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AKUSTIKAN I

Workshop Report

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Edited by : D. PETIT
F. GERLOTTO
N. LUONG
D. NUGROHO

With the collaboration of : P. COTEL
JR. DURAND
P. PETITGAS

PELFISH

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SUMMARY

The PELFISH project aims at a better knowledge of the small pelagic fish stocks in Java Sea and their exploitation, the ultimate goal being as usual to build a proper management scheme. To reach this goal one needs to have minimal data on environment, liable statistic data, knowledge on biology of the main species, as well as on socio-economics.

For pelagic resources, acoustic techniques represent a specific tool which is able to give very useful informations. Inside PELFISH, it has been used with two main objectives : at first, repartition and extension of the pelagic resources, and then, evaluation of the corresponding biomass. It means that the studies have to take into account the hydroclimatic factors and the seasonal and interannual variations, which possibly are very important for pelagic recruitments and production. Later, acoustic data could enable us to understand better the medium scale repartition of fishes (schooling and dispersion) and their behaviour towards fishing techniques.

This first report is focused on the general repartition of pelagic fish biomass in Java Sea; data have been processed during a workshop in Jakarta (5 to 9 December 1994). We used only the ones performed from November 1991 to March 1994. A more general exploitation of the whole data will be given in the next Seminar - AKUSTIKAN II - which is planned to take place during January 1996.

The main conclusions are the following :

- The sampling methodology has proved itself useful for acoustic stock evaluations, with a sufficient precision, through the study of two surveys during two opposite seasons.
- The distribution presents two kinds of gradients : the most prominent is a West to East gradient, it takes place during the dry season and the main

densities are found in the eastern part of the Java Sea. Another gradient is found from North to South during the wet season.

- The expected precision of evaluation could be around 15%. This low value must be related to the great regularity of the structures in the area.
- It is possible to propose a biological model of the stratification of the fish distributions. This global hypothesis is built on the definition of the three groups of fishes : a coastal group, a more pelagic and widely distributed group and a dense eastern group.

This contribution to acoustic studies in Java Sea led also to a few recommendations about processing of other data and/or collection of new ones in order to improve this first exploitation and also in order to check some hypothesis : threshold adjustments to have a better discrimination of plankton biomass ; use of biological information ; more detailed data on coastal stocks ; evaluation of West Java Sea biomass.

The general conclusion is that the comparison of acoustic results with bioecological studies of main species, together with fisheries knowledge prove to be very consistent and the usefulness of echointegration studies is - if it has to be - fully demonstrated.

RINGKASAN

Proyek PELFISH bertujuan untuk memperoleh pengetahuan lebih baik atas berbagai stok ikan pelagis kecil dan eksploitasinya. Sedang tujuan akhir adalah untuk menyusun kerangka manajemen yang memadai bagi sumber daya ikan tersebut. Untuk mencapai tujuan ini diperlukan data statistik yang dapat dipercaya, pengetahuan akan bioekologi dari jenis-jenis ikan utama, data tentang lingkungan, selain data sosial-ekonomi.

Untuk sumber daya pelagis, tehnik akustik merupakan suatu alat khusus yang mampu memberikan berbagai informasi yang sangat berguna. PELFISH telah menggunakannya untuk dua tujuan utama : pertama, distribusi dan penyebaran sumber daya pelagis, kemudian, evaluasi terhadap biomassa mereka. Ini berarti bahwa studi tersebut harus mempertimbangkan faktor-faktor hidroklimatik dan variasi musiman dan tahunan, yang diduga sangat penting bagi rekrutmen dan produksi ikan-ikan pelagis. Selanjutnya, data akustik dapat membantu kita memahami lebih baik penyebaran ikan menurut skala media di mana mereka berada (pembentukan kawanan dan dispersi serta perilaku mereka) terhadap tehnik penangkapan yang digunakan.

Laporan ini difokuskan pada penyebaran biomassa ikan di Laut Jawa secara umum ; data telah diproses selama lokakarya di Jakarta (5 s/d 9 Desember 1994). Hanya sebagian dari informasi yang telah diperoleh selama 15 kali pelayaran yang telah dilakukan sejak November 1991 sampai Maret 1994. Eksploitasi terhadap data secara menyeluruh akan disajikan dalam Seminar - AKUSTIKAN II - mendatang, yang direncanakan akan dilaksanakan pada bulan Januari 1996.

Kesimpulan utama adalah sebagai berikut :

- Metodologi penarikan contoh telah terbukti berguna bagi evaluasi stok, dengan ketepatan yang memadai, melalui studi terhadap dua survei panjang selama dua musim yang berlawanan.
- Distribusi stok menampilkan dua macam pola penyebaran : yang paling jelas adalah terdapatnya penyebaran dari barat ke timur, yang terjadi selama musim kemarau di mana densitas tertinggi ditemukan di bagian timur dari Laut Jawa. Sedangkan pola penyebaran dari utara ke selatan ditemukan selama musim penghujan.
- Presisi yang diharapkan dari evaluasi ini mencapai sekitar 15%. Nilai rendah ini harus dikaitkan dengan kestabilan struktur populasi di wilayah ini.
- Terbuka kemungkinan untuk menyusun model biologi terhadap stratifikasi distribusi ikan. Hipotesis umum ini disusun berdasarkan definisi dari 3 jenis pengelompokan ikan yaitu : kelompok pantai, kelompok yang lebih bersifat pelagis dan tersebar luas, serta kelompok padat di sebelah timur.

Sumbangan pertama dari studi akustik di Laut Jawa mengarahkan kepada sejumlah rekomendasi tentang pemrosesan terhadap data lain yang masih ada dan/atau pengumpulan data baru agar dapat melakukan pengecekan terhadap beberapa hipotesis ; pengaturan "threshold" agar dapat membedakan biomassa plaknton secara lebih baik ; penggunaan informasi biologi dan data perikanan untuk mengkonfirmasikan model stratifikasi studi tentang pergerakan dan migrasi ikan ; data beberapa stok pantai yang lebih rinci, dan evaluasi biomassa bagian barat dari Laut Jawa.

Kesimpulan umum ialah bahwa komparasi antara hasil-hasil dari studi akustik dengan studi tentang bioekologi terhadap beberapa spesies utama, serta pengetahuan akan perikanan ini ternyata konsisten dan kegunaan dari studi echointegrasi - bila harus dikemukakan - dapat ditunjukkan secara jelas.

TABLES AND FIGURES LEGENDS

FOREWORD

The PELFISH Project which studies the seiners fishing activity in the Java Sea is sponsored by Indonesia (Agency for Agricultural Research and Development, AARD), France (French Research Institute for Development through Cooperation, ORSTOM) and the European Union. Its research is focused on offshore pelagic fisheries (mainly medium and large seiners fisheries) and its main objectives are :

- the provision of scientific advice for the future management of these fisheries ;
- the improvement of the performance of this fishing system in term of catch, conservation and distribution ;
- the evaluation of the socio-economic impact of potential management measures and technical improvement ;
- the enhancement of fishermen's income.

To reach these objectives, PELFISH has developed three main fields of activities :

- RESOURCES AND EXPLOITATION

It refers to fisheries functioning as well as to bioecology or fish populations dynamics. A special attention is paid to fish behavior and biomass estimation through echo-prospecting and integration.

- SOCIO-ECONOMIC STUDIES

They evaluate production costs, fish prices, incomes in the fishing sector and downstream. The research also targets the fishermen conditions of work, the role of women in the production and the respective weight of the formal and informal sectors.

