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The Concept of Acoustic Populations: Its Use for Analyzing the Results of Acoustic Cruises.

by

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Abstract

One of the more critical limitations in the use of acoustics to assess the fish stocks concerns the difficulty in identifying precisely the surveyed populations. Information given by fishing operations are often insufficient, especially where there are many different species, as is usually the case in temperate and tropical areas.

This paper deals with the concept of "acoustic population" defined as a group of detections with rather homogeneous acoustic characteristics. The characteristics are provided by: -simple analysis of echograms (day/night counting of schools, type of schools, type of scattered fish, etc..); -integrated echo signals by categories (day, night, pelagic, demersal, etc..); -volume reverberation (average value of the layer and of the sample above a threshold).

The use of this concept is supported by the hypothesis of a correlation between observed acoustic characteristics and anatomic and behavioural characteristics of the surveyed population, leading to the conclusion that an "acoustic population" represents a true natural community. Therefore it should be possible to substancially reduce the number of fishing operations by a fine stratification of the sampling. Mapping the population is made using factor analysis on all the relevant acoustic data.

The comparison between data from fishing surveys and acoustic surveys conducted from 1982 to 1986 in Venezuela shows a good fit between the maps of natural communities and acoustic populations. Finally the weight of some acoustic parameters is tentatively assessed.

The authors conclude that the routine use of this method when the populations are multispecific may help to identify and to map more precisely the main natural communities living in such areas.

Résumé

L'une des limites les plus sérieuses à l'évaluation des stocks de poissons réside dans la difficulté à identifier précisément les populations: à peu près utilisable sur des groupes formés de peu d'espèces, la pêche de contrôle fournit des informations insuffisantes dès que l'on étudie des stocks multispécifiques (cas des zones tempérées et tropicales).

Les auteurs présentent dans cet article le concept de "population acoustique": il s'agit d'ensembles de détections présentant des caractéristiques acoustiques à peu près homogènes. Ces caractéristiques sont tirées des analyses simples des échogrammes (nombre de bancs de jour, de nuit, pélagiques, démersaux, types de dispersions, etc..), des valeurs d'écho-intégration (biomasses moyennes de jour, de nuit), et des valeurs particulières issues de l'analyse du signal (TS, densités par échantillon, par échantillons supérieurs au seuil, etc..).

L'utilisation des résultats s'appuie sur l'hypothèse que les caractéristiques acoustiques d'un stock sont liées aux caractéristiques anatomiques et éthologiques globales des espèces composant ce stock, et donc qu'une population acoustique représente bien une communauté naturelle. La confirmation de cette hypothèse permet alors, par une stratification fine, de réduire notablement l'échantillonnage par pêche. La cartographie des populations acoustiques s'effectue à l'aide d'analyses factorielles sur l'ensemble des différents paramètres acoustiques.

La comparaison entre les résultats de pêches exploratoires et de campagnes de prospection acoustiques effectuées entre 1982 et 1986 au Vénézuéla a permis de voir que les cartographies des communautés naturelles et des populations acoustiques coïncidaient remarquablement.

Enfin une tentative d'évaluation des importances respectives des différents paramètres acoustiques entrant dans la définition des populations acoustiques est présentée.

Les auteurs concluent que l'application systématique du concept de population acoustique sur des zones à stocks multispécifiques peut être une façon d'identifier et de cartographier précisément les principales communautés naturelles de ces régions, et donc d'améliorer notablement la précision des évaluations sur ces populations.

1. Introduction

Acoustic stock evaluation methods have greatly improved over the last few years, by using microprocessors that allow the digitalization of the received acoustic signals and the quick and precise analysis of the contained information (see for example the bibliographic list established by Venema, 1985).

Nevertheless the identification of the observed populations still depends on fishing operations, with all the bias and errors such methods could entail. This fact may considerably reduce the precision of the results, especially in tropical regions where these populations are very intricate. It is obvious that a good evaluation of a survey result precision is needed (Shotton and Bazigos, 1984). Several methods have been proposed to evaluate and reduce the observed variance (Shotton, 1981; Barbieri, 1981, etc...), but all of them indicate that a good stratification of the observed area is required. Such a stratification can be based on various criteria: biological and ethological (Laloe, 1985; Gohin, 1985), bathymetric (Shotton, 1981), depending on the population distribution (Aglen, 1983; Gerlotto and Stequert, 1983) or on the delimitation of homogeneous populations (Barbieri, 1981). This shows how useful an automatic, non fishing-dependent, stratification method might be.

2. Definition of the "Acoustic Population" concept

A natural fish community may be defined as a group of species mixed in more or less constant proportions, each species being characterized within the community by its individual mean length and weight and its behaviour. The determination of these criteria and the distribution of this community may be obtained by fishing operations which give (if the fishing gear is non-selective):

- a catalogue of the present species;
- the species proportions;
- the individual mean length and weight.

Acoustic populations are defined from the following hypothesis: behaviour, taxonomic and biometric characteristics of the fish inside a natural community are sufficiently typical and permanent to allow their resultant to characterize this community. In this case the community can be described by all the acoustic observations that depend on these behaviour, taxonomic and biometric characteristics, their synthesis representing the so-called "acoustic population".

Such a concept has been approached by various authors: Azzali (1982) distinguishes five parameters to identify species: vertical extension, horizontal extension, formation coefficient, day time, group shapes. Nion and Castaldo (1982) separate an anchovy population in five groups: superficial schools (day), superficial schools (night), deep schools (day), scattered fish (night).

We propose here to generalize this method by using all the parameters likely to help to characterize a community. These parameters come from two origins: visual analysis of echograms and electronic processing of the acoustic signals. We present the following list:

- TS mean values and histograms;
- day and night variations of each parameter;
- individual echoes distributions;
- type of fish aggregation (pelagic, demersal, schools, scattered...)
- global fish density (echo integration);
- variation of target distributions (school/scattered, pelagic/demersal)

It could be possible to include in this list some abiotic characteristics, being some communities related to particular ecosystems (hydrology, sedimentology, bathymetry). Nevertheless in this study we shall only take acoustic data into account.

If the former hypothesis is confirmed, a fish community can be correctly represented by an acoustic population index. In this case we are justified in using acoustic populations to post-stratify a surveyed area: acoustic samples are many more numerous than fishing samples, so it seems that using acoustic populations distribution instead of natural community mapping would improve significantly the precision obtained by stratificating area.

In order to confirm this hypothesis we have studied two natural communities and their corresponding acoustic populations, and evaluated the fitness existing between them.

3. Equipment and methods

3.1. The surveys.

We have conducted this study in two different regions in Venezuela: the Gulf of Venezuela in the West and the "Oriente" in the East. (fig. 1). Six surveys were performed in these two regions, the characteristics of which are summarized in table 1. Four of them (FALCON 1 to 4) were done in the Gulf of Venezuela, and two in the Oriente (ECHOVEN 1 and 2).

Fishing and acoustic data were obtained in separate surveys in the West: FALCON 1 was a fishing survey and FALCON 2 to 4 acoustic surveys. In the East, ECHOVEN 1 did not cover the complete zone and no fishing has been done, so we data of this survey are not included in the present study, although neat acoustic populations have been observed during this cruise (Gerlotto and Marchal, 1985). ECHOVEN 2, which covered completely the eastern area, was a mixed fishing and acoustic survey.

3.2. Equipment.

Two boats have been employed: R/V La Salle (39 m) in the Gulf of Venezuela and R/V Capricorne (46 m) in Oriente.

- FALCON 1. The fishing has been done using a semi-pelagic trawl, in fishing operations between one and three hours long.

- FALCON 2 and 3. During these acoustic surveys, the echosounder was a SIMRAD 120 kHz EK/S, and the echo-integrator a SIMRAD analogic QM 2.

- FALCON 4. The equipment was the same as during FALCON 2 and 3, with the exception of the integrator, a digital AGENOR (Protechno). During FALCON 2 to 4, although they have not been used in the present work, a few fishing operations took place, with the same net as during FALCON 1: their results showed that the communities observed during FALCON 1 did not change significantly until FALCON 4.

- ECHOVEN 2. The fishing was done with a pelagic trawl (8 m mesh size in the mouth). The echo sounder was a SIMRAD EK400, used at the 120 kHz frequency, and the integrator a digital AGENOR.

3.3. The data.

Depending on the surveys, different types of data have been analyzed (table 2), according to the following list:

(a). fishing: yield (catch/hour)
(b). number of pelagic schools per Elementary Sampling Distance Unit (ESDU) by day;
(c). number of pelagic schools per ESDU, night;
(d). number of demersal schools per ESDU, day;
(e). number of demersal schools per ESDU, night;
(f). mean density/ESDU, day;
(g). mean density/ESDU, night;
(h). number of samples above the threshold/number of samples (E+/E), day
(i). E+/E ratio, night;
(j). density/E+ (high, medium, low), day;
(k). density/E+ (high, medium, low), night.

The definition of data (h) to (k) is given by Marchal and Gerlotto (1987). Lacking the necessary equipment, we have not been able to collect sufficient "in situ" TS values to include this type of information in this work.

3.4. Data processing

The data obtained for each ESDU (in all the cruises, ESDU are six-minutes intervals, corresponding more or less to one nautical mile (N.M.) at 10 knots) are gathered in geographic squares (15x15 N.M. in the Gulf of Venezuela, 10x20 N.M. in Oriente) (fig. 1). These empirical dimensions are supposed to be sufficient to consider that the squares are independent (McLennan and McKenzie, 1985).

Each square was considered as an individual; we used factorial analysis as processing device. In fact we used it as a cluster method, in order to classify all the squares in a non-subjective way, as far as possible.

The groups of squares are then mapped in order to observe possible homogeneous regions according to the parameters introduced. This analysis is done first of all on the fishing data, to map the existing natural communities (if any), then on the acoustic data to extract acoustic populations: the corresponding maps are finally compared.

4. Results

4.1. Gulf of Venezuela

4.1.1. Fishing. The Gulf is divided in 28 squares. Four of them have not been prospected acoustically, and will not appear in the maps. Sampling consists of one trawling in each square. The trawling results are presented in table 3, where the data are converted in species percentage of the total catch weight.

The direct observation of table 3 shows that two specific groups are present in the gulf, one in the lower part of the Gulf (SW) and the other one in the mouth (NE). Fig. 2 presents the distribution of the most representative species.

That observation can be confirmed by the factorial analysis of the data of table 3. Figure 4, which shows the distribution of the squares on axes 1 and 2, permits to define five main groups of points, named A to E. Mapping these points (fig. 6A) reveals that the two main regions observed on table 3 are clearly circumscribed (sectors A and C). Sector D will not be studied further, as we have no acoustic data in squares 24, 25, 26. Finally sectors B and E appear geographically as intermediary zones between sectors A and C.

4.1.2. Acoustic data. As presented in table 2, two kinds of data have been used in the gulf of Venezuela. All the data are summarized in table 4 and presented in the figures 2 and 3. The results of the factorial analysis are given in fig. 5. On this figure the number of each square is affected by a letter related to the corresponding natural community of fig. 6A. Figure 5 enables one to identify three groups:

- group (a), rather well individualized: squares 5, 6, 8, 9
- group (b), not so neat: squares 4, 13, 14, 19
- group (c), with a rather arbitrary limit: squares 22, 23, 27, 28.

Although the other points look too central to be non-subjectively separated, it is interesting to note that the points around group (a) belong to the natural community A, as the squares of this group (squares 7, 17, 18). The same observation can be arrived at group (c): squares 2, 3, 21. They are presented with the letter group in parenthesis on fig. 6B.

The other squares are presented with an X. Finally fig. 6B shows, as fig. 6A, two main populations, on the SW and on the NE of the gulf, with intermediary squares that cannot be gathered with these populations.

4.2. Oriente.

Oriente has been divided in 10x20 N.M. "squares", 55 of them having been prospected and included in this analysis.

4.2.1. Fishing. It was not done in the same way as the Gulf of Venezuela, for two reasons: on the one hand, because one cannot use the pelagic trawl in a completely random sampling as one can when using a bottom trawl, and on the other hand because, as the trawling took place during the acoustic survey, it depended on the selected route. 30 trawlings were carried out on detections (fig. 10), three of them have been eliminated (no catch): numbers 23, 27, 30. The rasult of the catches (in species percentage of the total catch) are summarized in table 5.

Following the same method as for FALCON 1, we have applied a factorial analysis on the data, but after ignoring all the species which appeared only once in the catches and those which always represented less than 1 % of the catch (as it is difficult to know the actual representativity of these species in a pelagic trawl catch).

