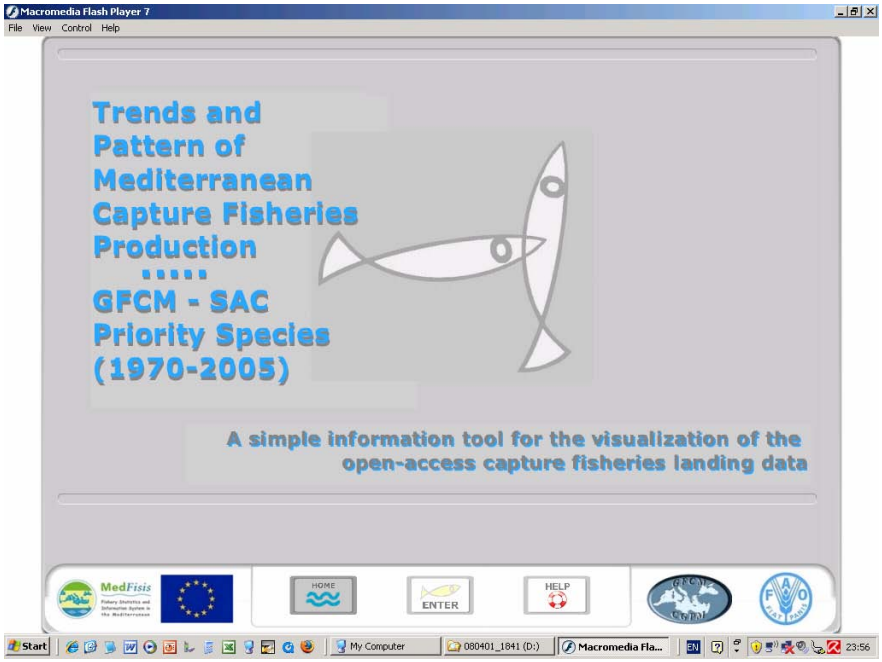

Figure 2.3.3.1. The main screen of the Xcelsius-based application dealing with basic analyses using GFCM time series of landings

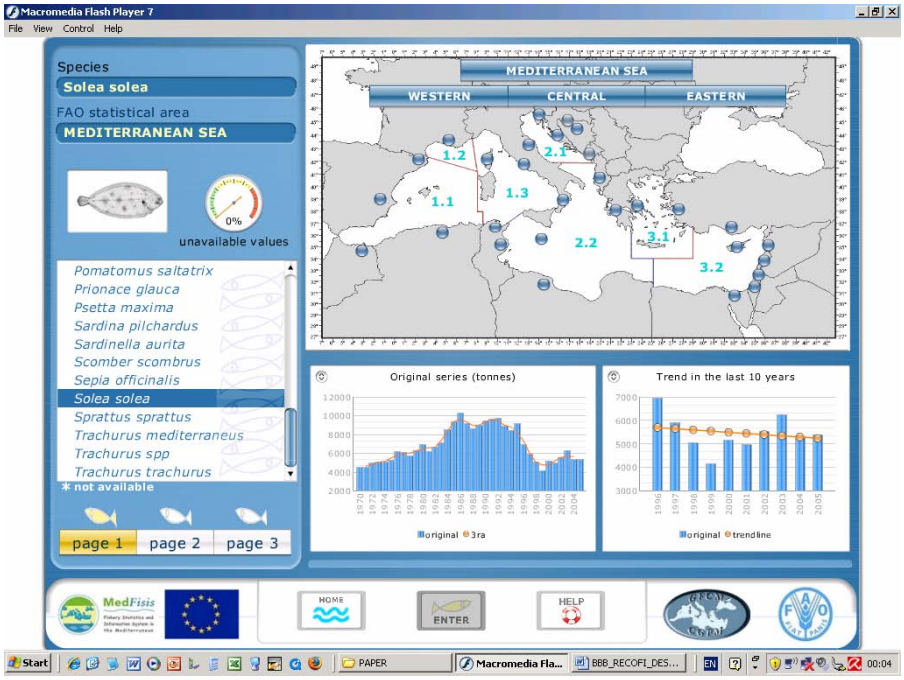

Figure 2.3.3.2. An example of a first set of outputs deriving from the application of the Xelcius software for *Solea solea* in the whole Mediterranean

Figure 2.3.3.3. An example of a second set of outputs deriving from the application of the Xelcius software for *Solea solea* in the whole Mediterranean

Figure 2.3.3.4. An example of a third set of outputs deriving from the application of the Xelcius software for *Solea solea* in the whole Mediterranean

Chapter 3

Harmonization and integration

It has already been mentioned that looking at the RECOFI fisheries statistics in a regional perspective requires that each national fisheries statistical programme becomes a component of a logical network comprising not only data but also integration processes and standardized methodology. In this chapter the desk study first examines the level of harmonization already achieved in species classification, and it then proceeds to examining the more complex process of harmonization and integration of fishing fleet and effort statistics. It concludes by presenting a number of commonly used international standards in sample-based data collection operations, in order to set-up a minimum target for accuracy with regards to catch and effort estimates.

At this point it is perhaps useful to underline that the terms “harmonization” and “integration” do not imply the introduction of a single and uniform statistical system across RECOFI member countries. They rather mean the stepwise introduction of commonly agreed classifications with the view of making nationally-produced statistics comparable at regional level. This clarification hopefully responds to the concern expressed in the past by some RECOFI Members that a regional harmonization exercise might hamper the operations of their respective national systems and cause disruption to historical data and time series.

3.1 Harmonization of species classification in RECOFI

This section takes stock of the achieved integration of annual catch data and provides some first findings relating to the commonly used species classification for reporting to FAO. The desk study assumes that (at least for the foreseeable future) the same species classification will be used for other regional datasets with expanded scope, such as the one proposed in Section 3.2.

