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Computer application

ECOLOGICAL CONCERNS FROM QUERIES ANALYSIS OF PC FISHERY TIME SERIES DATABASE OF GREECE

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Abstract. New software approaches seem to be a necessity in order to facilitate end users in fields like ecology and ecosystem to analyse information extracted from databases. In the present paper the results of the queries applied on the Greek PC fishery time series database are generalised and analysed. The research concerns 71 registered fish species in 16 Greek fish regions in order to point out fish species without catches for 1990-1997 and 1998-2005 periods. A comparison between the two periods has been made and useful indications have appeared. The fish regions are divided into three groups: decreasing, sustainable and increasing catch diversity. The analysis of the results shows that the number of fish species without catches in certain regions is growing up and organisations and generally people in charge in Greece have to be concerned for taking measures for ecological, biological, etc. reasons. The software developed for the analysis of data can be applied for studying changes in fish catch diversity every following year.

Keywords: fish diversity, database queries, data mining.

AIMS AND BACKGROUND

Decreasing of fish resources means there may be no long-term future for fish catching of some fish species in many fish regions and consequently fish processing, causing ecological and economical problem in the field. Extensive researches have been conducted to find out probable causes for the ever-decreasing fish resources in the seas. The diminishing of fish diversity is related to discarding, over-fishing, seasonality, etc. and will probably cause ecological problems in these fish regions.

Discarding. Fishing has significant, direct and indirect, effects on the habitat, diversity, and productivity of communities. The main direct effect is that trawling is responsible for increasing the mortality of marketable as well as discarded spe-

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cies[1]. As a result, the discard of commercial catches greatly affects the estimation of fishing mortality which relies upon landings[2] and Philippart[3].

The threat to species populations, the wastefulness of the activity, and the problem that undocumented discarding poses to stock assessment are all major issues[4]. According to Stergiou et al.[5], the replacement of trawls with 28 mm codend mesh size, as presently used, by a mesh size of 40 mm, will not be accompanied by any significant commercial loss while the weight of discards would be significantly reduced. Potential solutions might also include temporal and/or spatial closures or continuous monitoring of the fishery and closure once a given by-catch quota has been reached[4].

Over-fishing. Severe over-fishing in the world's continental shelf has resulted in declines in shallow water and has stimulated deep-water fisheries[6]. Environmental variability and over-exploitation, as well as differences in species' life-history-strategies, have both influenced the structure of the demersal fish assemblages found along the depth gradient studied[7]. Species diversity, richness and evenness decreased (N. E. Mediterranean, Greece) with water depth, with the highest values at depths <100 m (Ref. 8).

Seasonality. Fishery is one of the sectors, influenced by seasonal variations regarding both consumption and fishing yields. On the one hand, the lack of seasonality followed by a positive or sustainable trend is what sea fishery enterprises ask for in order to invest in the fishery industry for the viability of the enterprise, the benefit of the sector, the ensuring of employment, etc. On the other hand, being aware of the existence of seasonality: (a) biologists and ecologists are asked to discover the reasons that causes it; (b) fishery enterprises to avoid all expenses concerning fishing efforts with no fish catches and to engage their employees in other sectors of the field if it is possible; (c) workers to look for other jobs if they know in advance that for a certain period of time there will not be work for them, and (d) governments as well as local authorities to take social measures and measures for sustainable fishery in accordance with the suggestions of the scientists. Countries as Greece surrounded by sea are obliged to take advantage of this privilege in order sea food to be sufficient not only for domestic consumption but also for exports to other countries which will decrease the deficit and contribute to the financial balance of the country[9].

Easy used software techniques such as creation and application of simple queries to the PC-based Greek Fishery Time Series database, seem to be important when relatively big amount of data are stored and analysed[10]. It is needed more complex software approach in order to analyse time series towards the problems of diversity such as missing fish catches by species and by regions. The basic purpose of the paper is the creation and application of software analytical tools embedded in PC Fishery time series database of Greece for studying problems of fish diversity in Greek seas.

EXPERIMENTAL

Figure 1 presents the technological scheme of time series processing for studying fishery diversity in Greek seas.