The factorial analysis results are presented on fig. 7: three main groups (A, B, C) and a little one (D) can be distinguished on the distribution of the squares along axes 1 and 2. Observing now the distribution on axes 2 and 3, we can see that a sub-group appears, formed with some points from group B. This new group is called B' in figure 7B.

Mapping these groups gives an idea of the communities that are present in Oriente (fig. 11):

- community A: essentially composed of Sardinella aurita, it covers exactly an up-welling region (Fukuoka, 1963).

- community B': it is formed of a great number of species, especially Carangidae (Chloroscombrus chrysurus, Vomer setapinnis, Caranx spp), and those Clupeids present in low salinity waters (Opisthonema oglinum principally). All the trawlings of this group took place in the gulf of Paria, which is characterized by extremely low salinities, less than 20 %., the gulf being situated at the mouth of the Orinoco River (fig. 8).

- communities B, C and D cannot be easily defined. So we can only observe that group C is formed of the trawlings that caught mackerel (Scomber japonicus). Group B and D would require a finer analysis to be defined in community terms, and we only will consider them (together with group C) as an intermediary mixed community.

It is then possible to consider that the factorial analysis on trawling data made it possible to separate three communities in Oriente: the up-welling sardine community, the gulf of Paria community and an intermediary/peripherical community.

4.2.2. Acoustic data They are detailed in table 6, and the main part of them is presented in fig. 9. The factorial analysis is presented on fig. 10. The distribution of the squares on axes 1 and 2 shows two rather well individualized groups: A (squares 4, 6, 30) and B (squares 10, 31). Two other groups, called A' (squares 8, 41) and B' (squares 5, 9, 25, 32, 37, 38), less clearly individualized, may be observed. The other points cannot be individualized on axes 1 and 2.

Looking at axes 2 and 3, we can see that groups B and B' may be gathered, as well as groups A and A'. A third group is extracted from the central points: group C (squares 15, 17, 18, 20).

Finally the acoustic data analysis may show four acoustic populations:

- population A: squares 4, 6, 8, 30, 41;
- population B: squares 5, 9, 10, 25, 31, 32, 37, 38
- population C: squares 15, 17, 18, 20;
- population D: all the other squares.

The map of these populations shows a good consistency in the data (fig. 11):

- populations A and B cover almost exactly the Sardinella area, A being formed of the squares where the sardinella population looked the densest;

- population C covers a great part of the gulf of Paria;

- finally population D covers an intermediary zone, where no dominant species can be observed.

5. Discussion

Although it gives many information, factorial analysis in not an entirely reliable method, as it does not preclude subjective interpretation. In the case of its application on tropical fish communities, if we consider the fact that there is a very important number of parameters, often contradictory, which influence the characteristics of these communities, one cannot expect to find results enabling one to isolate these populations without any risk. That point is actually the reason why devices for the identification of populations are required in tropical surveys, even if these devices are not completely error-free.

In order, first of all, to test the concept in different situations, we selected two examples which were calculated with data extracted from different sources: four separated surveys extended over several years,using an analogic echo integrator and a bottom trawl in the case of the gulf of Venezuela; a single mixed acoustic/trawling survey,using a pelagic trawl and a digital echo integrator in Oriente.

It is also to be noted that these two regions are rather ecologically distinct: there is not a big sardine stock in the West as it appears in Oriente, and the peripherical systems of the two regions (Maracaïbo lagoon in the Gulf of Venezuela, Orinoco in Oriente) are completely different.

All these observations confirm the idea that stratification and mapping of the acoustically surveyed stocks by the way of acoustic populations seem consistent and should give usually good information, at least in the case of tropical populations.

Then, in order to see wether some subjectivity had been introduced in our interpretation, we carried out a little test on one of the acoustic data sets (ECHOVEN 2), using on the data a cluster analysis (fig. 12A). The obtained dendrogram reveals two things:

(1) except in a few cases, the squares are not strongly discriminated by a cluster method: this was expected.

(2) nevertheless, the classification obtained is rather close to that obtained through the factorial analysis, as is made clear on fig. 12B

These observations lead to the following conclusion:

(a): it seems that acoustic populations are a useable tool for community identification;

(b): in order to obtain the best discrimination of these acoustic populations, the different kinds of data available should be tested, because it is probable that all of them do not have the same significance. A little example is given below.

We have introduced with table 4 data those of the 7 most representative species of FALCON 1, and calculated the correlation matrix on the complete set (table 6). If we consider the correlations between acoustic data and specific catches, we can see that on 140 calculated correlations, 36 are significant at the confidence level 0.1. If one wishes to be more precise, it is possible to classify the data in three groups:

- data without any significant correlation with the fish;
- data with at least one significant correlation at level 0.1 (r=0.3233)
- data with at least one significant correlation at level 0.05 (r=0.3809)

These groups are presented in the following table:

group	type of data
0 corr.	DJF2, DJF3, BFJF2, BFJF3, BFNF3
corr (0.1)	DJF4, DBJF2, DBJF3, DBNF2, BFNF3
corr (0.05)	DNF2, DNF3, DNF4, BFJF2, BFNF2, BFNF3, DBNF3, DE1F4, DE2F4, DE3F4

(the names of the variables are explained in table 2)

This classification shows some points:

- the day-density values have no -or little- correlation with species distribution, while on the opposite the night-density values show a high correlation.

- the school data are more difficult to analyze: some of them look highly correlated with the distribution (number of pelagic schools), others have a low correlation (school densities), and the number of demersal schools seems to have no correlation at all with the distribution of species.

- the densities per sample above the threshold are, with the night densities, the most correlated parameter.

All these observations show that a more precise study of the significance of each acoustic parameters and of their influence on the acoustic populations elaboration has to be done.

Finally another point should be calculated, i.e. the gain in precision that a stratification through acoustic populations could give compared with a general study or a systematic stratification.

Conclusion

The analysis of acoustic data from the surveys in Venezuela made it possible to build in a rather satisfactory way maps of acoustic populations which were practically identical to the natural community maps of the same areas obtained through exploratory trawling.

This observation seems to be a good demonstration that the initial hypothesis, i.e. that a fish community can be represented by the acoustic data collected upon it, is very probably correct. In these conditions a closer analysis of the collected signals would permit:

- to obtain a good mapping of these communities, with many more values than a trawling survey could ever give, and consequently to rationalize the sampling time;

- to stratify or post-stratify in an automatic way, through the acoustic populations, the studied area, and to greatly decrease the variance in results of an hydroacoustic survey.

The last point is the following: an hydroacoustic survey generally gives one important result: the global biomass value. In fact the processed data could give much more than this single, low-precision, result. The maps obtained with all the other acoustic results bring a lot of information as far as the identification of communities, the behaviour, and the fishery biology are concerned. This type of information does not present the drawback of absolute density values, because it can be used directly in relative terms, and is consequently much more accurate.

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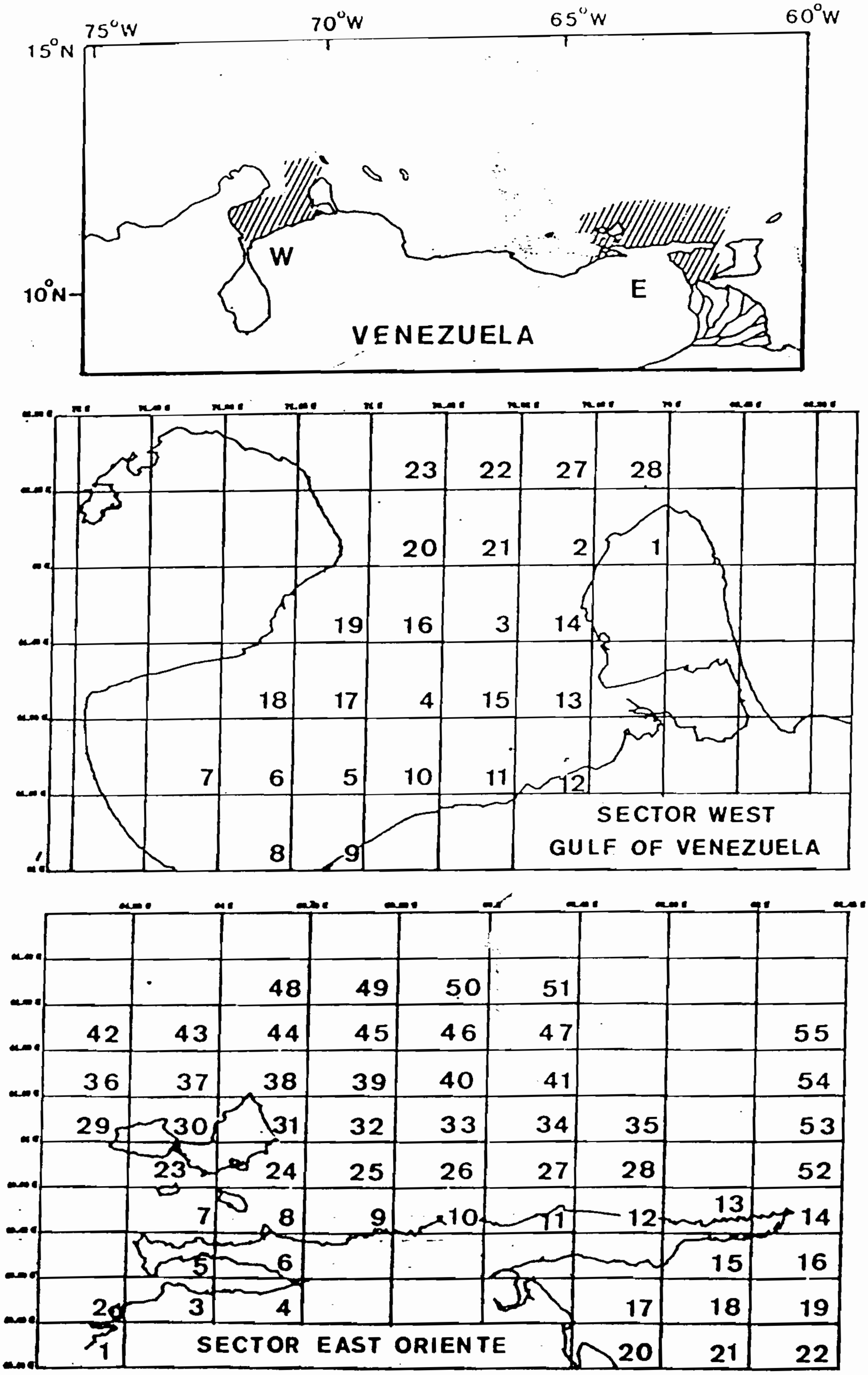
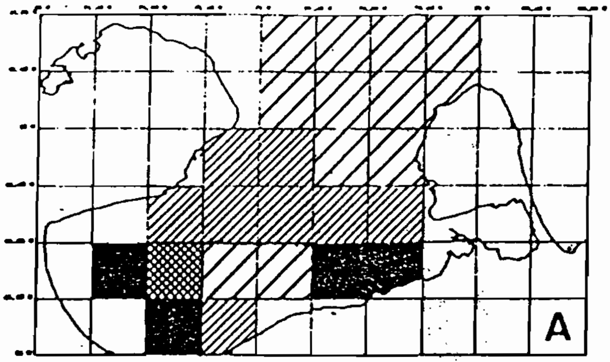
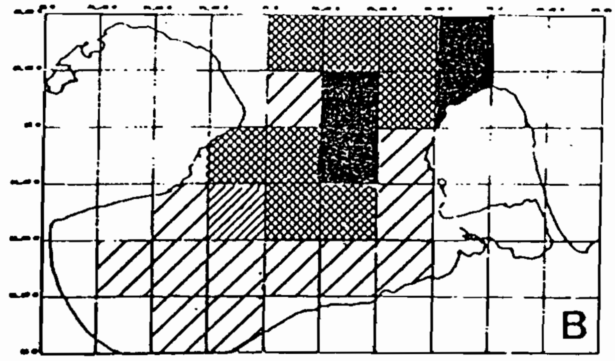


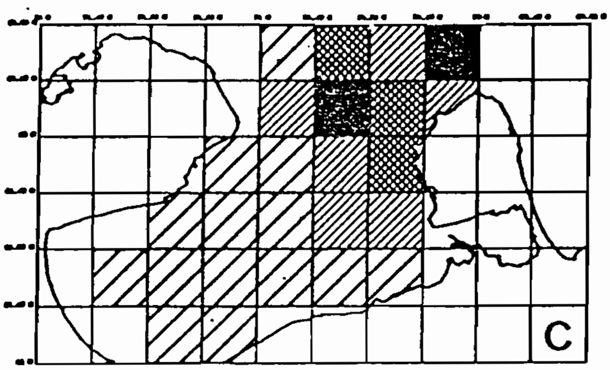
Fig. 1 : General map of Venezuela Coast and surveyed sectors, with numbered squares



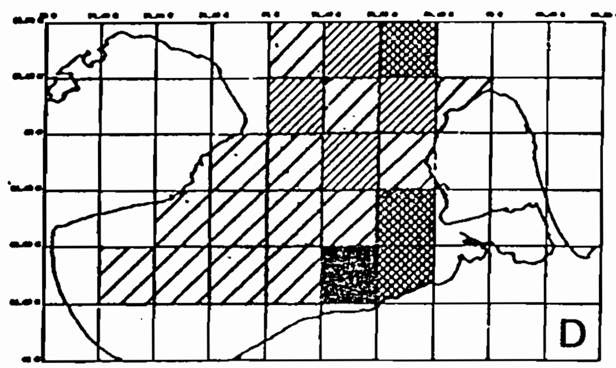
Chloroscombrus chrysurus



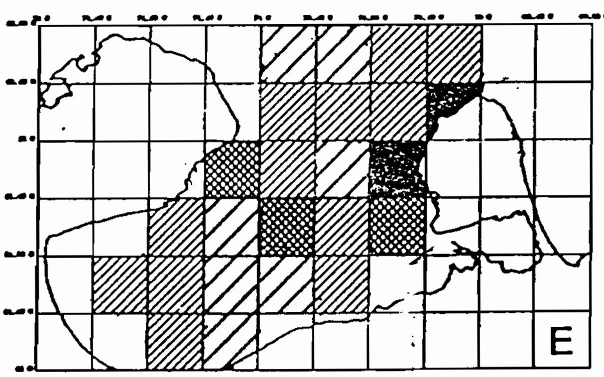
Lutjanus spp.