Annex C illustrates an Excel worksheet containing 177 different species reported by RECOFI Members to FAO as at June 2008. Table 3.1.1 is a segment of that table and shows the number of different species reported by each RECOFI member. It is known however that some national fisheries statistical programmes operated by RECOFI Members collect species data at a more detailed level; such a coverage will be better understood if and when a thorough review of the national programmes will be conducted (refer also to Sections 1.2 and 1.3).

Species refer to reported catches from sub-areas 51.2.0 (Gulf) and 51.3.1 (Sea of Oman).

Table 3.1.1. A segment of the RECOFI species reporting table (177 different species at ISSCAAP level). The number of species reported to FAO by countries is indicated below each country name.

A	B	C	D	E	F	G	H	I	J
	RECOFI: Harmonization of statistical data at regional level - Species classification as of June 2008								
	SPECIES COVERAGE	Bahrain	Iran	Iraq	Kuwait	Oman	Qatar	Saudi Arabia	UAE
		54	58	4	19	52	35	86	43
156	*Talang queenfish*	1	1					1	
157	*Terapon perches nei*							1	
158	*Threadfin and dwarf breams nei*	1				1	1	1	
159	*Threadfin breams nei*				1				1
160	*Tigertooth croaker*		1						
161	*Torpedo scad*	1				1			1
162	*Tropical spiny lobsters nei*		1			1			
163	*Trout sweetlips*	1							
164	*Tuna-like fishes nei*		1				1	1	
165	*Two-spot red snapper*							1	
166	*Twobar seabream*	1	1					1	1
167	*Various squids nei*							1	
168	*White-blotched grouper*							1	
169	*Whitefin wolf-herring*		1					1	
170	*Wolf-herrings nei*								1
171	*Yellowbar angelfish*	1						1	
172	*Yellowfin hind*							1	
173	*Yellowfin seabream*				1		1	1	1
174	*Yellowfin tuna*		1			1			
175	*Yellowstripe goatfish*							1	
176	*Yellowstripe scad*								1
177	*Yellowtail scad*							1	

3.2 Integration of catch, fleet and effort data in RECOFI

Harmonization of nationally-collected fisheries statistics at regional level can be achieved only progressively and only in those sectors where data are available at the required level of detail. At this stage it would not be practical to propose an all-at-once implementation of integrated databases containing monthly data on fleet, catch, effort, prices, fish size, fuel costs, etc., when it is yet not known if all RECOFI Members are in a position to participate in the exercise. This means that data types and variables on which information is to be integrated should be tailored to the capacity and structure of national fisheries and not be dependent on drastic changes to ongoing data collection operations that are being operated by member countries.

It is on the basis of these observations that the present desk study suggests that expansion of current RECOFI data be limited to annual catch, fleet capacity and effort statistics directly deriving from ongoing national fisheries statistical programmes and further integrated at regional level.

Such an approach will require further harmonization at regional level of: (i) boat types, (ii) fishing gear categories and (iii) fishing effort measures.

3.2.1 Boat types

With regards to boat types and in view of the increased complexity of dealing with multiple combinations of boats and gears, it is proposed here that the harmonization and integration exercise starts with only three major boat categories, namely:

- “Small” fishing craft;
- “Medium” boats;
- “Large” vessels.

The terms “small”, “medium”, “large” used in the present context are generic and refer to a commonly accepted differentiation of fishing boats using combined criteria involving length, power, capacity, trip duration and performance. For instance, the term “small boats” generally refers to non-motorized craft or to motorized boats with small engines, doing short fishing trips (mostly 1-2 days), carrying a small crew and be up to 12 metres in length overall (LOA).

Large boats are normally those that make one or two landings during a month or be absent from port for several weeks, are powered to sail long distances and carry on them a variety of equipment for fishing and fish processing operations. This category includes fishing vessel above 24 m LOA.

The middle category is perhaps the most difficult to determine. The term “medium” refers to boats that are neither “small” nor “large”, that is to fishing vessels that are longer and more powerful than the small ones, being at the same time smaller and less powerful and equipped than the large ones. Generally, the medium size category encompasses boats whose LOA is above 12 and less than 24m LOA.

Another conventional way of categorizing fishing boats is to use the terms “small-scale” (or “coastal”, or “artisanal”) for the first category, “semi-industrial” for the second, and “industrial” for the third. This categorization is mostly based on the kind of fishing operations and activity. Generally, however, the problem of setting-up a simple and, at the same time, accurate and practical categorization of boat types has not yet been satisfactorily resolved. There exists of course the statistical classification of fishing boats used by FAO for its fishing fleet database (Annex D), but such a detailed breakdown of

boat types combined with several gear categories would result in a practically unusable list of boat-gear combinations.

3.2.2 Types of fishing gear

Annex B illustrates the International Standard Statistical Classification of Fishing Gear (ISSCFG). Here, again, gear types applicable to RECOFI Members, if included at full detail and then combined with the three boat types described earlier, would result in a still complex and not too usable list of boat-gear combinations. It is thus suggested that only the major gear groups are used without further breakdown, such as TRAWLS (for bottom trawls, mid-water trawls, shrimp trawls, etc.), GILLNETS AND ENTANGLING NETS (for gillnets, driftnets, trammel nets, etc.), and so on, coming out with a total number of 11 major gear groups of which the last is reserved for "UNSPECIFIED". Of course the proposal presented here will first be thoroughly reviewed by RECOFI Members prior to any action taken toward its implementation at regional level.

3.2.3 RECOFI catch/fleet/effort data reporting format

Figure 3.2.3.1 illustrates a proposed format for the reporting of RECOFI annual catch split by vessel and gear type. In terms of data generation this type of reporting may be achieved through the following procedures:

- Automatic generation of records using grouped data contained in nationally maintained catch/effort databases;
- Manual inputting of grouped data using the Excel template illustrated in Figure 3.2.3.1.
- Semi-automatic approaches (a combination of first and second procedures);

In data reference terms each template will correspond to: (i) a RECOFI member, (ii) a calendar year, and (iii) a RECOFI sub-area (Gulf or Sea of Oman).