- TECHNOLOGICAL INNOVATIONS

It is related to nets design and its evolution, the implementation of electronic devices on the fishing boats, the evaluation of the fish quality and the methods of conservation.

In order to have a better transfer of knowledge PELFISH has organized three Seminars dealing with specific contents. The first one on **BIO**logy, **DYN**amics and **EX**ploitation took place in March 1994 and the related BIODYNEX proceedings are being edited by the Project (POTIER and NURHAKIM, 1995). "SOSEKIMA" (December 1995) will focus on socio-economics with a special attention on innovation and management. Then AKUSTIKAN 2 Seminar will take place in January 1996. The report presented here represents a first glance at acoustic results before the more global synthesis which will be performed during the Seminar.

1. BACKGROUND

1.1. General objectives

PELFISH is focused on the exploitation and uses of small pelagic stocks through "big" seiners fishery. It means that it is a multidisciplinary project which presents three main fields of activities :

- Biology, fisheries and stock assessment;
- Socio-economic studies ;
- Technological innovations and improvements.

The first description of the objectives was :
" .... to study and improve the exploitation and the organisation of off shore pelagic fisheries in the Java Sea, in order to increase the supply of the population in quality products and proteins, and to improve the revenue of the fishermen, who make up one of the poorest rural groups. In particular, the project aims at promoting the development of off shore pelagic resources in the long term, through a better knowledge of stocks (...), but also by suggesting better fishing methods as well as better conservation, handling and transformation methods capable of optimizing the profits of both consumers and fishermen ...".

In the revised 1990-1994 Work Plan, these objectives were simplified and clarified as :

- the provision of scientific advice on the management of the fishery;
- the improvement of the performance of this fishing system in term of catch, conservation and distribution;

- the evaluation of the socio-economic impact of potential management measures and technical improvement;
- the enhancement of fishermen's income.

It is clear that the objectives of the Project are oriented towards development and further management. To achieve this, the Project had, first of all, to gather the information necessary to get familiar with the environment and the fishing mode. From these databases we should know the availability of resources to allow or not some improvements in catches and yields.

The biomass evaluation method by acoustics (echointegration) is the only method able to supply the necessary information on the condition of stock and its availability, directly and at any time. That is the reason why it seemed judicious to use it, all the more so because, contrary to other world productive sectors, this method was little used in Indonesian waters, particularly in the Java Sea [(1)] . Its use, in the framework of the Project had to aim not only at evaluating stock but perhaps above all, at knowing the precise seasonal variation in the sector where the catch is the most intensive. Knowing the capacities and the restrictions of the method it was also necessary in the study, to take into consideration the behaviour of fish so as to better clarify the validity of the observations.

1.2. ***Physical environment*** *(from DURAND and PETIT, 1994)*

Within an aquatic ecosystem, productivity is deeply dependent on climatic and physical characteristics of the environment. Thus the level of catches relies first on specific characteristics of the ecosystem and then of course on the

[(1)] In 1972-1976 the surveys in the Java Sea which seem to have supplied only distribution cards (Venema, 1976) ; in 1985 the PECHINDON cruise, was very localized during one month in the Central part of Java Sea. (Boely *et al.*, 1987) efficiency of the fisheries exploitation. A good understanding of the functioning of the ecosystem is necessary to conduct a wise management of renewable living resources. The need for environment knowledge and studies has been identified by PELFISH initiators from the beginning. Nevertheless it has not been possible to conduct specific programs on environment or productivity issues, which require specific means and skills. Measurements of temperature and salinity have been done during the 15 R.V. "Bawal Putih I" acoustic cruises we performed from March 1992 to April 1994 (**Annex 3**). These horizontal transects and vertical stations allow us to give a good description of temperature and salinity variations during two successive annual cycles. It constitutes an important contribution on environment issue since global studies are quite ancient.

The great Sunda Shelf extends from the Gulf of Thailand southwards through South China Sea - between Malaysia, Sumatra and Kalimantan - and the Java Sea represents its south-eastern part (**Fig. 1a**). It is a large and shallow water mass. Morphologically, the Java Sea is roughly rectangular. It is well delimited on three sides materialized by the western part, it remains nevertheless open with the Sunda Strait, between Sumatra and Java, giving way to Indian Ocean, and the Karimata Strait opening northwards on South China Sea. Obviously the eastern boundary has not the same meaning, as it is wide open towards the Flores Sea and the Makassar Strait.

This quick description already gives 3 essential features of the ecosystem :

- The discharge of continental fresh water is considerable mainly from Kalimantan, but also Sumatra and Java rivers. It will explain partly the low salinities encountered seasonally.
- The seasonal exchanges with South China Sea through the Gaspar and Karimata Straits should not be underestimated.