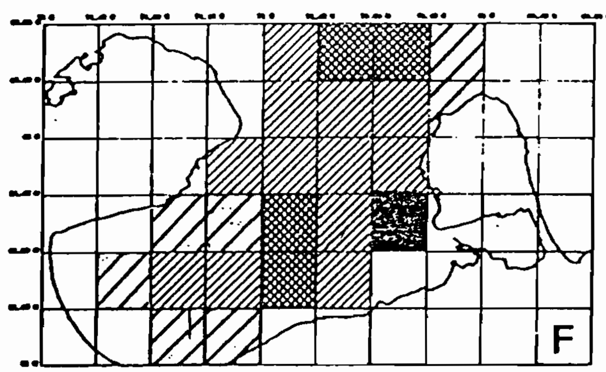
Priacunthus arenatus



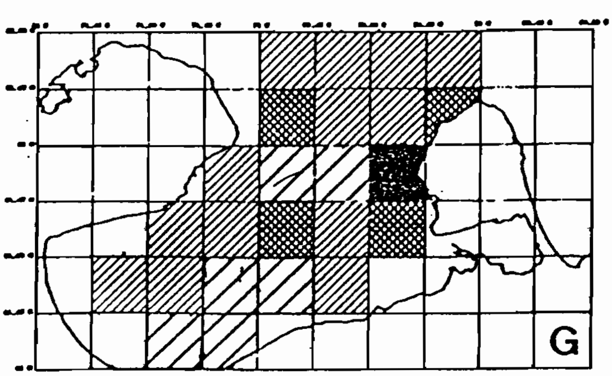
Pomadasydae



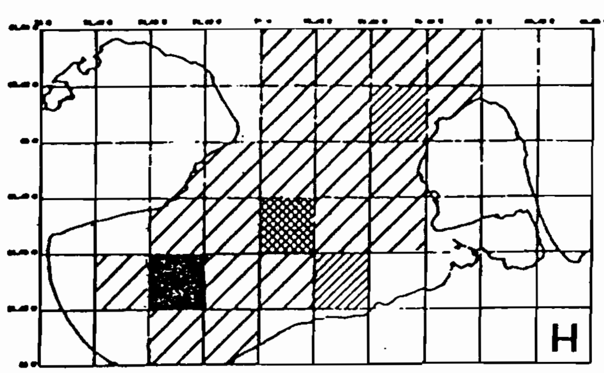
day density



night density

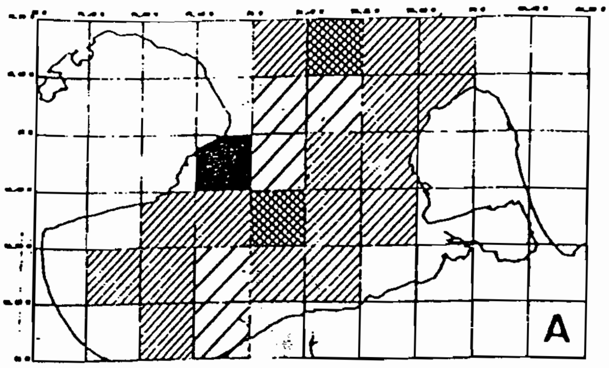


school day density

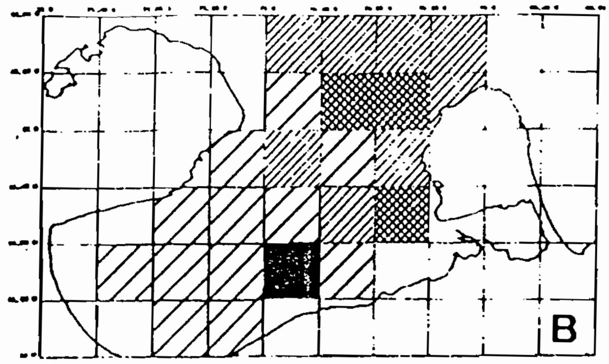


school night density

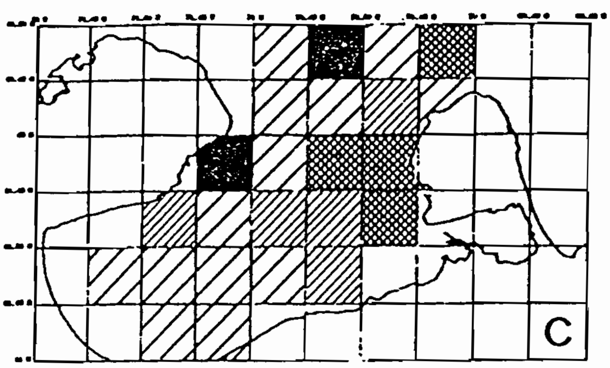
Fig. 2 - A,B,C,D : FALCON 1, examples of fish distribution
E,F,G,H : FALCON 2, examples of acoustic parameters distribution



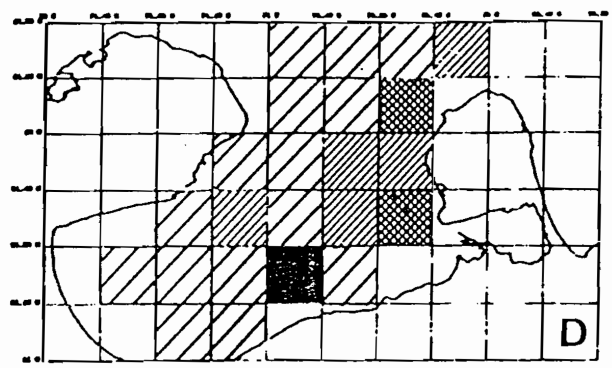
global density (day)



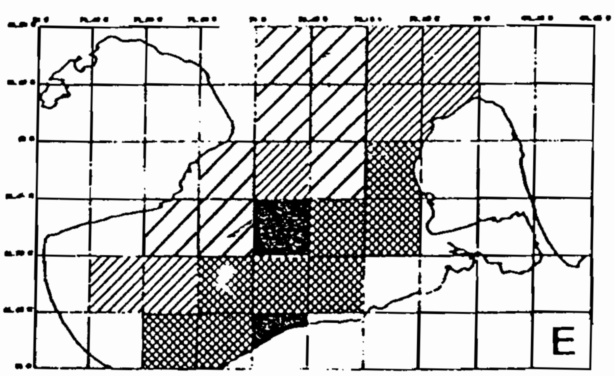
global density (night)



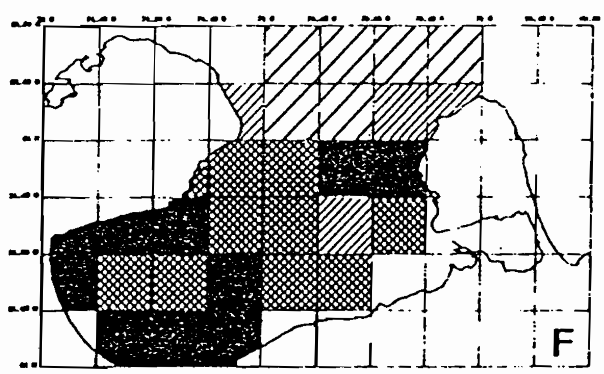
school density (day



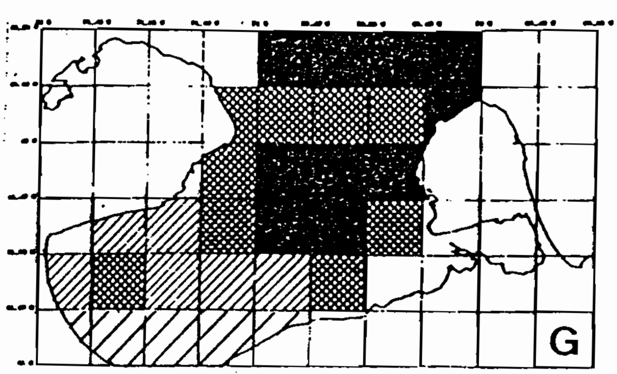
school density (nigth)



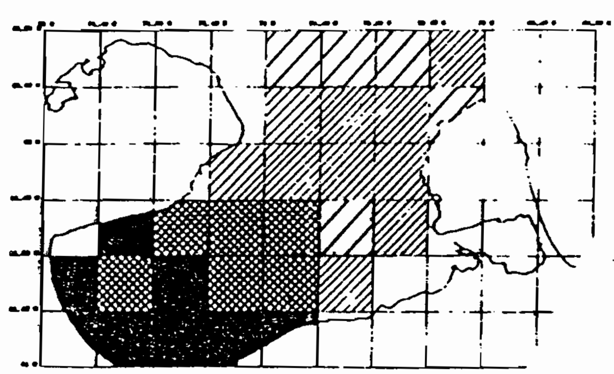
global density (day)



global density (night)



Density /E+ (low)



Density/E+ (medium)

Fig. 3 - A,B,C,D : FALCON 3, examples of acoustic parameters
E,F,G,H : FALCON 4, examples of acoustic parameters

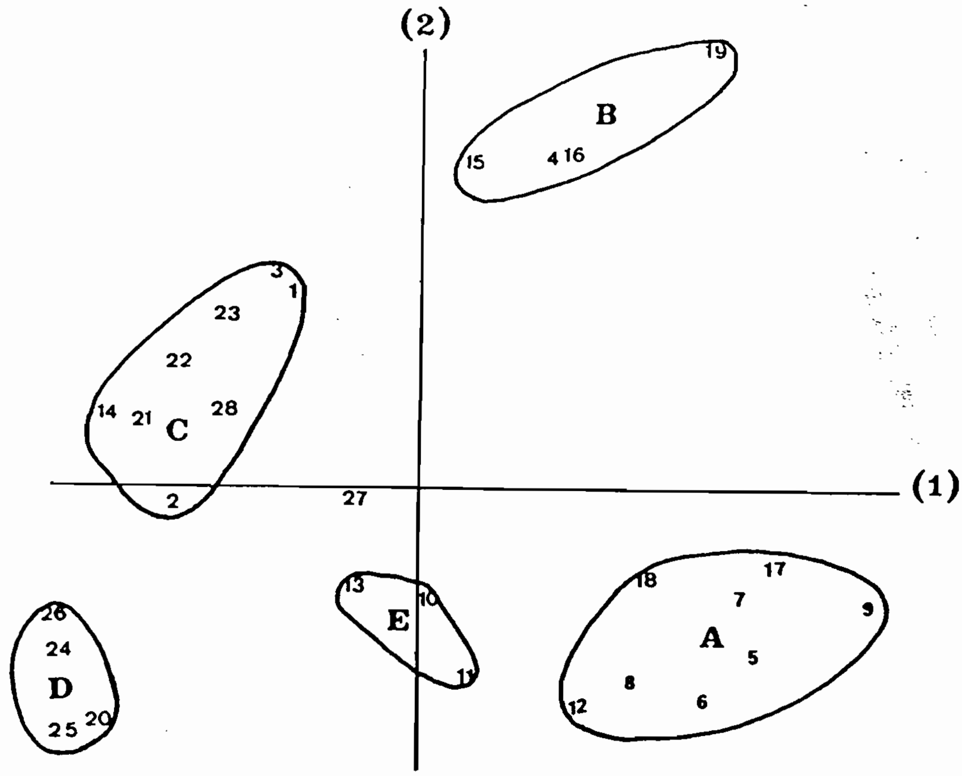


Fig. 4 - Factorial analysis on trawling data (FALCON 1)
distribution of the squares on axes 1 and 2
% inerty of axes 1 to 3 : 46.1 ;14.2 ; 8.7