The first record to be completed is the one specifying total numbers of active fishing units organized by boat category and gear type; "active" in the sense that the boats in subject are known to have operated in the sub-area of reference. For each of these items a second estimate will be given (using the record beneath) specifying an average number of days worked during the year. This empirical estimate should evidently be smaller than 365 (or 366). In the event that both the number of active boats and their effort (expressed in fishing days) are known, the number of days worked is found by dividing effort by the number of boats. It should be noted here that, conventionally, the duration of trips made by artisanal fishing craft is considered as a reasonably accurate measure of fishing effort, while in the case of medium and large boat categories fishing effort does not include time to sail to/from fishing grounds.

All other records of the template correspond to species according to the harmonized RECOFI classification used for reporting to FAO. Hence catch figures under TOTAL should always tally with those contained in the RECOFI capture database. Completion of these records constitutes the real task of the exercise since it involves splitting species totals into components according to the different boat/gear types used.

	A	B	C	D	E	F	G	H
1	**RECOFI: Reporting of fleet capacity, catches and fishing effort**							
2	Year: Country: RECOFI sub-area:							
3	Gears or fishing methods:		01 Surrounding nets			02 Seine nets		
4	Boat size category:		Small	Medium	Large	Small	Medium	Large
5	Number of operational vessels:							
6	Days worked in year (<=365):							
7	Species name	TOTAL						
8	*Abalones nei*							
9	*Albacore*							
10	*Amberjacks nei*							
11	*Anchovies, etc. nei*							
12	*Areolate grouper*							
13	*Barracudas nei*							
14	*Bartail flathead*							
15	*Batfishes*							
16	*Bigel nei*							
17	*Bigeye croaker*							
18	*Bigeye trevally*							
19	*Bigeye tuna*							
20	*Black marlin*							
21	*Black pomfret*							
22	*Blackspotted rubberlip*							
23	*Black-streaked monocle bream*							
24	*Bloch's gizzard shad*							

Figure 3.2.3.1. Section of a proposed format for the reporting of RECOFI annual catch data split by vessel and gear type.

3.2.4 First uses of a RECOFI catch/fleet/effort database

Assuming that the proposed data submission format proves realistic enough and that RECOFI Members would in the near future be able to regularly contribute annual statistics on fleet, catch and effort, it would then seem also reasonable to assume that integration of such data should not constitute a major task and that an expanded RECOFI database could be implemented within a relatively short period (Table 1.4.1).

Implementation of such a regional database should significantly increase the analytical potential of RECOFI Members, since they would be able to conduct studies, at regional level, in which fishing capacity and fishing effort would play a key role. From a long list of potential uses of the database the following four applications may be considered as most typical:

Abundance and exploitation

Catch-Per-Unit-Effort (CPUE) or catch rate is frequently the single most useful index for long-term monitoring of a fishery. It is often used as an index of stock abundance (relative abundance), where some relationship is assumed between the index and the stock size. It can also be used in monitoring economic efficiency. Catch rates by boat and gear categories, often combined with data on size at capture, permit a large number of analyses relating to gear selectivity and indices of exploitation.

Fishing operations

Fishing operations describe the composition of fishing fleets and fishing patterns and are the basis of most management decisions. They are important for monitoring compliance and in analyses involving fishing effort.

Gear selectivity and catch composition

It is often useful to obtain data indicative of the species that are targeted by different boat/gear categories and/or fishing methods, together with other information relating to the size of the fish being caught. These datasets are used for a wide variety of in-time and in-space comparisons of gear selectivity indicators.

Fishing mortality

Fishing effort is one of the variables used to estimate fishing mortality. Fishing mortality is a fundamental variable in stock assessment, representing the proportion of stock that is removed due to fishing. Effort is used in setting most fishery management measures. Changes in total fishing effort may be an indication of stock status, fishing profitability or fishery management implementation.

Section 3.3 Standard rules in sample-based data collection

This section deals with basic concepts relating to sample-based fisheries statistical programmes operated by RECOFI Members. It primarily focuses on practical operational aspects and its intention is to highlight some of the commonest problems encountered in sample-based fishery surveys. It will also provide a set of practical guidelines that may assist RECOFI Members to improve the cost effectiveness of their national statistical programmes.

RECOFI countries are at present operating a variety of methods for data collection and processing, involving both census-based and sample-based schemes for data collection. The first applies primarily to industrial and semi-industrial fisheries and data are directly obtained from the operators themselves, usually as part of the licensing process. The sampling approach is used for the small-scale fisheries which are generally characterized by high dispersion combined with large numbers, thus making impractical the collection of information on a complete enumeration basis.

Most of the RECOFI Members have well-defined and robust sample-based systems which operate regularly and cover satisfactorily basic variables on catch, effort, CPUE, prices and fish size. In fact, there are known cases of systems deploying intense and frequent sampling and which systems could become less demanding in data collection effort while maintaining present levels of reliability and accuracy. In some other countries sampling approaches ought perhaps to be upgraded using methodological and operational standards recently published by FAO (see References).

There are also cases that RECOFI national administrations with limited human resources cannot sustain census-based operations for the whole fishing fleet, with the result that there are always gaps in their catch reports. This difficulty might perhaps be resolved by switching from census-based to sample-based approaches, at least for important fishery sectors for which serious coverage problems seem to constitute a chronic problem.

3.3.1 A generic catch/effort estimation approach

While national catch/effort assessment programmes have different methodological and operational characteristics, they conceptually all obey the rule of estimating catch and effort within a specific logical entity consisting of: (i) a time period (i.e. calendar month), (ii) a boat/gear category (for instance motorized gillnets), and (iii) a limited geographical area or stratum. Within each entity (or estimation context) the following generic expression applies:

[Estimated total catch] = [Estimated overall CPUE] x [Estimated effort] (3.3.1)

From the above expression it becomes apparent that design and implementation of a sample-based data collection programme is a complex process which is summarized in next paragraph.