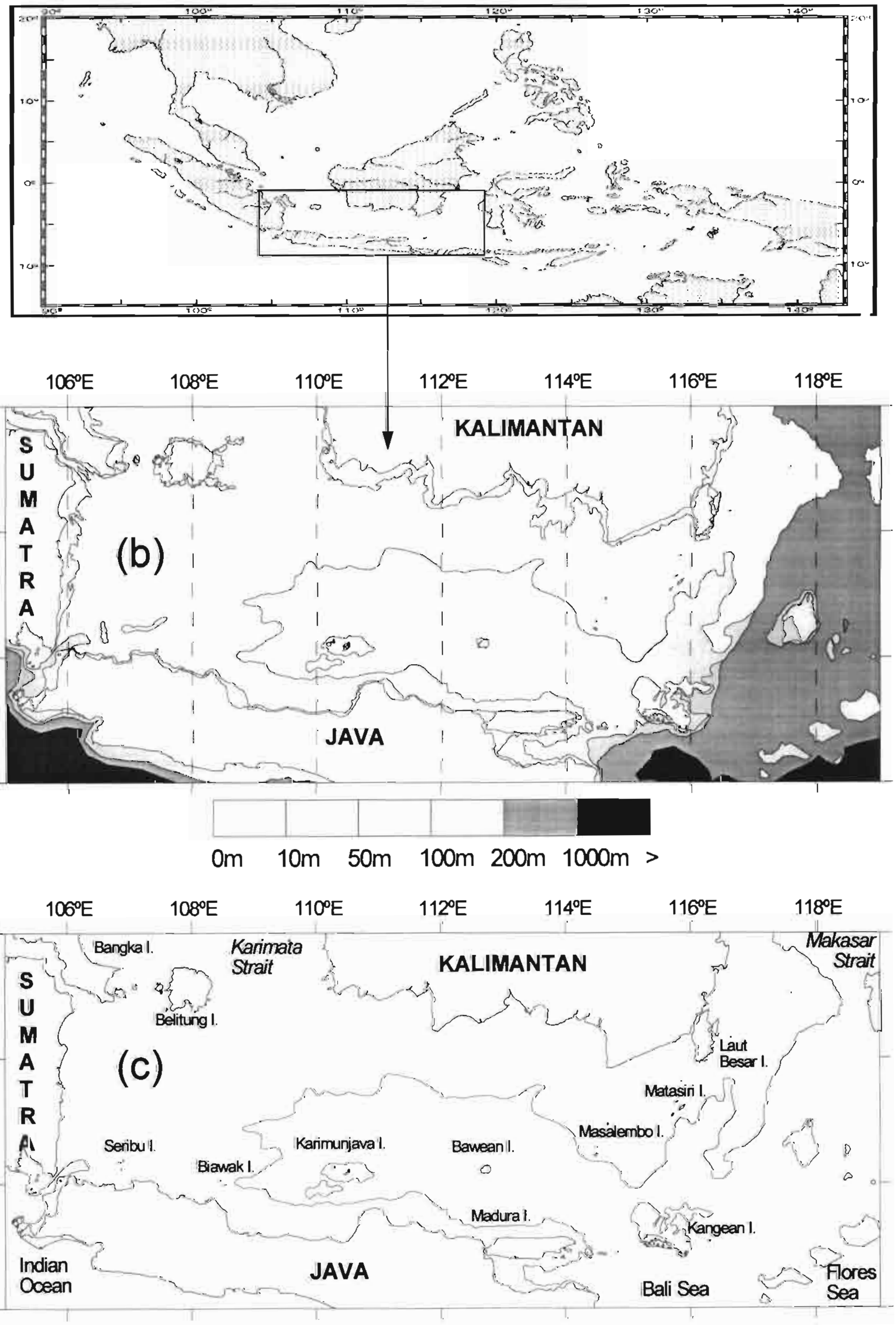


Figure 1 Java Sea situation and main physical features

a) Sunda Shelf b) Bathymetry c) Toponymy

- The eastern delimitation with the South China Sea raise the main issue : what are the relations with the eastern part of the Indonesian Archipelago?

We have choosen to define the Java Sea as the area of marine waters - for depth less than 100 meters - defined by Sumatra, Java and Kalimantan coasts, the latitude 3° South for Karimata Strait and 4° South for Makassar Strait (**Fig. 1c**). Owing to planimetry processing we obtained 442,350km². In fact one could ask if near the eastern border the estimation should not include a large part of continental shelf in Makassar Strait (this northern extension represent 57,790 km² above 100 m depth).

The mean depth of Java Sea is about 40 meters and on longitudinal axis, its bottom is slightly sloping towards east. The maximum is found north of Madura Island Strait (**Fig. 1c**). It is interesting to note that there is a clear dissymmetry between Kalimantan and Java coasts, with shallow waters much more developed in the northern part than in the southern. Owing to the spatial definition given above, the deep waters (i.e. more than 50 meters) represent 156,000km² (about 35% of total area) whereas the coastal shallow ones, less than 10 m, cover 30,300km² (nearly 7%).

Many islands and/or coral reefs lie in Java Sea (**Fig. 1b**), from West to North East : Seribu, Biawak, Karimun Java, Bawean, Masalembo, Kangean, Matasiri, Laut Besar. But for the first one, they all correspond to pelagic fishing zones. The bottom of Java Sea is mainly - more than 90% - constituted of a deep layer of dense mud. Near the coast, rocky outcrops associated with coral formations are observed.

The prevailing climate in the Java Sea is a typical monsoon climate marked by a complete reversal of the wind regime. This phenomenon is caused by differences in temperature between the continental and oceanic areas. The rainy monsoon occurs between mid December and March and is characterised by very windy periods with frequent rainfalls lasting for days. The dry monsoon occurs from June to September and is more regular. The climate varies considerably throughout this zone. The winds are the essential feature of the climate. From November to February they blow from the Northwest with a mean ivelocity of 3 Beaufort. From May to September they blow from a South or Southeast direction and are more regular, their force sometimes exceeding 4 Beaufort.

Owing to circulation and salinities, we can consider four types of waters circulating seasonally in the Java Sea (the last three types are more or less subject to a mixing) :

- The oceanic water masses coming from the Pacific and the Indian Oceans. Permanently present in the Eastern part of the Indonesian archipelago, they can reach the Java Sea, through the Makassar Strait or through the Flores Sea. The salinity is more than 34‰.
- "Mixed" waters between 32-34‰, mixed waters from the south of the China Sea, or oceanic water mixed with rainfalls or streaming in the Java Sea.
- "Coastal" waters between 30-32‰, like the diluted waters from the south of the China Sea by streaming along the East of Sumatra or the South Kalimantan borders.
- "River" waters below 30‰ which represent coastal waters more diluted at the mouth of rivers.

In reality, there are only two types of original waters in the Java Sea : one from the west (South of the China Sea), one from the east, oceanic.

The moving and/or the formation of these types of waters is ordered by the alternative system of monsoon : the wet monsoon from the north-west, the dry monsoon from south-east.

1.3. Cruises : choices and methodology.

Admitting that fishermen operate in the most accessible, rich sectors for profitability, orienting research towards intensive fishing zones as a priority was justified. It was just as imperative to know the real extension of these abundant zones, then their moving according to the seasons.

Let us recall however that the Java Sea has a surface area of some 440,000 km^2. A sufficiently precise inventory of that area demanded the organisation of cruises from one to two months, with a ship that was sufficiently fast, autonomous and equipped. "Bawal Putih I" at the disposal of the Project did not present sufficient qualities to insure big surveys. Its indispensable improvement, its equipment in navigation techniques as well as in scientific casting off has been achieved by mid 1993 only. The prospection strategy had then to be modified by applying to the available knowledge : the possible existence of an island effect on abundance, the necessary influence of a gradient in the east-west environmental characteristics on species, finally the presence of important catches in the north east of the Java Sea.

Taking into account the time available for each cruise (autonomy), the best way to associate previous facts or hypotheses in the prospection was to run a transect from island to island up to the intensive fishing zone. The duration of this prospection would moreover permit the carrying out of complementary observations for the study of local variability, natural behaviour and the one modified according to practices of traditional fishing, methodological observations which are indispensable to avoid biases or simply to assure evaluations (calibration and reverberation measurements in a cage).

It was only once that the sure means of navigation and research have been acquired that three more ambitious surveys could be carried out ; South of the China Sea : April 1993 and the most extensive prospection possible in the Java Sea : respectively in October 1993 and February 1994. The calendar of cruises and the types of observations carried out can be found in the appended document here after (**Annex 3**).

1.4. Equipment and data exploration strategy.

Besides supplementary navigation equipment (GPS, radar), the instrumentation of "Bawal Putih I" concerned 3 domains :

1) The automatic acquiring of environmental parameters which is assured by :

    - a LICOR quantameter connected to a data logger (aerial light) ;
    - a surface SEABIRD thermosalinometer (temperature, salinity) ;
    - a SEABIRD profiler for in situ measuring of the temperature, salinity and light penetration from the surface to the bottom.

2) The acquisition of density measurements of fish completed by target reverberation measurements.