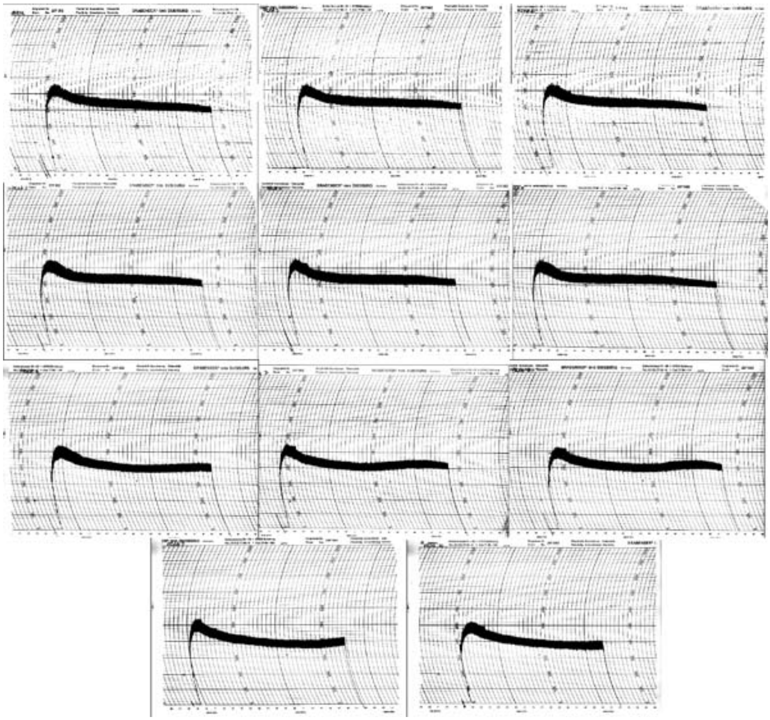

Fig. 1. Farinograms corresponding to chosen samples

The basic steps of data processing are as follows:

• *PC-based FTS database*. The basic idea for the creation of the FTS database is to store the yearly received data from the database of the National Statistical Service of Greece (NSSG) for 1990-2005 as well as to input data to be selected every following year without modification of the software that supports it. Data are organised into time series that concerns fish catches for 71 registered fish species in 16 Greek fish regions for the period 1990- 2005 (Ref. 11);

• *Queries*. The queries from FTS database are significant as far as they are founded on the basis of modern information technologies capable of transforming raw data into meaningful information and knowledge easily accessed by a large number of users in different fields[10];

• *Analytical software tools*. They are procedures for the analysis of the results obtained by queries. The basic purpose of these procedures is to extract interesting information existing in different queries. These analytical software tools are built on the basis of formulated 'classification rules' that is the feature of data mining approach. These rules refer to missing catches of fish species in regions for different periods of time and are classified as follows:

– division of data set into X time semi-periods;

– examination of missing catches for Y consecutive years for all fish regions;

– extraction of fish species with missing catches in more than Z regions in the examined X time semi-periods. The rule is: $P>Z$, where P is the number of regions without catches;

– estimation of fish species with increasing (>) and decreasing (<) miss of catches for the defined time periods;

– estimation of fish regions with increasing (>) and decreasing (<) miss of catches for defined time periods.

The direct application of particular rules to databases in order to extract their specific data is a usual way used in data mining. The developed approach here has the following special features. First, the subsets of data are extracted from FTS database by queries and consequently the constructed rules are applied. The advantage of this approach is the application of these rules to well-known structures of the data subsets, the queries results. Indeed, the FTS database is working on principles of data warehouse nevertheless the used PC database is relatively small.

It is needed to point out that the developed software provides the ability for flexible changes of the important parameters X, Y and Z, and proper Excel format to the end user to present the results of data analysis.

RESULTS AND DISCUSSION

The developed analytical software tools are applied on the following conditions. First, the whole period of time is divided into two semi-periods 1990-1997 and 1998-2005 (X=2). Second, examination of missing catches for 3 consecutive years for all fish regions (Y=3). Third, we consider, that the resulted fish species are 'low disseminated' in fish regions when there is no fish catches in more than 5 fish regions (Z=5).

The following tables and charts present the most important results obtained by applying the developed software analytical tools to the queries from FTS database. The discussion emphasises on the negative aspects referred to fish species diversity in Greek fish regions.

Table 1 presents the list of fish species and number of regions without fish catches. Here the rule for missing catches in more than 5 regions is applied. Very negative values are obtained for the fish species: guitarfish, mussel and bay scallop. For fish species daouki, eel and crab, there is some improvement in the studied period. Nevertheless their diversity by regions to year 2005 is still not good. Table 2 presents another interesting pattern concerning fish species diversity in Greek fish regions. It shows fish species whose diversity by regions has been changed positively to a great extent during the studied period.