3.3.2 Operational features of the generic catch/effort expression

- Structuring approaches for partitioning the statistical area into geographical strata (administrative and logical-statistical);
- Structuring must also include all locations at which boats land their catch or ports from which boats habitually start their trip (home ports). A location may be both a home port and a landing site.
- Setting-up classification schemes for species, boat categories and gear types. This operation is of utmost importance because it will condition and streamline the operations of all data collection surveys.
- Establishing a fishing vessel register for all fishing units. The design of the register must be such so as to allow for the following functions:

    - Automatic generation of boat counts by site and by boat/gear category. This is feasible only when the register contains data at a level of detail which is higher than that of other sub-systems.
    - Automatic re-allocation of boats to home ports and/or gears in cases of anticipated seasonal variations (i.e. seasonal migration of fishing units).
    - The vessel register system must have built-in mechanisms for the continuing updating of records, so as for the database to reflect latest additions, removals and modifications of boats.

- A sampling frame is a table organized by site and boat/gear type that contains boat counts and thus supplies spatial extrapolating factors for the estimation of fishing effort. Whether or not a register of artisanal fishing boats is available or not, a frame survey should be periodically conducted (e.g. every five years at the most) in order to set-up or cross-check the sampling frame in use. Regarding classification schemes and seasonal variations the rules for vessel registers also apply here.
- After a sampling frame has been set-up the system operates with samples on landings and effort. A landings survey is used to collect data for the estimation of sample overall CPUE and species proportions.
- Another parallel survey will collect data on fishing effort. Effort samples are raised to totals using spatial extrapolating factors supplied by the sampling frame (generated automatically by vessel register or by a frame survey). If the effort samples refer to daily boat activity state (boat fishing or boat not fishing), then another set of in-time extrapolating factors is used (calendar days of the month minus the days of overall zero or negligible fishing activity).

3.3.3 Accuracy issues

With respect to sampling accuracy the following simple rules apply:

- Within each estimation context (month, stratum, boat/gear type) and in order to achieve an accuracy level of at least 90% for the CPUE, 32 representative landings must be collected. If 95% is required then 128 samples will be needed. From then on improvement in accuracy becomes rather demanding; for instance it will take 356 samples to raise it to 97%.
- Regarding effort, if sample data are collected from fishermen at the end of the reference period (i.e. number of days worked), then the same rules as for the CPUE apply.
- If, on the other hand, effort is estimated using samples of ACTIVE, NON-ACTIVE records, then the target population is different and so are the sampling requirements. In this case the

survey attempts to estimate the Probability a Boat is Active. To achieve 90% in its estimation 96 samples of activity status are needed. For an accuracy level of 95% the samples needed become 384, while for 97% we shall need 1067 samples.

3.3.4 Accuracy of the frame survey

In the case of frame surveys the principal difficulty is that its contents are not synchronized with sampling surveys. In fact, a frame survey reflects the results of a boat enumeration during a specific time period and all extrapolating functions that are performed since that event operate under the assumption that this "snapshot" of boat/gear distribution has not changed significantly. This is often not the case, and several adjustments have to be made to effort estimates in order to remove the bias caused by changes in the fleet typology and distribution.

There exist, however, two practical rules that can help reduce extrapolating errors. These are:

- Incorporation into the frame survey of a data items allowing for the seasonal re-distribution of boats according to expected variations (migration and/or change of fishing gear);
- When sampling for activity status, home ports should be visited the same number of days (that is with equal frequency and irrespective of dates). In this manner estimation of the Probability of Boat Activity will be a function of the proportion of boats in sample ports against totals and not of the actual numbers[15]. This means that several additions or removals might have occurred since the last frame survey was conducted, but if such changes have occurred more or less proportionally over the statistical area, estimation of effort should still be correct.

[15] A mathematical proof of this property is provided by Stamatopoulos in Fisheries Technical Paper FI/TP/425 (see References).

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Annex A

Terms of Reference

Consultant- Fisheries Statistician (RECOFI)

Background

During the fourth session of the Regional Commission for Fisheries (RECOFI), held during 7–9 May 2007 in Jeddah, Kingdom of Saudi Arabia, the Commission endorsed the implementation of activities to improve the quality, reliability and utility of fisheries statistics both the national and the regional levels.

Particularly the Commission suggested that further effort should be undertaken by Member countries to improve the cost-effectiveness and reliability of their statistical programmes. In this respect use should be made of reference material and expertise available from the FAO. Furthermore, regarding issues relating to harmonisation of national data for establishing regional statistical data sets, the Commission agreed that this would mainly concern species naming practices and classification practices of boat types and fishing gears. The Commission also recommended that best use should be made of available statistics. Finally, the Commission considered that guidelines are needed for the effective use of RECOFI Capture Fisheries Production Database compiled by FAO/FIES (FISHSTAT+ software).

Activities

Under the general supervision of the Senior Fisheries Officer (RECOFI Secretary), FAO Regional Office for the Near East (FAORNE), and in direct and close cooperation with the Technical Secretary of the Working Group on Fishery Statistics and Management, and in consultation with the FAO/FI Technical Units as appropriate, the incumbent will undertake the following tasks:

- Review current methods of data collection adopted by the RECOFI member countries.
- Maximize the utility of the RECOFI capture database, including grouping of landing trends into categories of similar patterns.
- Develop appropriate explanatory data handling and processing exercises using the available data and time series at the national and regional scale.
- Elaborate scenarios for data harmonization and integration identifying the most suitable stepwise approach, from the most basic to the more detailed and sophisticated, and including the assessment of data preparation effort and cost implications.
- Prepare questionnaires for distribution to RECOFI Members for the purpose of: (i) to facilitate the identification of most feasible and cost-effective integration scenarios and, (ii) to obtain an updated feedback on the actual state of national fisheries statistical programmes.
- Ensure the follow-up of questionnaire survey by contacts with national counterparts to have returned and available the filled questionnaires within two months from receipt date.
- Prepare a full technical report on the above showing the kind of results and information which could be obtained and be available for fisheries appraisal and management purposes. The report will include the appropriate guidelines and recommendations for the continued and sustainable use of the national and regional fisheries statistics data and information.