    A dual beam Biosonics 120 kHz echo-sounder permits the detection of echoes. Two softwares : INES-MOVIES and ESPTS permit the processing of information stored in two computers (**Fig. 2**)

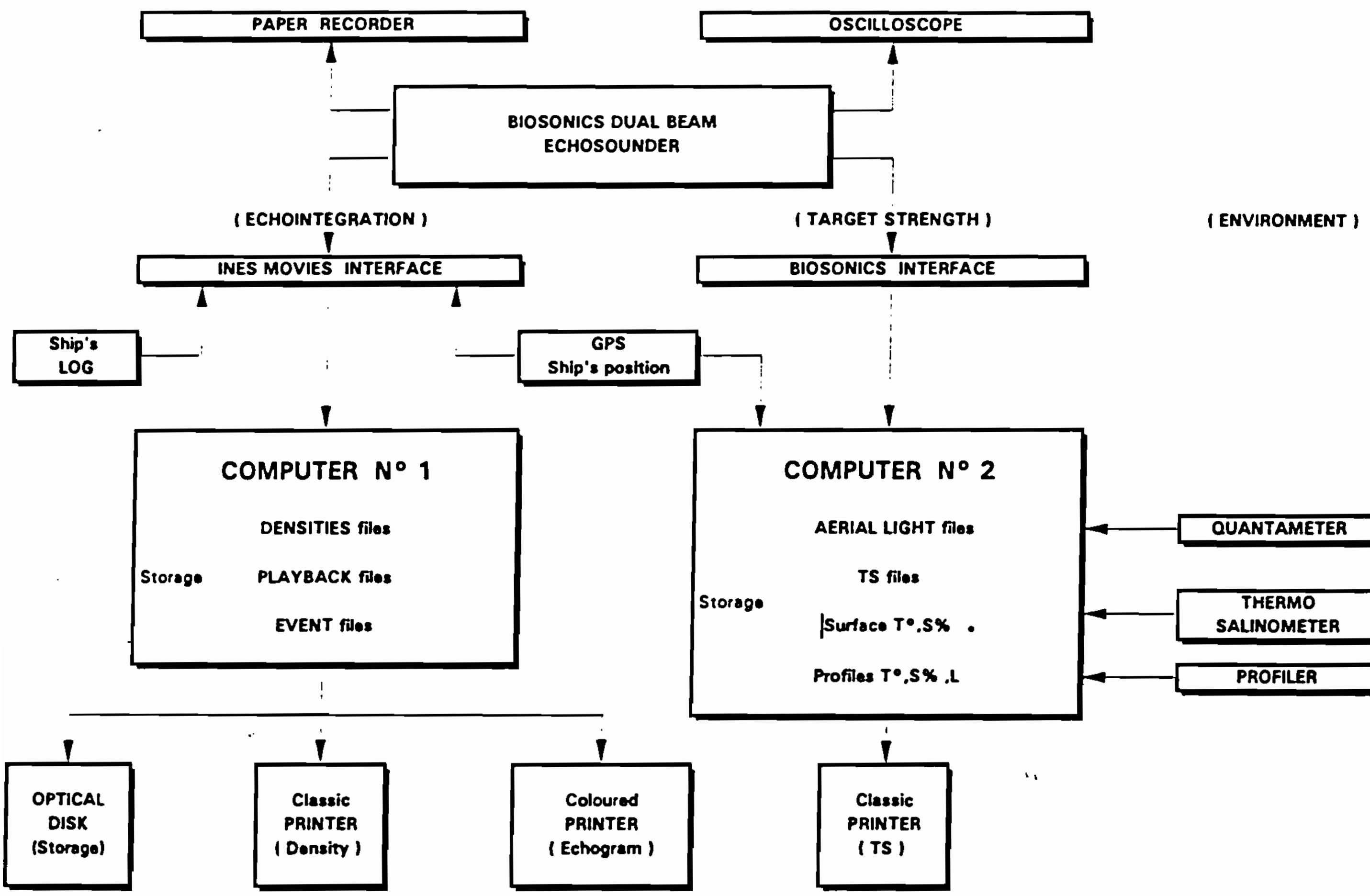


Figure 2 Main equipments and data acquisition

1) The sampling of detected fish.

    With a bottom trawl (vertical opening 5 m) and a pelagic trawl (vertical opening 11m) equipped with a netsond (FURUNO) localizing the position of the net.

The execution of a cruise always takes place according to the same outline: once the regulated casting off is underway, echointegration occurs continually during day and night, interrupted only for environmental measurements in station or sampling (trawls, seiners) following expected planning. Information on density is provided at each nautical mile. It is not useful to explain in detail the information which is gathered during a cruise. It will be indicated only that echointegration supplies three kinds of data files, reverberation measurements and environmental observations, either one file by observation ("station") or by survey.

Even though this data capture is fairly automated, with the exception of the sampling, it does not prevent to execute various controls before processing. That is what can be called the "validation phase", important operation after which measurements are considered exact. For echointegration, this stage is carried out through OEDIPE and EXCEL softwares. It consists on one hand of controlling the catch of all parameters, on the other hand of "cleaning" data so as to eliminate "noises" : bottom integration, parasites due to superficial agitation, as well as due to untimely "meeting" (waves, immersed objects or undesirable detections such as jelly fish field). It is also during this first work that the operator takes knowledge of the echogram that informs him on the distribution variations and allows to collect informations not entirely quantified (for example, shape of detecting, description of shoals).

The storage of reverberation measurement supplies *a priori* only average values. They should be positioned geographically and analyzed in detail if one wishes to process on elementary measurements. Data from environmental parameters also necessitate processings and are either carried out with the equipment software or with EXCEL.

The second phase that could be called the formating process will consist in extracting the needed information from each file (under EXCEL) for graphic or cartographic representations. This is carried out with OEDIPE, EXCEL, SURFER, STATGRAPHICS or GEO-EAS softwares.

2. RESULTS

INTRODUCTION

The first objectives of acoustic studies in Java Sea in the PELFISH frame were to operate global surveys of the whole Java Sea. Due to potentialities of the Research Vessel Bawal Putih compared with the area of java Sea open waters - nearly 300,000 km² - it was quickly understood that our initial strategy was not a realistic one (cf 1.2. supra). Even with this more restricted design, the volume of acoustic data was huge and did not allow to undertake in depth processing during the data collecting phase.

On the other hand we had to identify Indonesian scientists with acoustic knowledge and skills, in order to have a good transfer of PELFISH results, results which could find application beyond Java Sea such as the prospection and evaluation of pelagic resources of major importance in eastern Indonesia.

All these reasons led us to organize a workshop where a group of specialized scientists would gather and process together a first set of data, this work being the first step to a broader seminar during which a true synthesis could be attempted. The major theme of the workshop was "Stratification of the Data" **(Annex 1)**

In order to have a wide representation of Indonesian scientists we invited lecturers and students from various universities : Bogor Agricultural University and Bandung Institute of Technology (West Java) ; University of Hasanuddin (South Sulawesi) ; University of Pattimura (Mollucas) ; University of Riau (Sumatra) ; University of Sam Ratulangi (North Sulawesi) ; College of Fisheries (Jakarta) **(Annex 2A)**. The Research Institute for Marine Fisheries (RIMF) was also represented through PELFISH, and ORSTOM sent two specialists Dr. F. GERLOTTO and Dr. P. PETITGAS whose activities and skills have been particulary appreciated.

2.1. Material and methodology

During an evaluation review in December 1993, F. GERLOTTO (ORSTOM Montpellier) defined an exploration procedure (GERLOTTO, 1993). One part of this document enabled us to define the contents of the workshop. Its goals aim to start up a first data analysis with a view to respond to the most important objectives defined in our workplan. The carrying out of this analysis goes through a descriptive stage of the phenomena permitting the answer to elementary questions : "where" "what" and "which" :