Table1. Fish species and number of regions with missing species

Fish species		1990		1997		2005	
code	name	miss	%	miss	%	miss	%
33	Daouki	10	62.5	5	31.25	7	43.75
42	Guitarfish	12	75	10	62.5	12	75
61	Eel	10	62.5	4	25	6	37.5
74	Crab	10	62.5	4	25	6	37.5
77	Warty venus	9	56.25	6	37.5	9	56.25
78	Mussel	11	68.75	11	68.75	13	81.25
79	Oyster	13	81.25	10	62.5	11	68.75
80	Bay scallop	10	62.5	12	75	12	75

Table2. Fish species with increasing dissemination by regions

Fish species		1990		1997		2005	
Code	Name	miss	%	miss	%	miss	%
9	Thornback ray	10	62.5	4	25	2	12.5
38	Couch's whiting	8	50	1	6.25	0	0
41	Skipjack	8	50	5	31.25	4	25
59	Gilt sardine	6	37.5	2	12.5	1	6.25
72	Common prawn	8	50	4	25	2	12.5

The obtained results permit the division of fish regions into three groups: decreasing, sustainable and increasing catch diversity. The studying of fish catches in 16 Greek fish regions shows that 12 of them belong to the group of regions with sustainable or small increasing of fish species diversity. The results for the 4 left fish regions are the most important for the aim of this paper. Table 3 presents the number and the percentage of missing fish species catches, related to the 'last year', 'last two years' and 'more than two years' periods. The decreasing fish diversity for these 4 fish regions in Greece during the studied period is obvious. These results raise serious concerns. The extraction and graphical representation (Fig. 2) of numerical data for fish regions 3 and 6 from Table 3 is analysed as follows:

- There are missing catches for 11 fish species in the 'more than two years' period for region 3 'Coasts of Ipiros and Kerkyra'. It represents 15.5% of all registered fish species in Greece.
- The most negative result for the number of fish species without catches is observed in region 6 'The Gulf of Kyparissia and the Gulf of Messinia' for year 2005. It represents 40.9% of all registered fish species in Greece.

Table 3. Four fish regions with decreasing species diversity – three periods

Regions		Last year				Last two years				More than two years			
		1997		2005		1997		2005		1997		2005	
code	name	miss	%	miss	%	miss	%	miss	%	miss	%	miss	%
3	Coasts of lpiros and Kerkyra	9	12.7	13	18.3	6	8.5	12	16.9	2	2.8	11	15.5
6	Gulf of Kyparissia – gulf Messinia	9	12.7	29	40.9	5	7.0	10	14.1	3	4.2	8	11.3
12	Eastem coast of Evia and Sporades	6	8.5	7	9.7	3	4.2	7	9.7	2	2.8	7	9.9
18	Kriti	4	5.6	13	18.3	2	2.8	7	9.9	1	1.4	4	5.6

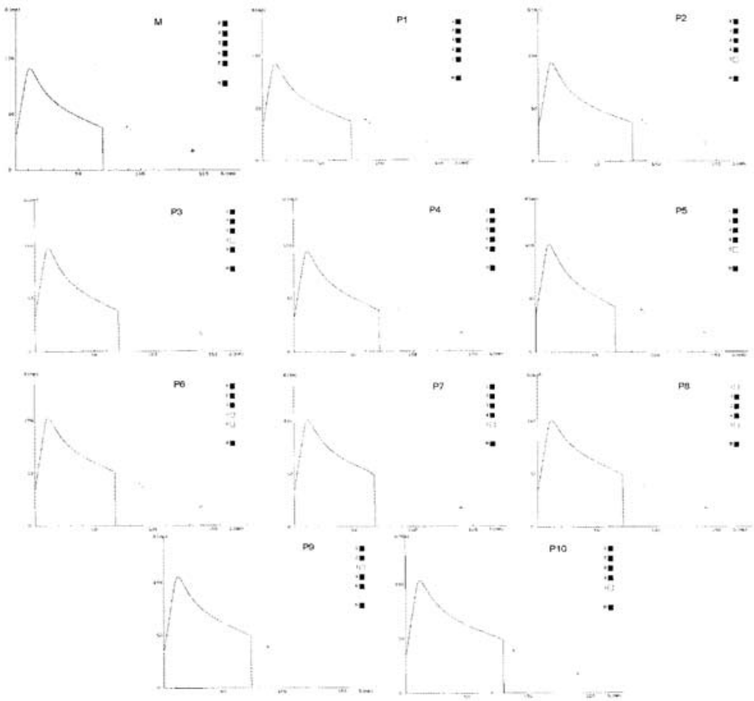

Fig. 2. Alveograms of analysed samples

CONCLUSIONS

Queries analysis using data mining is a powerful approach for finding some interesting patterns concerning fish species diversity in Greek fish regions for the period 1990-2005. The advantage of the created classification rules and software tools is the opportunity to apply them to fishery data for future periods of time as well as the ability to provide flexible changes of the important parameters *X*, *Y* and *Z*, and proper Excel format to the end user to present the results of data analysis. Therefore, the developed approach provides the study and analysis of changes in fish catches by species and by regions intending to help people in charge in Greece to take measures for ecological, biological, etc. reasons. For the benefit of future generation, countries as Greece with grate tradition in sea fishery should at least have in mind to leave to the descendants the marine wealth that inherited from the ancestors.

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