Output description

The output of the consultancy shall consist of a comprehensive technical document appraising RECOFI national and regional fisheries statistics (data characteristics, quality and trends), including the strategy to apply for their integration/use at the regional (RECOFI) level. The work is to be carried out in 30 working days. The work will commence on 01 May 2008 and be completed and submitted to FAO no later than 20 June 2008. The document will be presented at the meeting of the RECOFI Working Group on Fishery Statistics and Management in late October 2008.

Travel

The consultant will be required to travel from his residence to Cairo, Egypt to attend a four-day meeting of the RECOFI Working Group on Fishery Statistics and Management and to present the findings of his work. The meeting is tentatively scheduled from 27 to 30 October 2008. This travel is not included in the present arrangement and it will be dealt with separately in due course.

Qualifications

Advanced University Studies in statistics and minimum 12 years of experience in the design and implementation of fisheries statistical programmes. Good knowledge of English. Ability to write clear and exhaustive technical reports.

Annex B

INTERNATIONAL STANDARD STATISTICAL CLASSIFICATION OF FISHING GEAR (ISSCFG) (29 July 1980)

Gear Categories Abbreviation Code	Standard Abbreviations	ISSCFG
SURROUNDING NETS		**01.0.0**
With purse lines (purse seines)	PS	01.1.0
- one boat operated purse seines	PS1	01.1.1
- two boats operated purse seines	PS2	01.1.2
Without purse lines (lampara)	LA	01.2.0
SEINE NETS		**02.0.0**
Beach seines	SB	02.1.0
Boat or vessel seines	SV	02.2.0
- Danish seines	SDN	02.2.1
- Scottish seines	SSC	02.2.2
- pair seines	SPR	02.2.3
Seine nets (not specified)	SX	02.9.0
TRAWLS		**03.0.0**
Bottom trawls		03.1.0
- beam trawls	TBB	03.1.1
- otter trawls[1]	OTB	03.1.2
- pair trawls	PTB	03.1.3
- nephrops trawls	TBN	03.1.4
- shrimp trawls	TBS	03.1.5
- bottom trawls (not specified)	TB	03.1.9
Midwater trawls		03.2.0
- otter trawls[1]	OTM	03.2.1
- pair trawls	PTM	03.2.2
- shrimp trawls	TMS	03.2.3
- midwater trawls (not specified)	TM	03.2.9
Otter twin trawls	OTT	03.3.0
Otter trawls (not specified)	OT	03.4.9
Pair trawls (not specified)	PT	03.5.9
Other trawls (not specified)	TX	03.9.0
DREDGES		**04.0.0**
Boat dredges	DRB	04.1.0
Hand dredges	DRH	04.2.0
LIFT NETS		**05.0.0**
Portable lift nets	LNP	05.1.0
Boat-operated lift nets	LNB	05.2.0
Shore-operated stationary lift nets	LNS	05.3.0
Lift nets (not specified)	LN	05.9.0
FALLING GEAR		**06.0.0**
Cast nets	FCN	06.1.0
Falling gear (not specified)	FG	06.9.0

[1] Fisheries agencies may indicate side and stern bottom, and side and stern midwater trawls, as OTB-1 and OTB-2, and OTM-1 and OTM-2, respectively

GILLNETS AND ENTANGLING NETS		**07.0.0**
Set gillnets (anchored)	GNS	07.1.0
Driftnets	GND	07.2.0
Encircling gillnets	GNC	07.3.0
Fixed gillnets (on stakes)	GNF	07.4.0
Trammel nets	GTR	07.5.0
Combined gillnets-trammel nets	GTN	07.6.0
Gillnets and entangling nets (not specified)	GEN	07.9.0
Gillnets (not specified)	GN	07.9.1
TRAPS		**08.0.0**
Stationary uncovered pound nets	FPN	08.1.0
Pots	FPO	08.2.0
Fyke nets	FYK	08.30
Stow nets	FSN	08.4.0
Barriers, fences, weirs, etc.	FWR	08.5.0
Aerial traps	FAR	08.6.0
Traps (not specified)	FIX	08.9.0
HOOKS AND LINES		**09.0.0**
Handlines and pole-lines (hand-operated)[2]	LHP	09.1.0
Handlines and pole-lines (mechanized)[2]	LHM	09.2.0
Set longlines	LLS	09.3.0
Drifting longlines	LLD	09.4.0
Longlines (not specified)	LL	09.5.0
Trolling lines	LTL	09.6.0
Hooks and lines (not specified)[3]	LX	09.9.0
GRAPPLING AND WOUNDING		**10.0.0**
Harpoons	HAR	10.1.0
HARVESTING MACHINES	**11.0.0**	
Pumps	HMP	11.1.0
Mechanized dredges	HMD	11.2.0
Harvesting machines (not specified)	HMX	11.9.0
MISCELLANEOUS GEAR[4]	**MIS**	**20.0.0**
RECREATIONAL FISHING GEAR	**RG**	**25.0.0**
GEAR NOT KNOW OR NOT SPECIFIED	**NK**	**99.0.0**

[2] Including jigging lines
[3] Code LDV for dory-operated line gears will be maintained for historical data purposes
[4] This item includes: hand and landing nets, drive-in-nets, gathering by hand with simple hand implements with or without diving equipment, poisons and explosives, trained animals, electrical fishing

Annex C

Species reported to FAO by RECOFI Members.
The total number of species reported is 177. Number of species reported by each country is indicated below the country name.