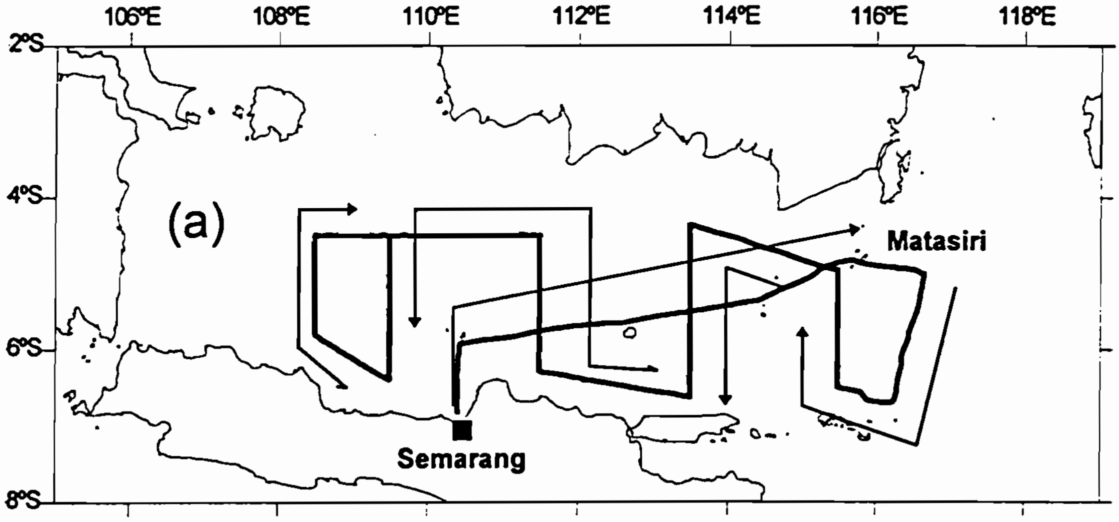
- where are the more productive zones and what are their limits?
- what is the importance of seasonal shifting under the influence of the environment ?
- which species are these stocks composed of ?

The development of this descriptive phase will permit the reaching of the analytical phase to implement the answer to the question "How much?". The latter needs a schematization of phenomena ending up with the stratification of data. That is the reason why the theme "STRATIFICATION" was chosen as the main goal of the Workshop AKUSTIKAN I.

2.1.1. Material

Among the whole of the 15 cruises that were available, it was decided to choose, on one hand, the two surveys covering the most important area of the Java Sea, on the other hand, three transects from Semarang to Laut Besar Islands, the latter being the most frequently prospected to follow the abundance gradient throughout the seasons.(**Fig. 3a**).

For each of these cruises, a data formating was necessary for acoustic as well as for environmental data. This work nedeed the "validation " and



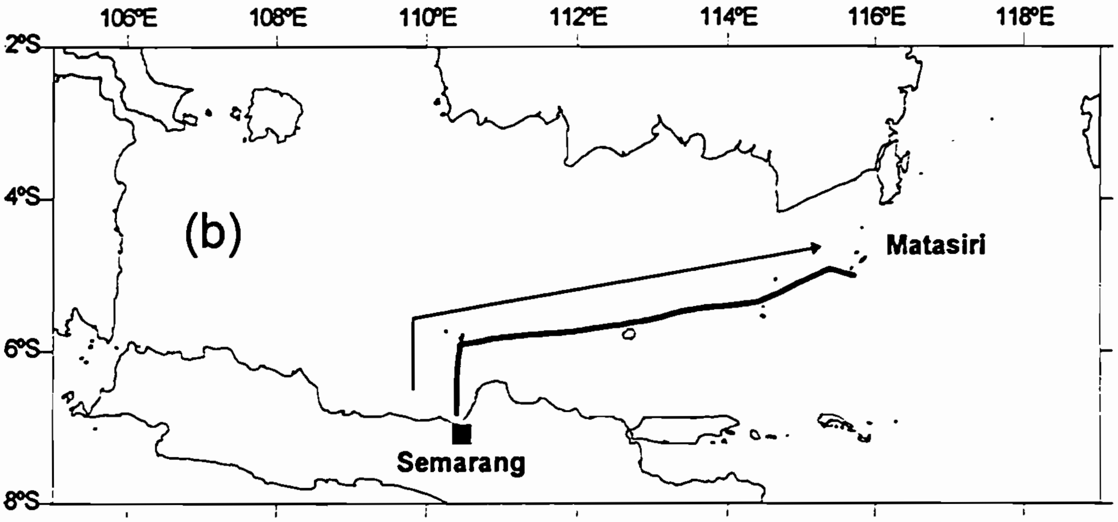


Figure 3 Routes followed by the vessel during two typical cruises

a) Overall coverage survey in October 93 (survey 34)

b) Transect survey in December 93 (survey 36) "formating" to use adapted softwares. In acoustics, the "valídation" and "formating" need two sets of tools in accordance with echointegration or with T.S. measurements.

In echointegration, the principal tool is OEDIPE software. This allows the correction of the values in accordance with the visual interpretation of echograms. For various reasons a playback of data can often be used with the INES MOVIES software. Once this data are validated, OEDIPE allows the carrying out of some succint cartographic works (tracks, positions of stations...), and moreover the selection of data files transferable to another software. At last we used EXCEL software to develop usable files by analysis software such as EVA, SURFER, LOTUS, GEOAS, STATGRAPHICS ...

For reverberation data (TS), "validation" does not exist strictly speaking ; the selection of data under certain criteria demands long manipulations, impossible to make use of in a routine. The systematic analysis carried out by the constructor's software has been preferred ; it supplies directly an average value by station and the distribution of data frequency. Unfortunately these data are not stored : they have to be manually keyboarded in the desired format, with the help of EXCEL.

The description of aggregations in shoals can be carried out by MOVIES B software. This software was not available at the time of the cruises. An elementary measure of the shoals then was made manually from echograms to create "shoals files".

Environmental measurements, essentially temperature and salinity for the moment are taken automatically from vertical profiles. A software "SEASOFT" supplied by the constructor allows the processing of gross data transferable to EXCEL. Thus these files can be completed (location) for an ulterior use.

The list of databases necessary for the implementation of descriptive phase can be given succinctly. It necessitates the following types of files, each with more or less complementary information indispensable according to the processing treatment (hour, depth, position, date ...).

In echointegration :

- Total density
- Density by layer
- Number of samplings
- Number of samplings with detection
- Number of shoals (pelagic, demersal)
- Density of shoals (pelagic, demersal)
- All these data are referenced by nautical mile.

For the reverberation :

- Average TS by station
- Average TS by cruise
- TS distribution by station

For environmental data :

- Average salinity by meter by station
- Average salinity by station (the same information can be available for temperature but this last factor which is very secondary in the Java Sea is not used).

Caution : during the workshop the densities have been expressed in units of integration (u.i.) so all the densities values published in this report should not be taken as absolute data.

The softwares used for the descriptive and analytical phase are the following:

- EXCEL (and WINDOWS) to elaborate new files and create elementary graphs ;
- LOTUS which has the same function ;
- SURFER for cartographic or graphic representation in three dimensions ;
- EVA which is an analytical software essentially of spatial structure and modelization (PETITGAS, 1991 ; PETITGAS and PRAMPART, 1993) ;
- GEOEAS which is a krigeage software and allows the calculation of the mean and variance on data of which the structure was modeled.

2.1.2. Data analysis methodology

This procedure stated by F. GERLOTTO is the one that, applied to the results, has permitted during the Workshop to proceed to the descriptive phase and then led to a tentative stratification through further analysis :

- Description of environmental frame ;
- Description of the spatial repartition of density ;
- Representation of distributions (densities and shoals) ;
- Description of the reverberating populations ;

- Description of the structures and research of modelization ;
- Analysis of descriptive elements in view of stratification.

Description of environmental frame : the repartition and the life history of population are linked to environmental factors. Thus the representation of general characters of the environment at the moment of cruises is of primary interest.
This in fact permits one to know quickly the homogeneity level of the environment and the geographic location of the phenomena which can potentially act on the abundance or the composition of populations. Knowledge of the times of change in environmental conditions allows to situate timing marks beyond which it is certain that the environment has some repercussion on the inhabitants.