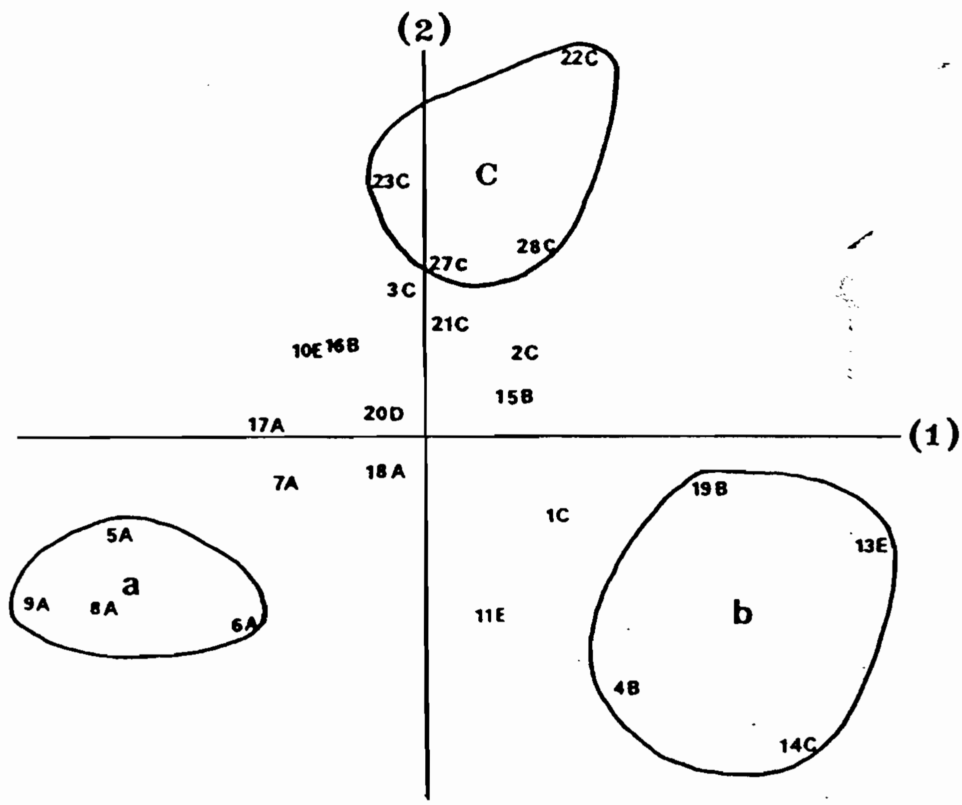


Fig. 5 - Factorial analysis on acoustic data (FALCON 2-4)
distribution of the squares on axes 1 and 2
% inerty of axes 1 to 3 : 26.9 ; 16.9 ; 13.9

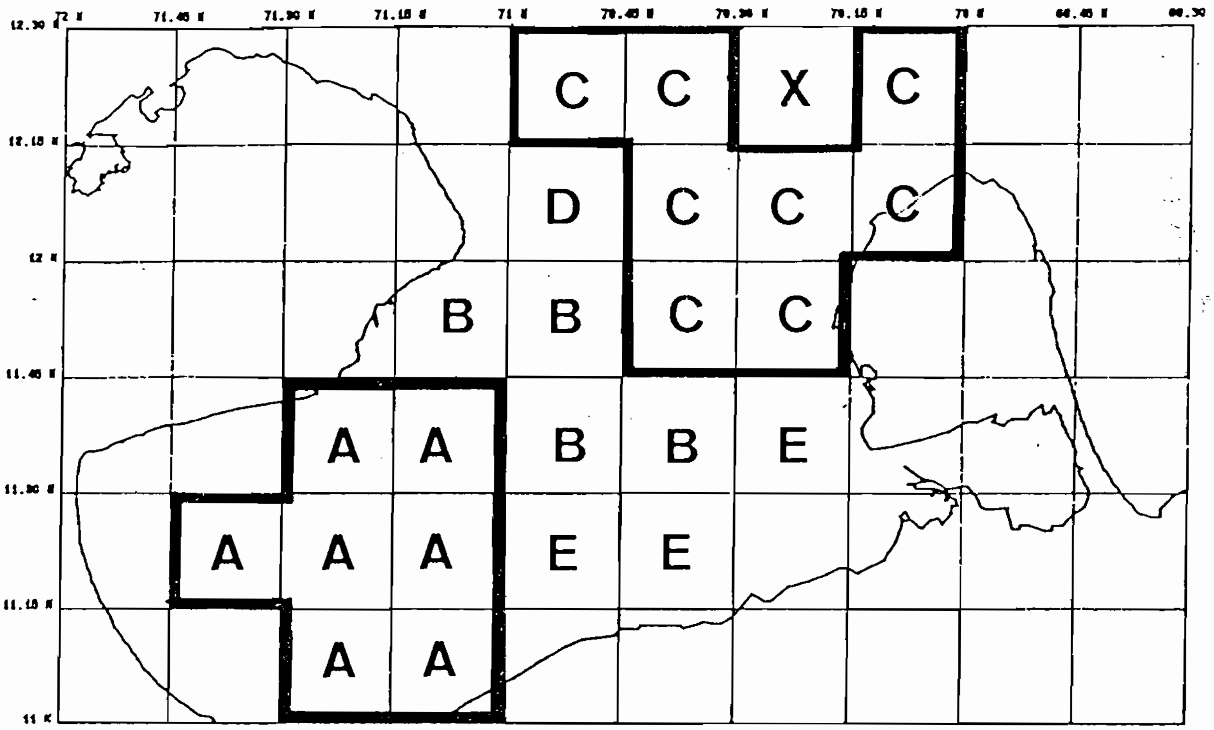


Fig. 6A : Map of natural communities, FALCON 1

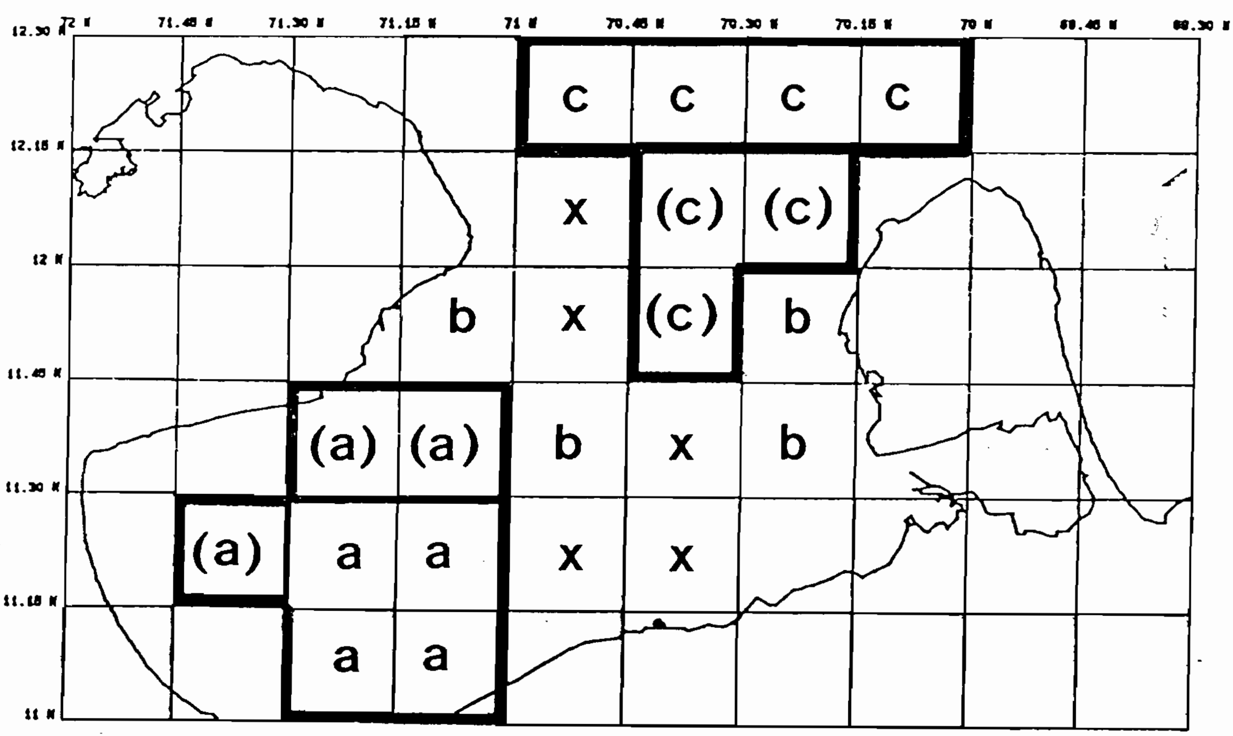
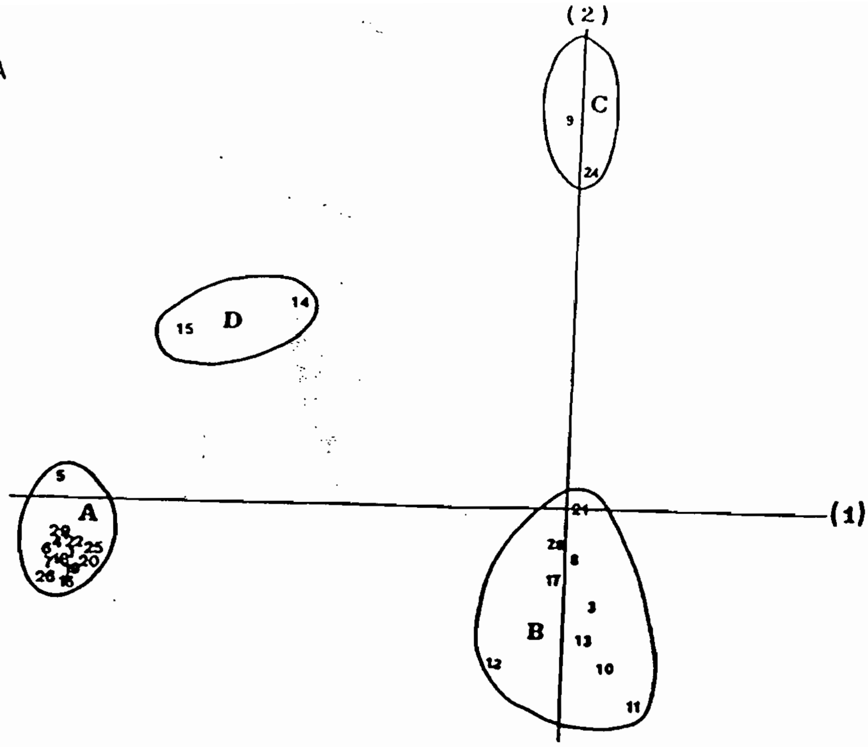


Fig. 6B : Map of acoustic populations, FALCON 2 to 4



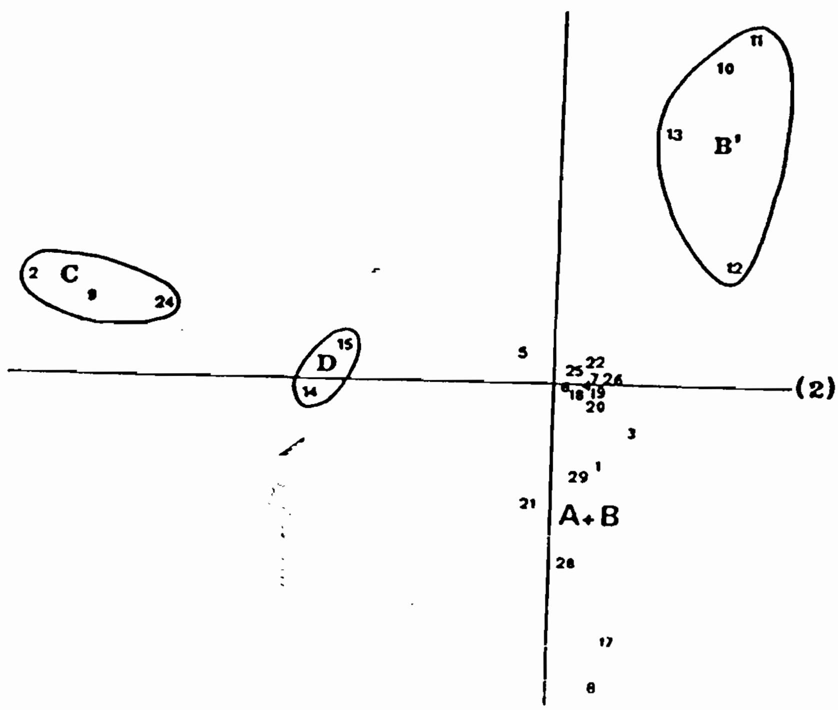


Fig. 7 : Factorial analysis on trawling data (ECHOVEN 2)
7A : trawlings distribution on axes 1 and 2
7B : trawlings distribution on axes 2 and 3
% inerty on axes 1 to 5 : 50.5 ; 10.3 ; 6.5 ; 5.1 ; 5.0