	RECOFI: Harmonization of statistical data at regional level - Species classification as of June 2008								
	SPECIES COVERAGE	Bahrain	Iran	Iraq	Kuwait	Oman	Qatar	Saudi Arabia	UAE
		54	58	4	19	52	35	86	43
1	*Abalones nei*					1			
2	*Albacore*		1						
3	*Amberjacks nei*	1							
4	*Anchovies, etc. nei*					1			
5	*Areolate grouper*							1	
6	*Barracudas nei*	1	1			1	1	1	1
7	*Bartail flathead*		1						
8	*Batfishes*	1							
9	*Bigeye croaker*		1						
10	*Bigeye trevally*							1	
11	*Bigeye tuna*		1						
12	*Bigel nei*					1			
13	*Black marlin*		1			1			
14	*Black pomfret*		1					1	
15	*Black-streaked monocle bream*							1	
16	*Blackspotted rubberlip*							1	
17	*Block's gizzard shad*	1							
18	*Blue swimming crab*	1	1					1	
19	*Blue-barred parrotfish*							1	
20	*Bluefish*					1			
21	*Bluespot mullet*		1					1	
22	*Brownspotted grouper*							1	
23	*Brushtooth lizardfish*				1				
24	*Butterfishes, pomfrets nei*				1	1			
25	*Carangids nei*	1			1		1	1	1
26	*Clupeoids nei*		1					1	
27	*Cobia*	1	1		1	1	1	1	1
28	*Common bluestripe snapper*							1	
29	*Common dolphinfish*		1			1			1
30	*Common silver-biddy*							1	
31	*Coral hind*							1	
32	*Croakers, drums nei*		1		1	1			
33	*Cuttlefish, bobtail squids nei*	1	1			1	1	1	1
34	*Demersal percomorphs nei*					1			
35	*Dogtooth tuna*							1	
36	*Dorab wolf-herring*						1		
37	*Emperors(=Scavengers) nei*	1			1	1	1	1	1
38	*Five-lined snapper*							1	
39	*Flat needlefish*						1		
40	*Flatfishes nei*					1			
41	*Flathead grey mullet*				1				
42	*Flathead lobster*	1					1	1	
43	*Flatheads nei*	1				1			
44	*Fourfinger threadfin*		1						
45	*Fourlined terapon*	1							
46	*Frigate and bullet tunas*		1			1			1
47	*Giant catfish*	1						1	
48	*Giant guitarfish*		1						
49	*Giant trevally*		1				1		
50	*Goatfishes, red mullets nei*	1				1	1		1

	RECOFI: Harmonization of statistical data at regional level - Species classification as of June 2008								
	SPECIES COVERAGE	Bahrain	Iran	Iraq	Kuwait	Oman	Qatar	Saudi Arabia	UAE
		54	58	4	19	52	35	86	43
51	*Golden trevally*	1					1	1	1
52	*Goldsilk seabream*	1						1	
53	*Goldstripe sardinella*					1			
54	*Greasy grouper*							1	
55	*Great barracuda*							1	
56	*Greater lizardfish*		1				1		
57	*Green humphead parrotfish*							1	
58	*Green tiger prawn*	1					1	1	
59	*Groupers nei*	1			1	1	1		
60	*Groupers, seabasses nei*							1	1
61	*Grunts, sweetlips nei*	1			1	1	1	1	1
62	*Gulf parrotfish*		1						
63	*Haffara seabream*	1						1	
64	*Hairtails, scabbardfishes nei*					1			1
65	*Halfbeaks nei*	1				1			1
66	*Hilsa shad*		1	1	1				
67	*Hound needlefish*							1	
68	*Humpback red snapper*							1	
69	*Indian driftfish*	1							
70	*Indian halibut*		1						
71	*Indian mackerel*		1			1		1	1
72	*Indian oil sardine*		1			1			1
73	*Indian pompano*		1						
74	*Indian scad*					1		1	
75	*Indo-Pacific king mackerel*		1		1			1	
76	*Indo-Pacific sailfish*		1			1		1	
77	*Jack and horse mackerels nei*	1							
78	*Jacks, crevalles nei*					1			1
79	*Japanese threadfin bream*		1						
80	*Javelin grunter*		1						
81	*Jellyfishes*	1							
82	*John's snapper*		1						
83	*Karanteen seabream*							1	
84	*Kawakawa*	1	1			1		1	1
85	*King soldier bream*						1	1	1
86	*Klunzinger's mullet*		1						
87	*Largehead hairtail*		1						
88	*Leopard flounder*	1						1	
89	*Live sharksucker*	1							
90	*Lizardfishes nei*					1		1	
91	*Longtail tuna*		1			1			1
92	*Malabar blood snapper*		1				1		
93	*Malabar trevally*						1	1	
94	*Marine crabs nei*						1		1
95	*Marine fishes nei*	1	1	1	1	1	1	1	1
96	*Marine molluscs nei*		1						
97	*Marlins,sailfishes,etc. nei*								1
98	*Milkfish*								1
99	*Minstrel sweetlips*							1	
100	*Mojarras(=Silver-biddies) nei*	1					1	1	1