Spatial distribution of densities : this very important point aims first of all to locate spatial distribution of the density by cruise, and the global abundance in order to get known the spatial variations. This description otherwise will attempt to take into account strictly pelagic or demersal populations (vertical distribution). The behaviour of detection will also be taken into account in this description since it is known that the values on day and night have not generally the same magnitude ; such a variation between night and day is then a behavioural indication which indicates a change either of the composition or of the proportion of species.

The next phase will consist of operating the same observations in the temporal dimension in order to recognize the seasonal variations.

- Aggregated level

It is a matter of trying to know the level of aggregation of the fish : in fact fishes are, more or less dispersed. At present, two ways permit the description and quantification of this mode of distribution : the proportion of samplings with fish target and the counting of shoals.

- Structure analysis of density distribution

The populations of fish are not homogeneously distributed. Instead of an "underdispersion" where densities would be uniform and homogeneously dispersed, one always observes phenomena of concentration at different spatial scales (overdispersion). The knowledge of these dimensional structures is of utmost importance since it will permit a modelling in the density distribution and then, extrapolation on unprospected zones.

- Species and size

The biological sampling analysis carried out throughout the cruises allows to attribute measured densities to certain species. This sampling should otherwise permit the spatial delimiting of each species. It is always insufficient. The sampling from fishing boats (at sea or at landing points) is indispensable. Reverberation measurements otherwise supply first rate information. Assuming that the species have approximately the same reverberation, the measured values of TS permit the evaluation of respective proportions in size for all these species.

The analysis of descriptive elements provided by the preceding observations should permit the stratification elaboration. It is a synthesis allowing to give zoning hypothesis for the studied area in "strata" having specific representative characteristics. Their borders are adjusted as well as possible since they only rarely coincide with a visible or measurable limit. This stratification will be a tool for a better adjustment of the biomass evaluation with the contribution of the structural analysis.

This report is the synthesis of the works of the scientists and students (**Annex 2**). We choosed 5 acoustic surveys performed in the Java Sea by the PELFISH Project (**Fig. 3a,b**) selected among a set of 15 surveys already performed, which are the following :

- Survey 21, performed in March, 1992. This survey is constituted of a single transect, repeated twice, from Semarang to Matasiri (harbour-fishing grounds)
- Survey 27, performed in December 1992. This survey has the same design as the survey 21
- Survey 34, performed in october, 1993. This survey covers the complete central part of the Java Sea (**Fig. 3a**), i.e. mainly the area with depths more than 50 meters and the "Matasiri bank" (part of the shelf around the Archipelago, with shallow waters (depths less than 50 m). It includes also the same transect as in survey 21), not repeated.
- Survey 36, performed in December, 1993. Same survey as survey 21.
- Survey 41, performed in February, 1994. Same coverage as in survey 34.

The main objectives of the workshop were to establish a descriptive model of the exploitable fish populations in the Java Sea through acoustic data processing, making possible an evaluation of the biomass with confidence interval. This objectives have been reached through two studies :

- a biological modelling of the Java Sea populations ;
- a characterization of these main populations in terms of spatial and environmental distribution.

This characterization has been made possible through the study of two main sets of criteria : environmental and biological.

Environmental criteria : the fish density distributions have been compared and related to the main environmental characteristics, such as :

- sea temperature (surface and profiles)
- sea salinity (surface and profiles)
- morphological characteristics (depth, presence of islands, etc).

Biological criteria : these characteristics were studied on one hand through the observation of fishery data, and on the other hand using acoustic data, such as :

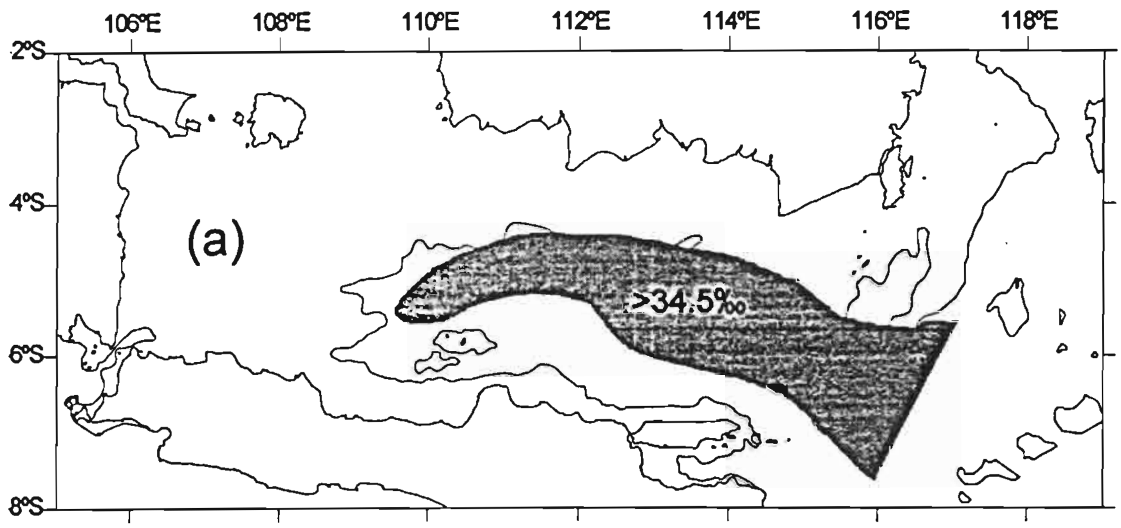
- data of acoustic density per ESDU (samplings of 1 nautical mile)
- TS data, average along larger distance (around 2 nautical miles)
- day-night differences in the TS and acoustic densities
- parameters of the schools measured on the echograms and echo-integrator values (density by nautical mile).

2.2. Synthesis of the results

2.2.1. Hydrological results synthesis

It is the most important factor in hydrology, and two seasons are defined, according the monsoon regime. This is clearly visible on the maps of salinity average on the water column, drawn from the data of the surveys 41 (February 94) and 34 (October 93) (**Fig. 4a,b**).

The distribution of salinity within the two large surveys shows the following :



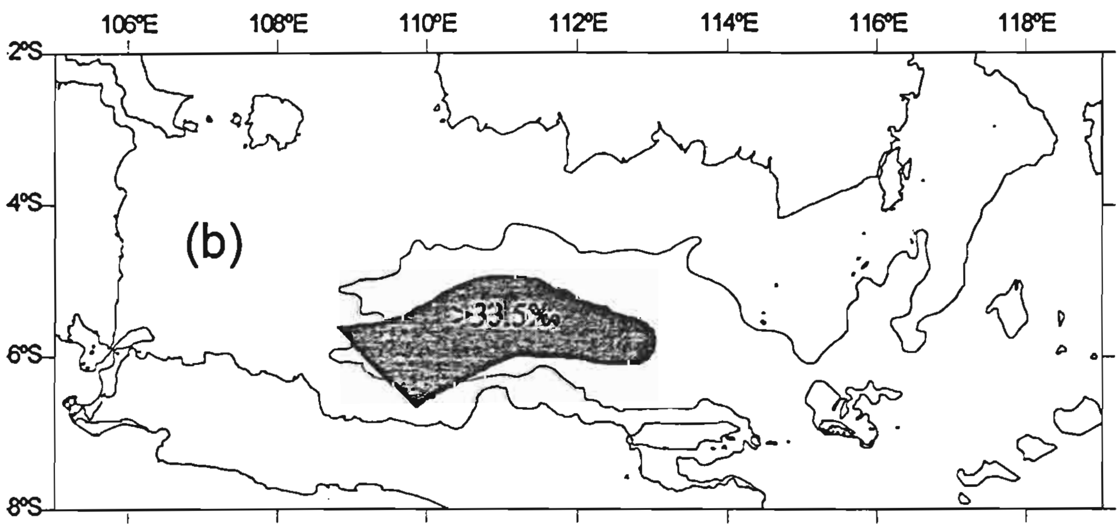


Figure 4 The mean salinities

a) upper than 34,5‰ in October 93 (survey 34)

b) upper than 33,5‰ in February 94 (survey 41)

- the marine influence is stronger on the central and eastern parts of the area studied in October, when the marine waters come from the east, with salinities above 34.5‰
- the only marine influence in February is observed on the western part of the area, with salinities above 33.5‰, probably coming from the Sunda Strait.