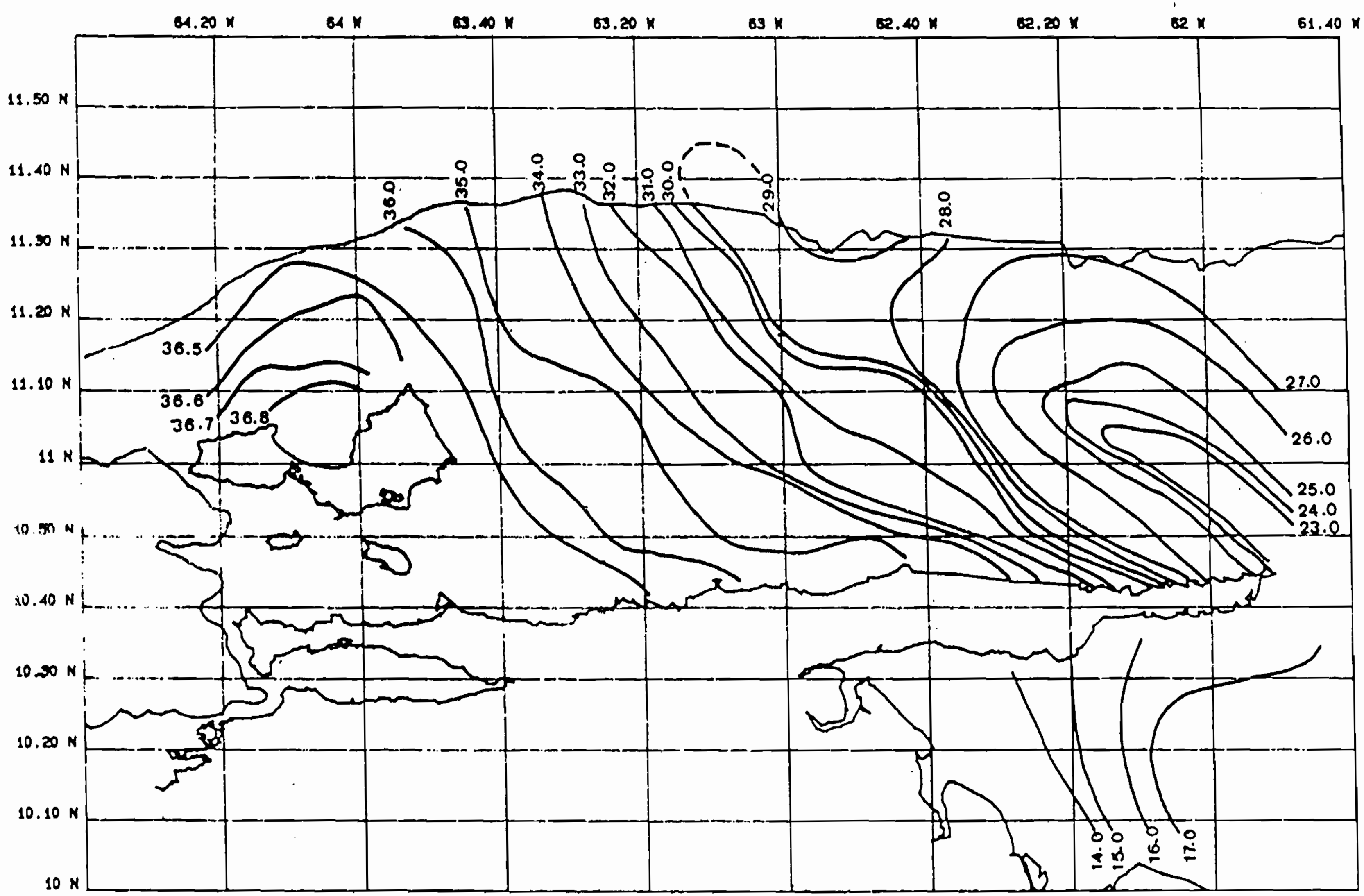
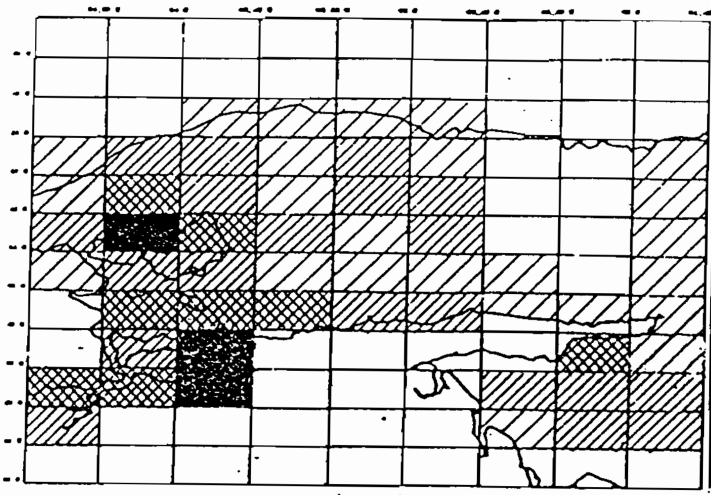
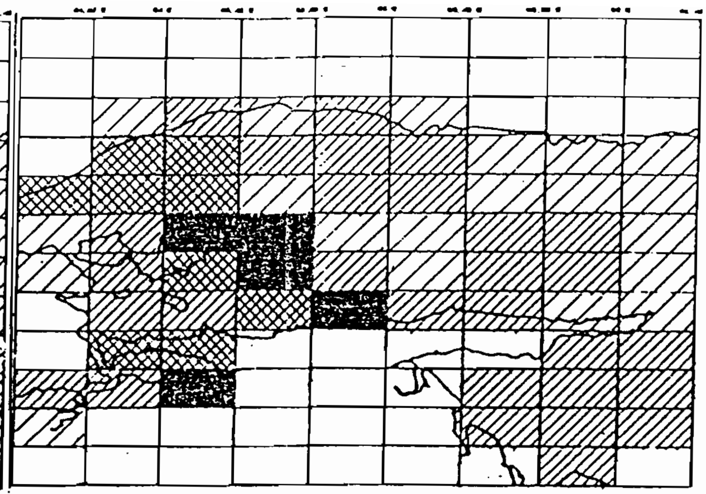


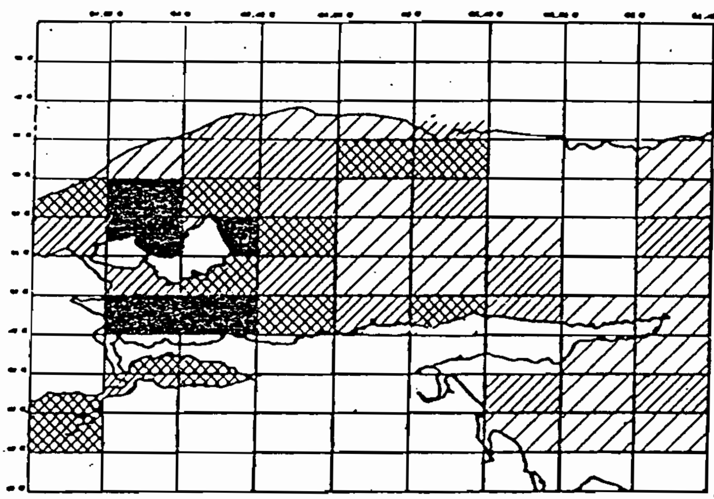
Fig. 8 : Map of surface salinity (ECHOVEN 2).



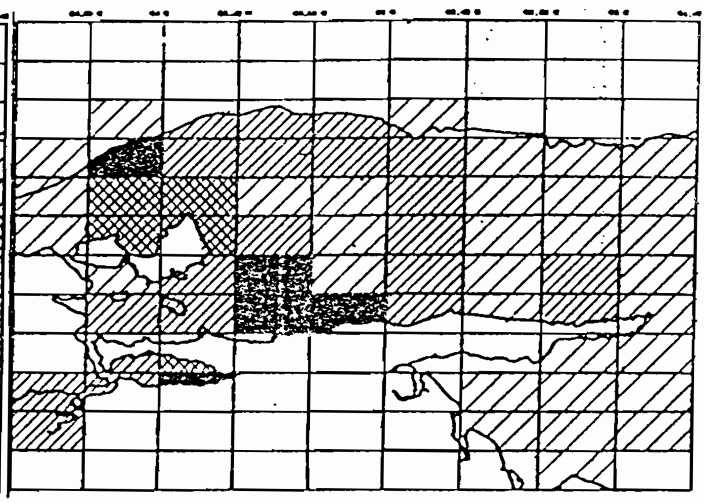
Global density (day)



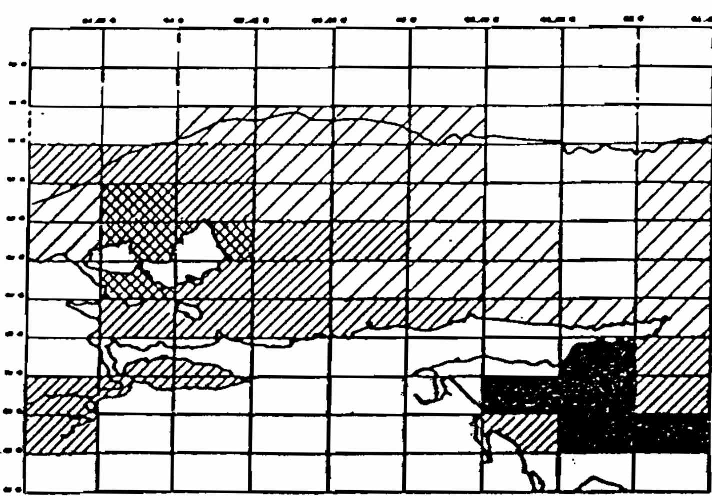
global density (night)



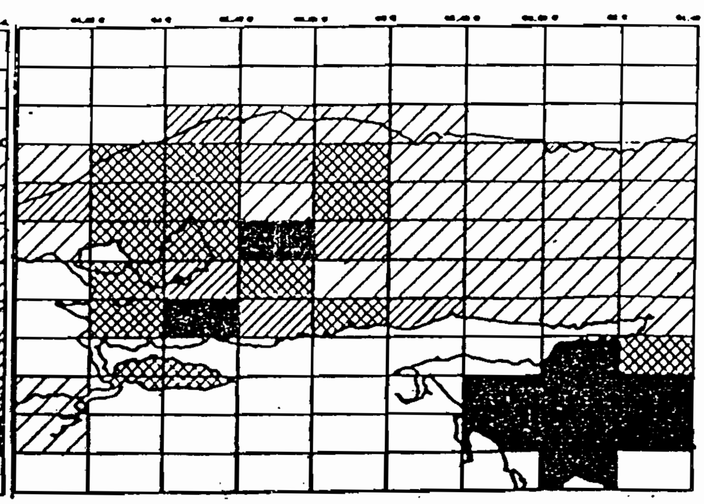
mean number of schools/ESDU (day)



mean number of schools/ESDU (night)



E+/E (day)



E+/E night)