	RECOFI: Harmonization of statistical data at regional level - Species classification as of June 2008								
	SPECIES COVERAGE	Bahrain	Iran	Iraq	Kuwait	Oman	Qatar	Saudi Arabia	UAE
		54	58	4	19	52	35	86	43
101	*Mullets nei*	1		1	1	1	1		1
102	*Narrow-barred Spanish mackerel*	1	1		1	1	1	1	1
103	*Natantian decapods nei*		1		1	1			
104	*Needlefishes nei*					1			
105	*Needlefishes, etc. nei*	1							
106	*Needlescaled queenfish*							1	
107	*Obtuse barracuda*							1	
108	*Orange-spotted grouper*		1					1	
109	*Orangespotted trevally*							1	
110	*Pandoras nei*					1			
111	*Parrotfishes nei*	1					1	1	1
112	*Pelagic percomorphs nei*					1		1	
113	*Penaeus shrimps nei*			1				1	
114	*Pickhandle barracuda*							1	
115	*Pink ear emperor*	1						1	
116	*Pompanos nei*					1			
117	*Ponyfishes(=Slipmouths) nei*								1
118	*Porgies, seabreams nei*	1				1	1	1	
119	*Queenfishes*	1				1	1	1	1
120	*Rainbow runner*					1			
121	*Rays, stingrays, mantas nei*		1			1			
122	*Requiem sharks nei*	1					1		
123	*Santer seabream*	1							
124	*Sardinellas nei*	1					1		1
125	*Sawfishes*		1						
126	*Scads nei*						1		1
127	*Sea catfishes nei*		1			1	1		1
128	*Seerfishes nei*								1
129	*Sharks, rays, skates, etc. nei*					1		1	1
130	*Sharpnose stingray*							1	
131	*Sillago-whitings*	1							
132	*Silver grunt*							1	
133	*Silver pomfret*		1		1			1	
134	*Silver sillago*							1	
135	*Skinnycheek lanternfish*		1						
136	*Skipjack tuna*		1			1			
137	*Smalltooth emperor*	1						1	
138	*Snappers nei*				1		1		
139	*Snappers, jobfishes nei*	1				1		1	1
140	*Snubnose emperor*							1	
141	*Snubnose pompano*							1	
142	*Sobaity seabream*	1						1	
143	*Sordid rubberlip*	1							
144	*Spadefishes nei*							1	
145	*Spangled emperor*	1	1						
146	*Speckled shrimp*							1	
147	*Spinefeet(=Rabbitfishes) nei*	1	1			1	1	1	1
148	*Spot-tail shark*		1						
149	*Spotfin flathead*							1	
150	*Spotted sicklefish*		1						

	RECOFI: Harmonization of statistical data at regional level - Species classification as of June 2008								
	SPECIES COVERAGE	**Bahrain**	**Iran**	**Iraq**	**Kuwait**	**Oman**	**Qatar**	**Saudi Arabia**	**UAE**
		54	**58**	**4**	**19**	**52**	**35**	**86**	**43**
151	*Stingrays, butterfly rays nei*	1							
152	*Stolephorus anchovies*								1
153	*Striped bonito*					1			
154	*Striped piggy*	1							
155	*Swordfish*		1						
156	*Talang queenfish*	1	1					1	
157	*Terapon perches nei*							1	
158	*Threadfin and dwarf breams nei*	1				1	1	1	
159	*Threadfin breams nei*				1				1
160	*Tigertooth croaker*		1						
161	*Torpedo scad*	1				1			1
162	*Tropical spiny lobsters nei*		1			1			
163	*Trout sweetlips*	1							
164	*Tuna-like fishes nei*		1				1	1	
165	*Two-spot red snapper*							1	
166	*Twobar seabream*	1	1					1	1
167	*Various squids nei*							1	
168	*White-blotched grouper*							1	
169	*Whitefin wolf-herring*		1					1	
170	*Wolf-herrings nei*								1
171	*Yellowbar angelfish*	1						1	
172	*Yellowfin hind*							1	
173	*Yellowfin seabream*				1		1	1	1
174	*Yellowfin tuna*		1			1			
175	*Yellowstripe goatfish*							1	
176	*Yellowstripe scad*								1
177	*Yellowtail scad*							1	

Annex D

FAO Fleet Statistics: FF-1 and FF-2 questionnaires

FISHERY FLEET – NUMBER OF DECKED VESSELS / TOTAL TONNAGE AND TOTAL POWER BY L.O.A. (LENGTH OVERALL) AND TYPE

FISHSTAT FF-1

Country: Year: ....

L.O.A. (Metres)	Code N = Number * GT = Gross Tonnage * P = Power kW *		Total	VESSEL TYPES: Trawlers 01	Purse Seiners 02	Seiners others 03	Gill Netters 04	Trap Setters 05	Long Liners 06	Liners others 07	Multipurpose vessels 08	Dredgers 9.1	Other fishing vessels 9.0
Up to 11.9	100	N											
		GT											
		P											
12 - 17.9	110	N											
		GT											
		P											
18 - 23.9	120	N											
		GT											
		P											
24 - 29.9	130	N											
		GT											
		P											
30 - 35.9	140	N											
		GT											
		P											
36 - 44.9	150	N											
		GT											
		P											
45 - 59.9	160	N											
		GT											
		P											
60 - 74.9	170	N											
		GT											
		P											
75 and over	180	N											
		GT											
		P											

FISHERY FLEET – NUMBER OF UNDECKED, POWERED AND NOT POWERED VESSELS, BY L.O.A. (LENGTH OVERALL) AND TYPE

FISHSTAT FF-2

COUNTRY: YEAR: ....

L.O.A. (Metres)	Code P = No. Powered NP = No. not Powered		Total	VESSEL TYPES: Trawlers 01	Purse Seiners 02	Seiners others 03	Gill Netters 04	Trap Setters 05	Long Liners 06	Liners others 07	Multipurpose vessels 08	Dredgers 9.1	Other fishing vessels 9.0
Up to 5.9	200	P											
		NP											
6 - 11.9	210	P											
		NP											
12 - 17.9	220	P											
		NP											
18 - 23.9	230	P											
		NP											
24 - 29.9	240	P											
		NP											
30 and over	250	P											
		NP											
TOTAL		P											
		NP											

Annex E

Proposed RECOFI fleet/catch/effort reporting format

RECOFI: Reporting of fleet capacity, catches and fishing effort

Year: Country: RECOFI sub-area:

Gears or fishing methods:		#1 Surroundin			#2 Seine ne			#3 Trawl			#4 Dredges			#5 Liftnets			#6 Falling ge			#7 Gillnets/Enta			#8 Traps			#9 Hooks and li			#10 Harpoons			99 M	
Boat size category:		Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	M
Number of operational vessels:																																	
Days worked in year (<=365):																																	
Species name	TOTAL																																
Abalones nei																																	
Albacore																																	
Amberjacks nei																																	
Anchovies, etc. nei																																	
Areolate grouper																																	
Barracudas nei																																	
Bartail flathead																																	
Batfishes																																	
Bigeyes nei																																	
Bigeye croaker																																	
Bigeye trevally																																	
Bigeye tuna																																	
Black marlin																																	
Black pomfret																																	
Blackspotted rubberlip																																	
Black-streaked monocle bream																																	
Bloch's gizzard shad																																	
Blue swimming crab																																	
Blue-barred parrotfish																																	
Bluefish																																	
Bluespot mullet																																	
Brownspotted grouper																																	
Brushtooth lizardfish																																	
Butterfishes, pomfrets nei																																	
Carangids nei																																	
Clupeoids nei																																	
Cobia																																	
Common bluestripe snapper																																	
Common dolphinfish																																	
Common silver-biddy																																	
Coral hind																																	
Croakers, drums nei																																	
Cuttlefish, bobtail squids nei																																	
Demersal percomorphs nei																																	

Annex F

Request for feedback information on sample-based surveys operated by RECOFI Members

Country: _____ Year: _____

Statistical Area: _____

1. Structural data	**Estimated No.**		
1.1 Number of strata			
1.2 Total number of sites			
1.3 Number of sample sites			
1.4 Number of boat/gear combinations			
1.5 Number of species		YES	NO
2. Register of fishing vessels? (If NO go to Section 3)			
2.1 Does it include all fishing units?			
2.2 Does it produce automatically effort extrapolating factors?			
2.3 Is it kept regularly updated?			
3. Does the system use frame surveys? (if not go to Section 4)			
3.1 Are frame surveys conducted frequently? (every 1-2 years)			
3.2 Are frame surveys conducted less frequently? (3-4 years)			
3.3 Are frame surveys conducted infrequently? (>= 5 years)			
4. Sampling aspects			
4.1 Visits to sample sites occur at least 8 times per month			
4.2 At least 32 landings sampled per month/stratum/boat-gear [16]			
4.3 At least 96 activity samples per month/stratum/boat-gear			
(or 4.4 if effort is directly queried)			
4.4 At least 32 fishermen sampled per month/stratum/boat-gear			
5. Basic variables involved		YES	NO
5.1 Date			
5.2 Location			
5.3 Name of recorder			
5.4 Boat-gear type			
5.5 Trip duration (sailing duration + fishing effort)			
5.6 Catch by species			
5.7 First-sale price			
5.8 No. of fish in catch (for selected species)			
5.9 Remarks			

[16] Stamatopoulos (1999,2003) set-up statistical tables providing sampling accuracy indicators separately for small and medium/large/infinite populations (see References).

Annex G

Guidelines for the submission of feedback information by RECOFI Members

Each RECOFI Member will be receiving two types of requests for feedback information. The first type will be an Excel worksheet of the structure and format illustrated in Annex E. This worksheet is a proposed format for subsequent data submission of annual statistics on fleet, catch and effort, provided that such an exercise will prove to be feasible. It is reminded that at this stage RECOFI Members need not submit any actual data; what is being requested here is simply an indication as to whether annual fleet, effort and catch statistics can be reported separately as shown by the worksheet. Data submission will also take into account the two RECOFI sub-areas 51.2.0 (Gulf) and 51.3.1 (Sea of Oman); hence Iran and Oman will each be receiving two Excel worksheets, one per sub-area.

The second type of feedback document (Annex F) concerns sample-based surveys and each form will describe a specific survey. RECOFI Members that happen to operate different types of sample-based surveys for their fisheries are requested to submit feedback information for each survey separately.

PART 1: Fleet/catch/effort data

The first question is whether RECOFI Members can annually provide information on fishing fleet capacity in terms of numbers of "small", "medium" and "large" fishing craft that operate fishing gears described by major gear categories.

Annex B provides a list of major fishing gear types and the types of gears and/or fishing methods included in each major group, while the criteria that resulted in the proposed boat-gear combinations are discussed in Section 3.2, paragraphs 3.2.1 and 3.2.2.

For numbers of boats RECOFI Members will insert a comment for each boat-gear column with the indication:

- NA = Boat-gear category does not apply to national fisheries
- YES = Applicable and related information CAN be supplied
- NO = Applicable, but related information CANNOT be supplied

Next record will contain similar types of comments relating to the average number of days worked in a year by each vessel of a given boat-gear category.

Concerning species there is no need to go over all species shown in the worksheet; it should suffice to include a remark as to whether a species total can, in general, be split into catches deriving from different boat-gear categories.

PART 2: Sample-based surveys

Section 1 will provide information regarding number of statistical strata used by the system to increase homogeneity in estimating catch and effort. It will also provide approximate numbers of all known locations at which landings occur or sites (home ports) from which boats start their fishing trips. This information will be followed by specifying the number of locations at which samples are taken.

Section 1 will be completed by indicating the combinations of boat-gear types for each of which catch/effort estimates are produced, as well as the number of species handled by the sample-based survey.

Section 2 will be needed only if a vessel register for small-scale fisheries is being operated. In the event that such a register exists it is of interest to know if it is 100% complete. If it is not 100% complete it would be useful to obtain some remarks indicating the boat categories that are included (or excluded).

Question 2.2 it indicates whether a vessel register (normally used for information purposes) is used for statistical purposes as well.

Section 3 concerns frame surveys and is self-explanatory.

Section 4 describes the most essential sampling aspects.

> Question 4.1: Whether sampling occurs at least 8 times in a month, 8 being the minimum allowable and conventionally implying two site visits per week.
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> Question 4.2: Whether at least 32 landings are collected over a month for each stratum and boat-gear type, thus achieving a minimum accuracy level of 90% for the overall sample CPUE.
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> Question 4.4: Whether at least 32 effort answers are collected over a month for each stratum and boat-gear type, thus achieving a minimum accuracy level of 90% for the average days worked by a fisherman.
>
> Question 4.3: Whether at least 96 activity samples are collected over a month for each stratum and boat-gear type, thus achieving a minimum accuracy level of 90% for the boat activity probability.