The structure of temperatures and salinities show a very regular distribution, and a low variability, the salinities from 32 to 34.5‰, the temperature from 26°C to 28°C. No thermal or saline front can be observed. Only long range trends are visible.

The main conclusions about hydrological data are the following :

- The oceanic influence covers mainly the deep area (i.e. depth more than 50 meters), with the exception of the Matasiri bank in October, which is shallow with marine waters.
- Although it is known from other data (particulary fishery data and general hydrobiological observations) that the hydrobiological wet season is centered on March, the brackish conditions are already visible on survey 41 (February). During this survey there only remains a small area around Karimunjava Island with salt waters, on the deep sectors (more than 50 m).
- The highest contrast between surveys 34 (October 93) and 41 (February 94) appears on the Matasiri bank, which is completely under oceanic conditions in October and under brackish conditions in February.

2.2.2. Data fihery synthesis

These data come from other parts of the Project, and include some observations recorded during the acoustic surveys (**Fig. 5**).

- Most of the purse seiner fishery is performed in waters with salinity above 32‰, and the target species is the Layang (*Decapterus spp*)
- The bulk of the fishery is centered on the Matasiri bank in October and moves to Lumu Lumu Island in February.
- The catch is twice more important in October on the eastern part of the Java Sea than in February.
- In April-May no catch is made on these areas.
- The central deep area of the Java Sea suffers a permanent fishery by the purse seiners, which represents between 9 (February) and 20% (October) of the total catches.

These characteristics of interest in the area under study show that the Matasiri bank is the most important exploited area during the oceanic influence, and that the fishery seems highly related to haline conditions.

2.2.3. Global acoustic fish densities

The acoustic values along the transects have been processed for all the surveys in different ways. In a first processing, the mean values of density by day and by night have been calculated for three areas of longitude : west of 112°E, between 112 and 114°E, and east of 114°E. Then the surveys have been classified according to empirical classes in a single survey, the lowest stratum representing 1, and the highest 3. On the other hand the 5 whole surveys have been classified in the same way, the lowest value being classified as 1 and the highest as 5. These classifications show the following :

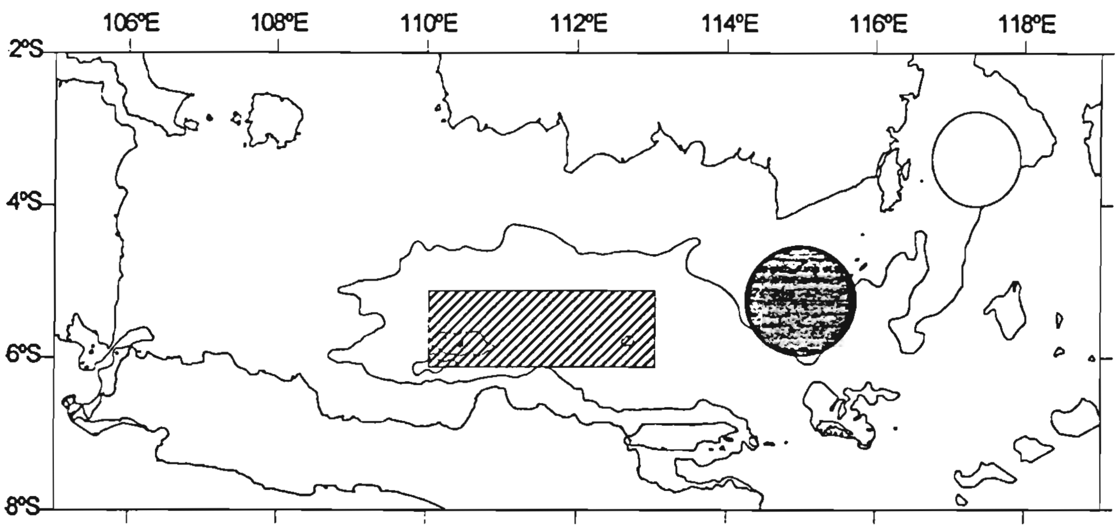


Figure 5 Main fishing grounds

80% of the catch in Oct. 93

80% of the catch in Feb. 94

10 to 20% of the catch in Oct 93 and Feb. 94

(Total catch in October twice bigger than in February)

1) Along the Karimunjava I-Matasiri bank transect.

- There is a great variability in the acoustic mean densities observed between day and night, the day representing less than the half of the night, in mean value on all the data set (**Tab. 1**).
- Day data : it may be observed a general trend in the density distribution, the western data being always lower than the eastern data (**Fig. 6b** to **11b**)
- Night data : two cases may occur :

  - in October and December, there is a neat trend in the density distribution, the west being less dense than the east area (**Fig. 8c** to **12c**) ;

  - in February and March, on the contrary, the western and eastern densities are rather similar (**Fig. 6c, 7c** and **13c**)

Table 1 Statistical values of the west <-> east transects

(SM : survey from Semarang to Matasiri, MS : survey from Matasiri to Semarang)

Survey		21SM	21MS	34SM	41MS	27SM	27MS	36SM	36MS
Number of data	day	124	222	194	247	204	268	187	172
	night	187	200	189	192	150	154	149	239
Minimum density (ui)	day	153	24	30	26	25	74	82	68
	night	27	75	271	164	95	430	487	94
Maximum density (ui)	day	1341	1291	3750	2548	2445	1643	5552	4925
	night	2345	1686	9850	2874	1456	2972	5769	3849
Mean density (ui)	day	254	234	1065	330	345	503	1312	942
	night	610	335	2863	791	387	1333	1767	1413
Variance	day	75E3	40E3	590E3	150E3	130E3	86E3	134E4	407E3
	night	62E3	56E3	334E4	231E3	59E3	218E3	906E3	658E3
Std. dev. / mean	day	0.45	0.86	0.72	1.17	1.05	0.58	0.88	0.68
	night	0.98	0.71	0.64	0.61	0.63	0.35	0.54	0.57