Fig. 9 - ECHOVEN : examples of acoustic parameters distribution

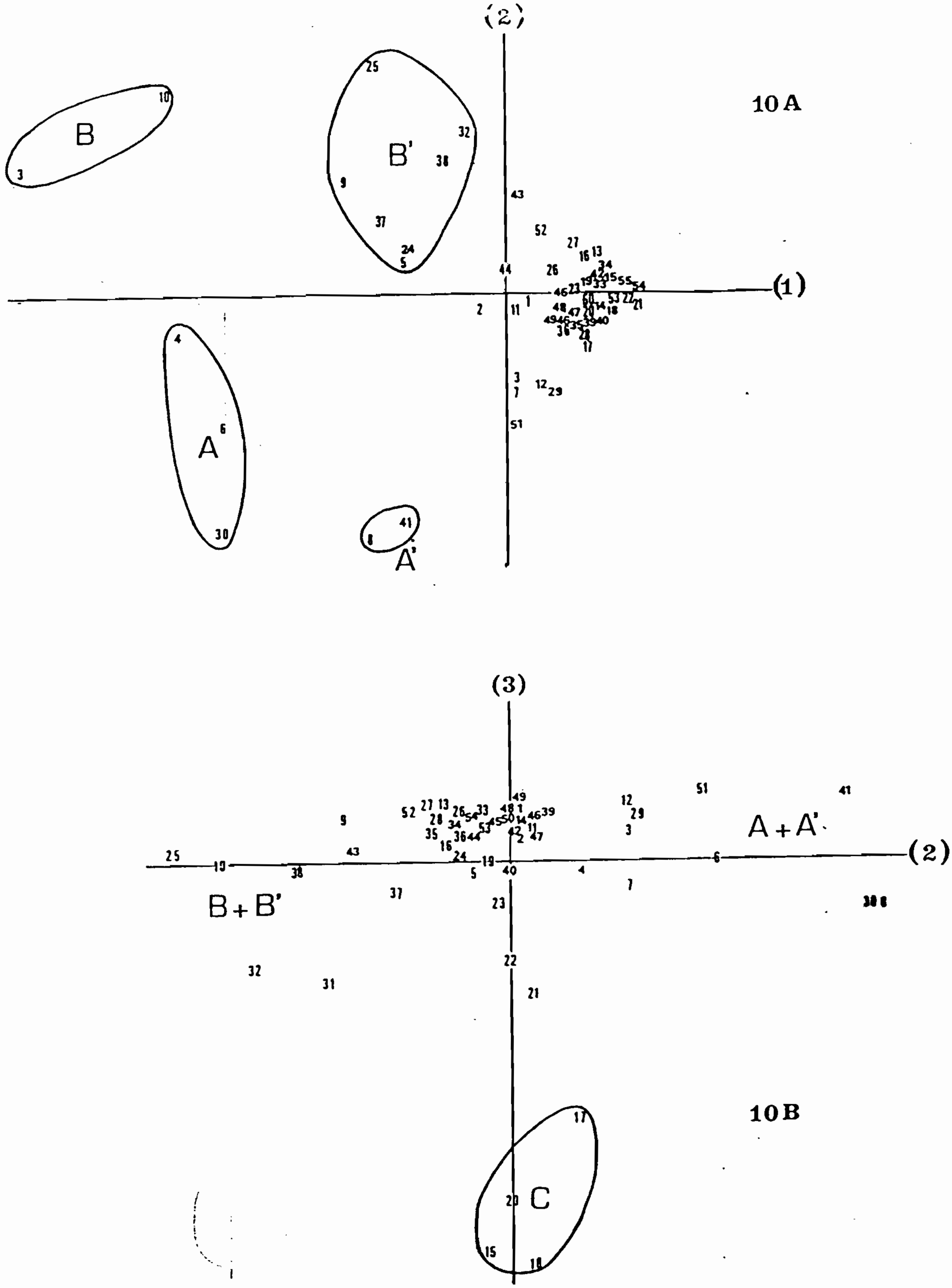


Fig. 10 - Factorial analysis on acoustic data (ECHOVEN 2)
10a : squares distribution on axes 1 and 2
10b : squares distribution on axes 2 and 3
% inerty on axes 1 to 5 : 41.2 ; 19.5 ; 12.9 ; 7.1 ; 6.3

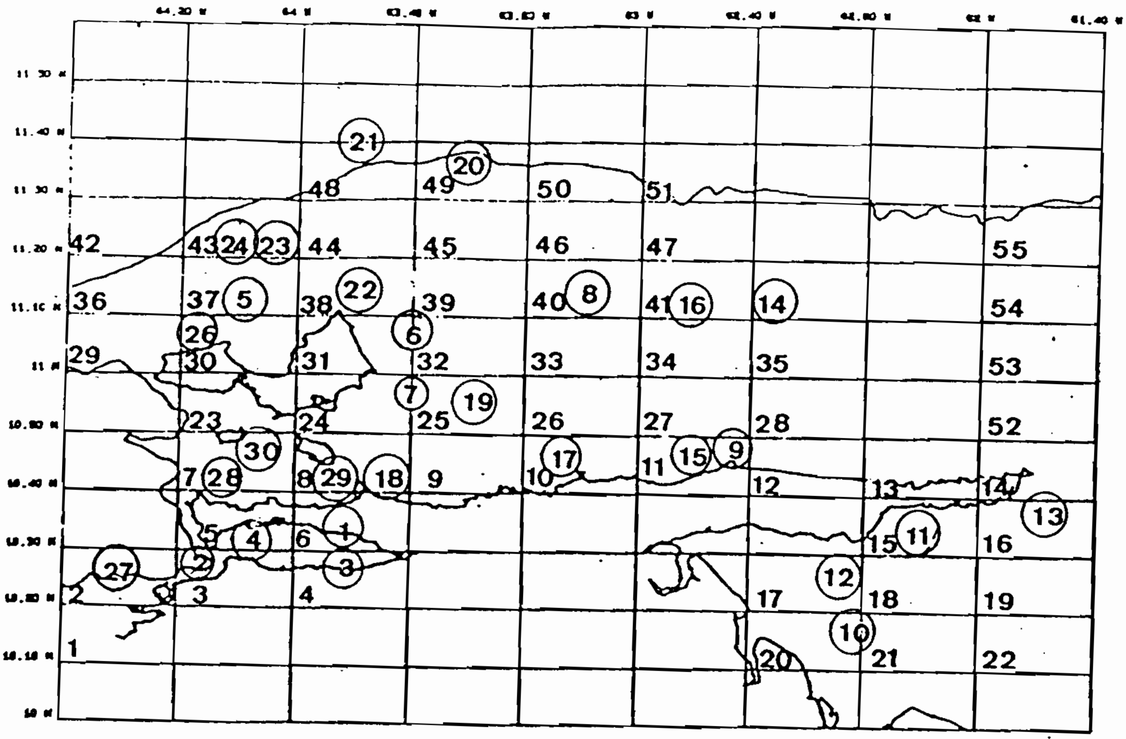


Fig. 11A : Position of trawlings (ECHOVEN 2)

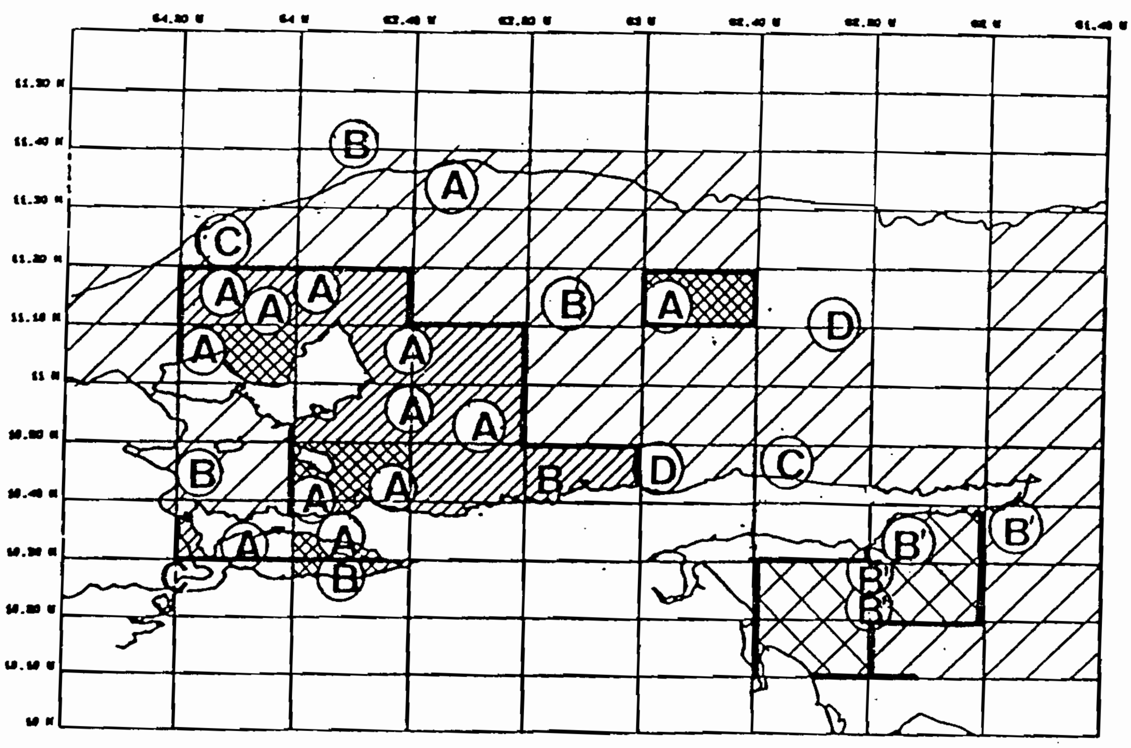
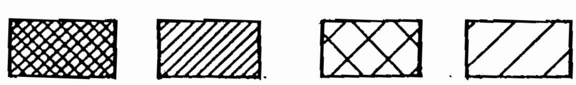


Fig. 11B : Distribution of natural communities (A to D)

Ditribution of acoustic populations



A B C D

Survey name	FALCON 1	FALCON 2	FALCON 3	FALCON 4	ECHOVEN 2
Beginning End	15/8/1982 25/8/1982	3/5/1983 20/5/1983	30/1/1984 12/2/1984	31/10/1985 12/11/1985	10/8/1986 11/9/1986
Vessel	LA SALLE	LA SALLE	LA SALLE	LA SALLE	CAPRICORNE
Sounder Frequency	EK/S 120 kHz	EK/S 120 kHz	EK/S 120 kHz	EK/S 120 kHz	EK400 120 kHz
Integrator	QM II	QM II	QM II	QM+AGENOR	AGENOR
Area prospected	Gulf of Venezuela	Gulf of Venezuela	Gulf of Venezuela	Gulf of Venezuela	Orient
Nb ESDUs	-	2300	2244	1800	4000
Trawl Nb stations	bottom 28	bottom -	bottom 11	bottom 14	pelagic 30

Table 1. Specifications of the surveys in Venezuela

Survey name	FALCON 1	FALCON 2	FALCON 3	FALCON 4	ECHOVEN 2
Beginning	5/8/1982	3/5/1983	30/1/1984	31/10/1985	10/8/1986
End	25/8/1982	20/5/1983	12/2/1984	12/11/1985	11/9/1986
Vessel	LA SALLE	LA SALLE	LA SALLE	LA SALLE	CAPRICORNE
Sounder	EK/S	EK/S	EK/S	EK/S	EK400
Frequency	120 kHz	120 kHz	120 kHz	120 kHz	120 kHz
Integrator	QM II	QM II	QM II	QM+AGENOR	AGENOR
Area prospected	Gulf of Venezuela	Gulf of Venezuela	Gulf of Venezuela	Gulf of Venezuela	Orient
Nb ESDUs	-	2300	2244	1800	4000
Trawl	bottom	bottom	bottom	bottom	pelagic
Nb stations	28	-	11	14	30

Table 1. Specifications of the surveys in Venezuela

Survey	FALCON 2	FALCON 3	FALCON 4	ECHOVEN 2
Density/ESDU, day	DJF2	DJF3	DJF4	DSJ
Density/ESDU, night	DNF2	DNF3	DNF4	DSN
Density/sample above the threshold, day: high; medium; low				D+J.H D+J.M D+J.L
Density/sample above the threshold, night high; medium; low				D+N.H D+N.M D+N.L
Density/sample above the threshold, day+night high; medium; low			DE3F4 DE2F4 DE1F4	
School density, day	DBJF2	DBJF3		
School density, night	DBNF2	DBNF3		
Schools number per ESDU, day				B/S.J
Schools number per ESDU, night				B/S.N
Pelagic schools number, day	BPJF2	BPJF3		
Pelagic schools number, night	BPNF2	BPNF3		
Demersal schools number, day (BFJ)	BFJF2	BFJF3		
Demersal schools number, night (BFN)	BFNF2	BFNF3		
Samples above threshold/ total samples, day (E+/EJ)				E+/EJ
Samples above threshold/ total samples, night (E+/EN)				E+/EN

Table 2. Types of acoustic data introduced in the acoustic populations analysis

Trawl number => / species v	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Lutjanus analis	42.1	0	14.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26.8	0	0	0	18.3	0
Lutjanus aya	0	0	0.3	3.2	0	0	0	0	0	0	0	0.3	0	0	13.6	0	0	0	0	1.9	12.1	0	12.1	0	3.7	0	0	0
Lutjanus synagris	14.0	0	23.4	13.0	0	0	0	0	0	0	0	0	0	0	13.6	25.3	4.6	0	14.6	0	6.1	11.4	6.7	0	0	0	9.0	5.2
Lutjanus maximus	3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.7	0	0	0	2.7	0	0	0	1.5	0
Lutjanus griseus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.7	0
Calamus sp	17.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37.0	3.6	0	6.7	3.4	0	6.8	9.0	5.2
Priacanthus aren.	3.7	38.2	2.9	0	0	0	0	0	0	0	0	0	4.3	38.5	9.1	0	0	0	0	18.5	36.4	11.4	0	0	0	27.0	1.5	15.7
Haemulon spp	0	0	2.9	0	0	0	0	0	0	0	0	0	5.8	0	0	0	0	0	0	37.0	0	4.5	0	16.9	15.9	6.8	3.0	0
Salmonete	0	3.1	0.3	0	0	0	0	0	0	0	0	0.3	1.4	2.6	0	0	0	0	4.9	0	1.8	4.5	0	6.1	0	4.7	0.3	0
Trachurus lathami	3.7	0	0	0	0	0	0	0	0	0	0	0	1.4	2.6	2.3	0	0	0	0	1.9	0	1.1	0	2.7	22.4	13.5	0	7.9
Pristipomoides m.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27.3	28.4	40.3	16.9	11.2	16.9	0	20.9
Rhomboplites aur.	8.5	15.3	0	0	0	0	0	0	0	0	0	0	1.4	2.6	2.3	0	0	0	0	1.9	12.1	4.5	3.4	50.7	46.7	20.3	0	5.2
Scomber japonicus	0	7.6	23.4	0	0	0	0	0	0	0.4	0	0.3	11.6	38.5	9.1	0	0	0	0	0	0	15.9	0.7	0	0	3.4	0.3	0.5
Sardinella aurita	1.8	6.1	29.2	0	0	0	0	0	0	6.3	0	0	29.0	0	0	0	0.9	0	0	1.9	0	1.1	0	0	0	0	0.3	0
Selar crumenopht.	0	11.5	2.9	0	0	0	0	0	0	0.4	0	0	0	12.8	0	6.3	0	0	0	0	0	0	0	3.4	0	0	0	2.6
Sphyraena spp	0	3.8	0	32.5	0	0	0	0	0	4.2	0	0	0	0	6.8	25.3	0	0	0	0	0.6	17.0	0	0	0	0	0	36.6
sharks	5.5	0	0	13.0	0	0	0	0	0	0	0	0	0	0	0	0	0.9	0	0	0	0	0	0.7	0	0	0	0	0
cornua	0	0	0	0	0	0	2.8	0	0	0	0	0	0	0	0	0	0	5.7	1.5	14.6	0	0	0	0	0	0.7	0	0
Micropogon sp	0	0	0	0	18.5	18.1	11.3	14.9	37.5	4.2	0	0	0	0	13.6	12.7	22.0	7.7	24.3	0	0	0	0	0	0	0	0	0
Opisthonema ogl.	0	0	0	2.6	37.0	0	4.0	0	12.5	0	0	13.8	14.5	0	0	1.3	0	0	12.6	0	0	0	0	0	0	0	0	0
Curbinata sp	0	0	0	0	0	0	2.8	1.5	2.5	0	0	0	0	0	0	1.3	13.7	63.9	4.9	0	0	0	0	0	0	0	0	0
Curvina sp	0	0	0	26.0	0	24.1	28.2	1.5	25.0	0	0	0	0	0	0	0	13.7	0	1.0	0	0	0	0	0	0	0	0	0
Chloroscombrus ch.	0	0	0	3.2	3.7	24.1	16.9	59.7	12.5	0	20.0	74.4	1.4	0	4.5	12.7	0.9	1.3	1.0	0	0	0	0	0	0	0	0	0
Dasyatis sp	0	0	0	0	0	20.5	0	0	0	0	0	0	0	0	0	0	0	0	5.1	1.0	0	0	0	0	0	0	0	0
Peprilus mono	0	0.8	0	6.5	3.7	0	5.6	0	0	0	0	0	0	2.6	22.7	12.7	0	6.4	9.7	0	0	0	0	0	0	0	0	0
Bagre spp	0	0	0	0	37.5	0	16.9	0	0	0	0	0	0	0	0	0	0.9	7.7	0	0	0	0	0	0	0	0	0	0
Trichiurus lept.	0	7.6	0	0	0	1.2	11.3	14.9	7.5	0	5.0	5.5	0	0	2.3	1.3	36.6	6.4	0	0	0	0	0	0	0	0	0	0
Orthopristis rub.	0	6.1	0	0	0	12.0	0	0	0	0	75.0	5.5	29.0	0	0	0	0	0	0	0	0	0	0	0	0	0	54.1	0
Vomer setapinnis	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	1.3	0	0	0	0	0	0	0	0	0	0	0	0
Scomberomorus spp	0	0	0	0	0	0	0	7.5	0	84.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3. Results of FALCON 1 trawlings (species % of total catch weight).

Square Nb	DJF2	DNF2	DBJF2	DBNF2	BPJF2	BPNF2	BFJF2	DFNF2	DJF3	DNF3	DBJF3	DBNF3	BPJF3	BPNF3	BFJF3	BFNF3	DJF4	DNF4	DE1F4	DE2F4	DE3F4
1	898	100	28.21	0	0.66	0	0.07	0	417	275	0	0	0	0	0	0	1600	189	93.5	0	3.0
2	119	268	1.90	0.53	0.17	0	0.08	0	163	270	6.19	17.39	0.06	0.04	0.03	0	244	206	94.0	2.2	3.3
3	86	119	0	0	0	0	0	0	391	73	6.20	0.97	0.06	0.03	0	0	42	13722	98.0	2.0	0
4	514	260	29.19	14.29	0.32	0.11	0.08	0	650	0	6.58	0	0.03	0	0	0	18538	1888	99.0	0.7	0.3
5	100	200	0	0	0	0	0	0	30	36	4.20	203.60	0	0	0	0	14	15	80.0	9.8	10.2
6	300	212	2.31	53.64	0	0	0.08	0	2327	15	0	0.20	0	0	0	0	0	842	80.5	16.1	4.4
7	308	78	3.27	0	0.02	0	0	0	367	0	0	0	0	0	0	0	200	8649	92.9	6.1	1.4
8	106	25	0	0	0	0	0	0	200	0	0	0	0	0	0	0	4000	12779	66.6	31.4	2.0
9	53	7	0	0	0	0	0	0	150	0	0	0	0	0	0	0	7269	13338	68.9	17.9	13.2
10	57	265	0	0	0	0	0	0	346	1176	0	117.5	0	0.06	0	0	83	8896	81.9	11.8	6.3
11	207	228	3.57	2.07	0	0.03	0.14	0.03	220	0	7.00	0	0.15	0	0	0	3670	3688	95.2	4.8	0
12	(no acoustic data on this square)																				
13	665	2921	20.29	0	0.24	0.17	0.12	0	262	461	16.19	15.69	0.19	0.06	0.05	0.01	52	34	94.5	3.6	1.9
14	949	148	54.65	0	0.65	0	0.07	0	425	233	10.00	1.48	0.13	0	0	0.11	3064	13905	97.9	1.3	0.9
15	12	139	7.32	0	0	0	0.12	0	106	144	0.71	3.46	0.12	0.03	0	0	3705	660	97.7	0	2.3
16	181	227	0	0	0	0	0.05	0	10	113	0	0	0	0	0	0	118	4052	99.3	0.7	0
17	76	89	1.21	0	0.03	0	0	0	310	44	0	0.15	0	0.02	0	0	7	5358	95.4	2.0	2.6
18	336	84	3.33	0	0.13	0	0	0	241	0	9.75	0	0.16	0	0.03	0	0	11536	89.0	11.0	0
19	411	100	4.00	0	0.42	0	1.00	0	4541	92	407.41	0	0.08	0	0.08	0	11	2202	96.4	2.4	1.2
20	288	105	24.12	0	0.06	0	0.03	0	10	76	0	0	0	0	0	0	0	90	93.6	3.3	3.1
21	133	205	4.17	0	0.24	0.09	0.08	0	33	400	0	0	0	0	0	0	5	43	98.3	1.7	0
22	61	273	3.48	0	0	0	0.08	0	867	153	66.67	0	0	0	0	0	0	22	100.0	0	0
23	55	191	0.91	0	0	0	0.02	0	214	147	0	0	0	0	0	0	4	13	100.0	0	0
24	(no acoustic data on this square)																				
25	(no acoustic data on this square)																				
26	(no acoustic data on this square)																				
27	136	273	3.57	0	0	0	0.08	0	242	286	0	0	0	0	0	0	100	51	98.1	0	1.9
28	277	100	0.48	0	0	0	0.07	0	255	332	3.68	10.00	0.05	0.16	0	0	100	48	98.0	2.0	0

Table 4. Summary of acoustic data collected during surveys FALCON 2, FALCON 3, FALCON 4. (names of data detailed in table 2)

Trawl number => species v	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Sardinella aurita	86.7	[illegible]	0	99.5	75.0	[illegible]	95.3	0	1.0	0	0	0	0	5.0	3.6	78.5	1.2	99.0	100	98.7	0	98.0	0	0.6	99.7	98.0	0	0	58.3
Anchoa spp	13.3	0	0	0.3	0	0	0	0	0	0	0	3.1	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	69.0	16.7
Anchoviella spp	0	0	0	0.2	0	60.0	0	0	0	0	0	0	0	0	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	16.7
Trachurus lathami	0	37.5	0	0	0	0	0	0	75.0	0	0	0	0	2.5	2.9	5.0	0	0	0	0	0	0	0	4.4	0	0	0	0	3.3
+Harengula clup.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	87.5	0	2.4	0	0	0	0	0	0	0	0	0	0	0	1.8
Opisthonema ogl.	0	0	0	0	0	0	0	0	0	4.5	21.6	3.1	15.0	0	0.2	0	1.2	0	0	0	0	0	0	0	0	2.0	0	0	1.2
Sphyraena picud.	13.3	0	0	0	0	0	0.7	25.0	1.0	0	0	0	0	0	0	0	23.7	0	0	0	0	0	0	0	0	0	0	1.0	0.8
Bagre marinus	0	0	0	0	0	0	0	0	0	22.7	2.7	3.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2
Voner setapinnis	0	0	0	0	0	0	0	0	0	1.5	10.8	12.5	62.5	0	0.2	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0.2
Chloroscombrus ch.	0	0	0	0	0	0	0	0	0	1.5	8.1	3.1	2.5	0	0	0	2.4	0.1	0	0	0	0	0	0	0	0	0	5.0	0
+Elops saurus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8.0	0
Orthopristis rub.	0	0	10.0	0	0	0	0.5	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	15.0	0
Trichiurus lept.	0	0	1.5	0	0	0	0.1	0	0	7.6	1.4	3.1	0.5	5.0	0.8	0	2.4	0	0	0	6.7	0	0	0	0	0	0	0.1	0
+Alectis scylaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.8	0
Peprilus paru	0	0	0	0	0	0	0	1.0	0	15.2	2.7	0	0.5	2.5	1.1	0	2.4	0	0	0	0	0	0	0	0	0	0	0	1.0
+Lile piquitinga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.0	0	95.0	0.9	0	0	0	0
Scomber japonicus	0	50.0	0	0	15.0	4.0	0.1	0	23.0	0	.0	0	0	2.5	0.2	0	0	0.9	0	1.0	0	0	0	0	0.1	0	0	0	0
Euthynnus allet.	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0	0	10.0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
+Priacanthus aren.	0	0.5	0	0	0	0	0	0.9	0	0	0	0	0	0	0	0.5	0	0	0	0.2	0	0	0	0	0	0	0	0	0
Etrumeus teres	0	0	0	0	0	0	0	0	0	0	0	0	0	1.3	0	0	0	0	0	0	66.7	0	0	0	0	0	0	0	0
+Nealotus tripes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10.0	0	0	0	0	0	0	0	0
+Gempylus serpens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16.7	0	0	0	0	0	0	0	0
Selar crumenopht.	0	0	0	0	5.0	0	0	1.0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0
Archosargus unim.	0	0	15.0	0	0	0	0.2	0	0	0	0	0	0	0	0.3	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
+Lagocephalus laev.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0
Cynoscion leiar.	3.3	0	2.0	0	0	0	0	0	0	0	0	6.2	0	0	0	0	4.1	0	0	0	0	0	0	0	0	0	0	0	0
+Lobotes surinam.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0
+Mugil brasiliens.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59.5	0	0	0	0	0	0	0	0	0	0	0	0
+Pellona harroweri	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Decapterus spp	0	0	0	0	0	6.0	2.7	0	0	0	0	0	0	1.3	0	5.5	0	0	0	0	0	0	0	0	0	0	0	0	0
+Balistes vetula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0
+Hemicaranx ambl.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+Pomatomus saltat.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+Macrodon ancylod.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upeneus parvus	0	0.3	0	0	0	0	0	0	0	0	0	0	0	5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+Rhomboplites aur.	0	0	0	0	0	0	0	0	0	0	0	0	0	75.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caranx hippos	0	0	0	0	5.0	0	0	0	0	22.7	5.4	0	15.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oligoplites palom.	0	0	0	0	0	0	0	0	0	22.7	21.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+Mugil trichodon	0	0	0	0	0	0	0	0	0	0	0	53.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arius proops	2.0	0	50.0	0	0	0	0	0	0	0	5.4	6.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+Ophioscion punct.	0	0	0	0	0	0	0	0	0	0	0	6.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+Saurida brasil.	0	0	0	0	0	0	0	0	0	0	1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carcharhinus spp	0	0	0	0	0	0	0	10.0	0	0	10.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+Haemulon boschmae	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eugerres plumieri	0.3	0	20.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+Centropomus paral.	0	0	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+Fistularia sp.	0	5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+Calamus penna	0.7	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+Haemulon aurolin.	0	6.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scomberomorus mac.	0	0	0	0	0	0	0	2.0	0	1.5	8.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 5. Results of ECHOVEN 2 trawlings (species in % of total catch)

Species names with + : not included in analysis

Acoust. D. Square nb	DSJ	DSN	E+/EJ	E+/EN	D+J.H	D+J.M	D+J.L	D+N.H	D+N.M	D+N.L	B/S.J	B/S.N
1	297	73	13	8	92.0	6.5	2.0	97.1	2.9	0	0.77	0.41
2	792	706	52	21	91.5	6.3	2.2	93.5	2.9	3.6	1.77	0.04
3	891	563	18	157	84.1	9.1	8.9	99.0	0.5	0.5	0.45	0.12
4	3832	5155	29	147	68.2	10.0	21.8	83.2	5.2	11.7	1.44	1.63
5	495	2373	41	313	86.4	8.3	5.4	88.9	4.5	6.6	1.14	0.76
6	4921	1602	50	179	67.0	12.8	20.2	88.5	6.4	5.1	1.85	1.09
7	642	436	69	384	87.0	10.1	2.8	99.4	0.5	0.1	2.02	0.02
8	1385	715	62	672	60.9	26.1	13.0	98.9	0.6	0.4	2.90	0.11
9	798	1526	14	50	90.0	4.2	5.8	85.7	11.4	2.9	0.86	1.95
10	351	3661	30	246	79.3	13.5	7.2	71.1	11.3	17.5	0.21	3.25
11	473	391	20	95	90.4	6.0	3.6	95.3	3.9	0.8	0.71	0.03
12	14	113	0	16	83.3	0	16.7	100.0	0	0	0.20	0
13	28	39	1	2	100.0	0	0	98.4	1.6	0	0	0.39
14	14	42	0	6	95.6	2.2	2.2	100.0	0	0	0	0
15	591	384	783	890	100.0	0	0	98.3	1.7	0	0	0
16	32	161	39	171	98.8	0.6	0.6	96.4	2.9	0.7	0	0
17	137	371	300	1454	90.6	7.8	2.4	100.0	0	0	0.12	0
18	430	620	669	1389	96.2	1.7	2.2	99.6	0.4	0	0	0
19	99	195	49	259	97.3	0	2.7	98.5	1.5	0	0.15	0
20	42	547	91	2776	94.3	5.7	0	97.3	2.7	0	0	0
21	214	201	266	617	94.8	5.2	0	100.0	0	0	0.03	0
22	245	114	245	381	98.2	1.8	0	100.0	0	0	0	0
23	415	166	144	259	96.7	1.3	2.0	97.5	2.0	0.5	0.40	0
24	88	2589	27	75	87.5	14.3	0	87.2	9.0	2.6	1.60	0.38
25	36	5133	17	175	100.0	0	0	80.6	11.5	7.9	0.13	1.74
26	40	184	10	36	95.2	3.2	1.6	95.2	4.8	0	0.09	0
27	9	62	3	11	100.0	0	0	95.0	3.8	1.2	0	0.06
28	9	146	2	14	100.0	0	0	95.1	0	4.9	0.28	0
29	154	36	10	28	87.5	6.3	12.5	100.0	0	0	0.50	0
30	8164	282	125	101	66.5	16.8	16.8	92.9	5.8	1.3	2.86	0.67
31	1914	15058	123	271	72.8	16.0	11.1	68.9	8.2	23.0	3.72	1.38
32	52	13175	39	578	100.0	0	0	74.4	15.4	10.3	1.00	0.03
33	25	41	51	61	97.0	3.0	0	98.4	1.6	0	0.06	0
34	73	68	10	21	100.0	0	0	98.3	1.7	0	0	0.07
35	1	201	1	13	100.0	0	0	96.3	1.5	2.2	0	0
36	24	2562	4	30	100.0	0	0	99.2	0.8	0	0.72	0
37	1707	2839	106	142	97.8	2.2	0	88.9	7.0	4.1	2.75	1.13
38	180	2148	63	125	100.0	0	0	85.2	4.9	9.9	0.97	0.72
39	29	22	5	30	93.2	3.4	3.4	100.0	0	0	0.29	0
40	62	411	2	466	93.8	3.1	3.1	98.9	1.1	0	0.07	0
41	141	108	7	41	54.5	36.4	9.1	97.7	2.3	0	0.44	0.05
42	23	37	11	15	94.4	5.6	0	100.0	0	0	0	0
43	98	1645	34	159	100.0	0	0	94.6	4.8	0.6	0.04	1.61
44	154	1046	17	163	91.7	7.1	1.2	95.2	3.4	1.4	0.39	0.78
45	29	301	2	84	94.4	5.6	0	97.4	2.6	0	0.36	0.12
46	463	235	8	116	93.0	3.5	3.5	98.6	1.4	0	0.52	0.04
47	15	123	1	44	94.1	5.9	0	100.0	0	0	0.56	0.35
48	24	187	1	38	94.5	5.3	0	98.3	1.7	0	0.35	0.08
49	4	44	0	10	92.3	7.7	0	98.9	0	1.1	0	0.17
50	26	186	1	28	96.4	3.6	0	100.0	0	0	0.06	0.10
51	14	5	0	1	75.0	25.0	0	100.0	0	0	0.50	0
52	9	149	0	5	98.0	2.0	0	91.2	3.3	5.5	0	0
53	10	4	2	1	100.0	0	0	100.0	0	0	0.44	0
54	0	46	0	5	100.0	0	0	98.6	1.4	0	0	0
55	0	24	0	4	100.0	0	0	100.0	0	0	0.10	0

Table 6. Acoustic data used in the analysis (ECHOVEN 2)
DSJ = global density, day; DSN = global density, night
E+/EJ (N) = samples above the threshold/total samples, day (night)
D+J.H (M;L) = Density/E+ by day, high (medium; low)
D+N.H (M;L) = " " by night, high (medium; low)
B/S.J (N) = Number of schools per ESDU (x10000), day (night)

	TRIC	SCOM	PRIA	LUTJ	CHLO	CLUP	DJF2	DNF2	DBJF2	DBNF2	BPJF2	BPNF2	BFJF2	BFNF2	DJF3	DNF3	DBJF3	DBNF3	BPJF3	BPNF3	BFJF3	BFNF3	DJF4	DNF4	DE1F4	DE2F4	DE3F4
POMA	.0075	.0401	.0924	-.0984	.117[illegible]	.2530	0.0000	.4683	.1336	.0551	-.1187	.4342	.1143	.6499	.0347	.0735	.2195	.0939	.4083	.0601	.2111	.0727	.0609	-.1782	.1652	-.3395	-.1758
TRIC		.3433	-.4143	-.3730	.7360	-.2829	-.2246	-.5729	-.2546	.1075	.3643	-.0652	-.0652	.3346	-.0989	-.3832	-.3346	-.0893	-.0220	-.1118	-.1709	-.2077	.0401	.3337	-.3696	.4488	.1970
SCOM			-.5064	-.4259	.5071	.0557	-.0566	.1284	-.1284	.3559	.1519	.1754	.1535	.3271	.1935	.0972	-.1309	.3002	.1626	.1603	-.1209	-.1117	.2517	.2648	-.2228	.3323	.0854
PRIA				.5155	.5276	.1343	.1988	.2254	.3381	-.1903	.2884	.1155	0.0000	-.1615	-.0796	.4735	.3769	.2108	.0369	.3562	.2386	.2696	-.2130	-.5519	.4286	-.4720	-.3487
LUTJ					.4894	-.0149	.0809	.0917	0.0000	-.1172	.1176	.0157	.0783	-.2118	.2182	.2275	.2469	-.0644	-.1003	.1593	.0799	-.2893	-.3628	-.5399	.6825	-.6169	-.5508
CHLO						-.2663	.0482	-.3276	-.1638	.3098	-.1830	.2052	.0746	.4609	.1106	-.4692	-.1687	-.2809	.1572	-.2408	-.1569	-.1306	.2944	.4176	-.4190	.5113	.1326
CLUP							-.1638	.4335	-.1858	-.2012	.0122	.0635	.0635	-.2071	-.0006	.1758	.1598	.4345	.0642	.3118	.1312	.0404	.0650	.2501	.0124	-.0063	.0804
DJF2								.0630	.7559	.1310	.8944	.2582	.5809	0.0000	.2848	.0572	.2408	-.0589	.3482	-.1180	-.0712	.5480	.2646	.0433	.3027	-.2059	.0503
DNF2									.2143	.1485	.0563	.4392	.2196	0.0000	.2422	.5192	.3822	.4009	.1974	.3345	.3229	.2485	.2400	-.2946	.3432	-.3503	-.2281
DBJF2										.1485	.7888	.2928	.4392	0.0000	.2422	.0649	.2730	0.0000	.2961	-.0669	.0807	.6214	.0600	-.2455	.4576	-.3503	0.0000
DBNF2											-.0146	.2790	.1775	.2010	.1923	-.1996	-.0875	-.1042	.0085	-.1536	-.0874	-.1130	.2755	.0829	-.0941	.3616	.0914
BPJF2												.2309	.5196	-.1615	.3025	.1152	.3338	.0527	.3114	-.0132	.0478	.5637	.1183	.0290	.2933	-.1957	.0112
BPNF2													.3500	.4663	.0276	.1552	.0933	0.0000	.3708	.0229	-.0276	.1273	.3280	-.0503	.0781	-.0199	-.2143
BFJF2														.0933	.3861	.0443	.3544	.0685	.3877	-.0229	.1103	.2547	-.0205	0.0000	.1563	-.1595	.0390
BFNF2															.0129	-.1757	.0435	-.1277	.4087	-.1172	-.0900	-.0594	.2103	.0704	-.0182	-.0651	-.0454
DJF3																-.0948	.6660	.0378	.3254	.0347	.4829	.0176	-.0622	-.0208	.2640	-.1787	-.2444
DNF3																	.0269	.6981	-.0523	.4990	.1498	.2117	.0863	-.3848	.1862	-.3691	-.1835
DBJF3																		.1788	.6098	.2706	.6454	.3444	-.1185	.0047	.3680	-.3366	-.3906
DBNF3																			.2308	.7823	.0378	.2906	.2245	.0689	0.0000	-.0273	.0800
BPJF3																				.2234	.1766	.3863	.1382	.3223	.1317	-.1546	-.2430
BPNF3																					-.0158	.0727	.1171	-.1322	.1116	-.0661	-.1224
BFJF3																						.0176	-.3109	-.1873	.0916	-.2667	-.3519
BFNF3																							.2871	.2670	.1741	-.0889	.1364
DJF4																								.4022	-.2002	.3147	.5071
DNF4																									-.5210	.6672	.3872
DE1F4																										-.8220	-.5214
DE2F4																											.4448

Table 7. Correlation matrix on FALCONs data.
Acoustic data names explained in table 2
POMA = Pomadasidae; TRIC = Trichiurus lepturus;
PRIA = Priacanthus arenatus; SCOM = Scombridae; LUTJ = Lutjanidae
CHLO = Chloroscombrus chrysurus; CLUP = Clupeidae;