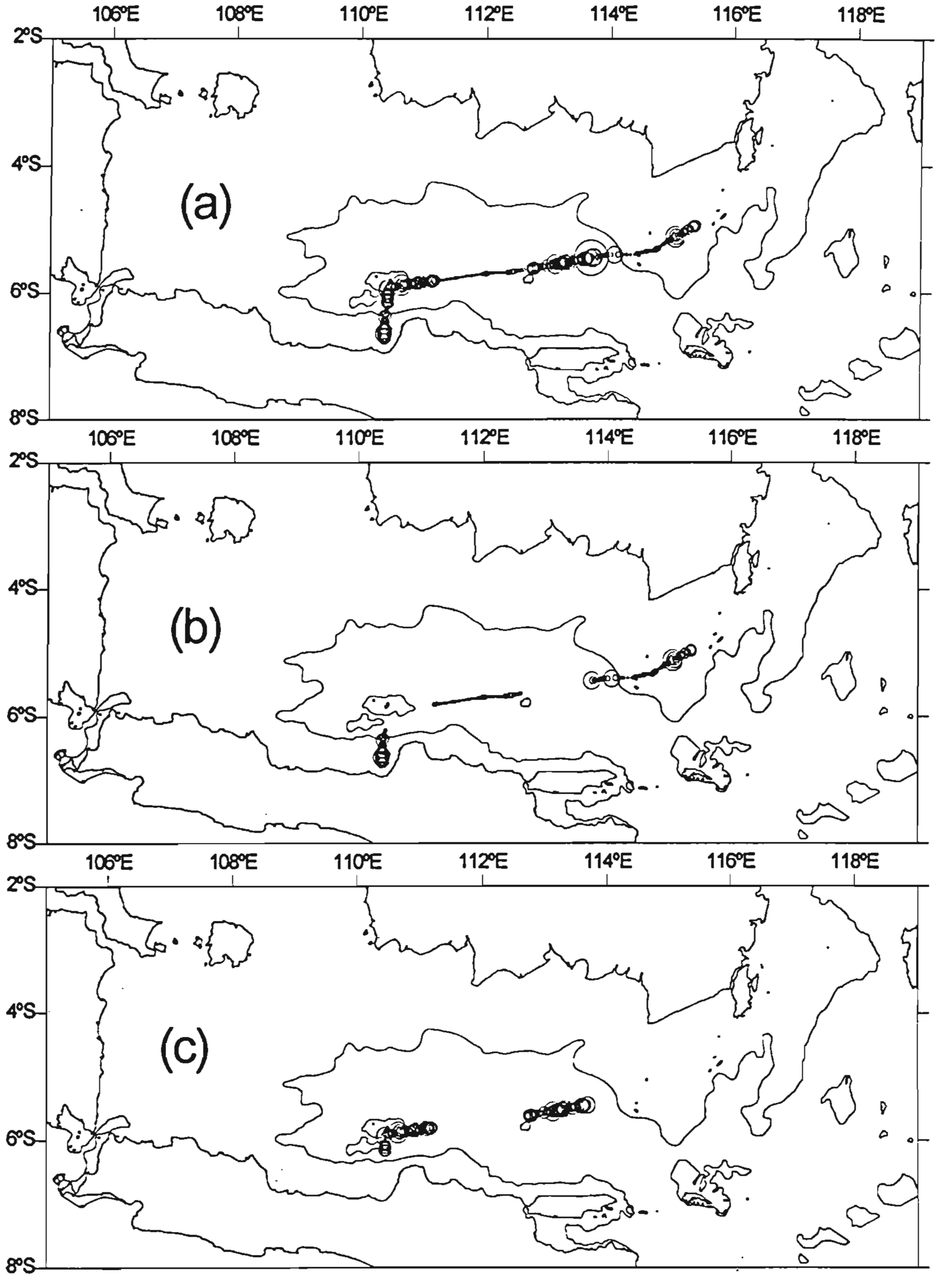


Figure 6 Proportional distribution of the fish density along the transect from Semarang to Matasiri in March 1992 (survey 21)

a) Total b) Day c) Night

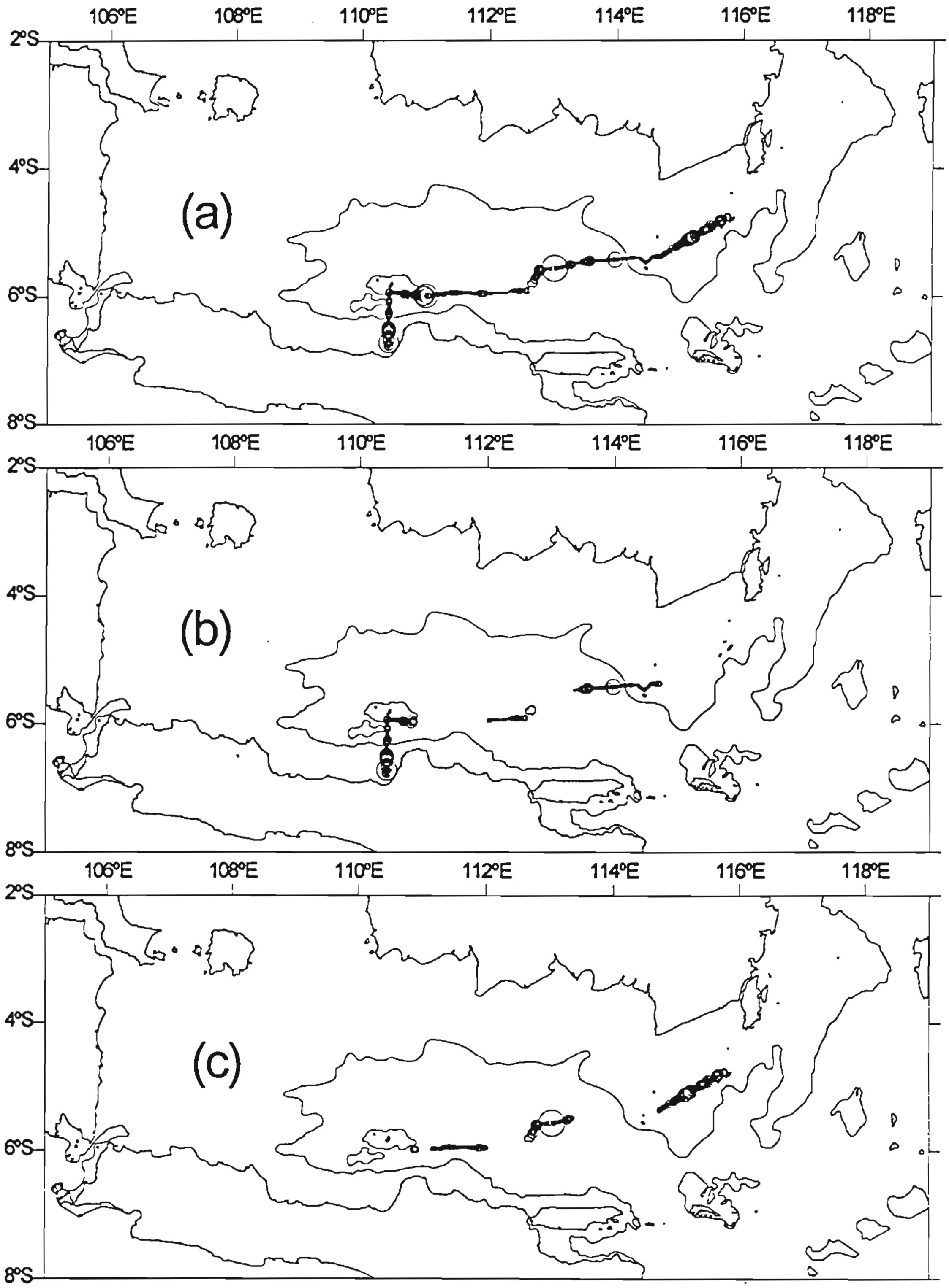


Figure 7 Proportional distribution of the fish density along the transect from Matasiri to Semarang in March 1992 (survey 21)

a) Total b) Day c) Night

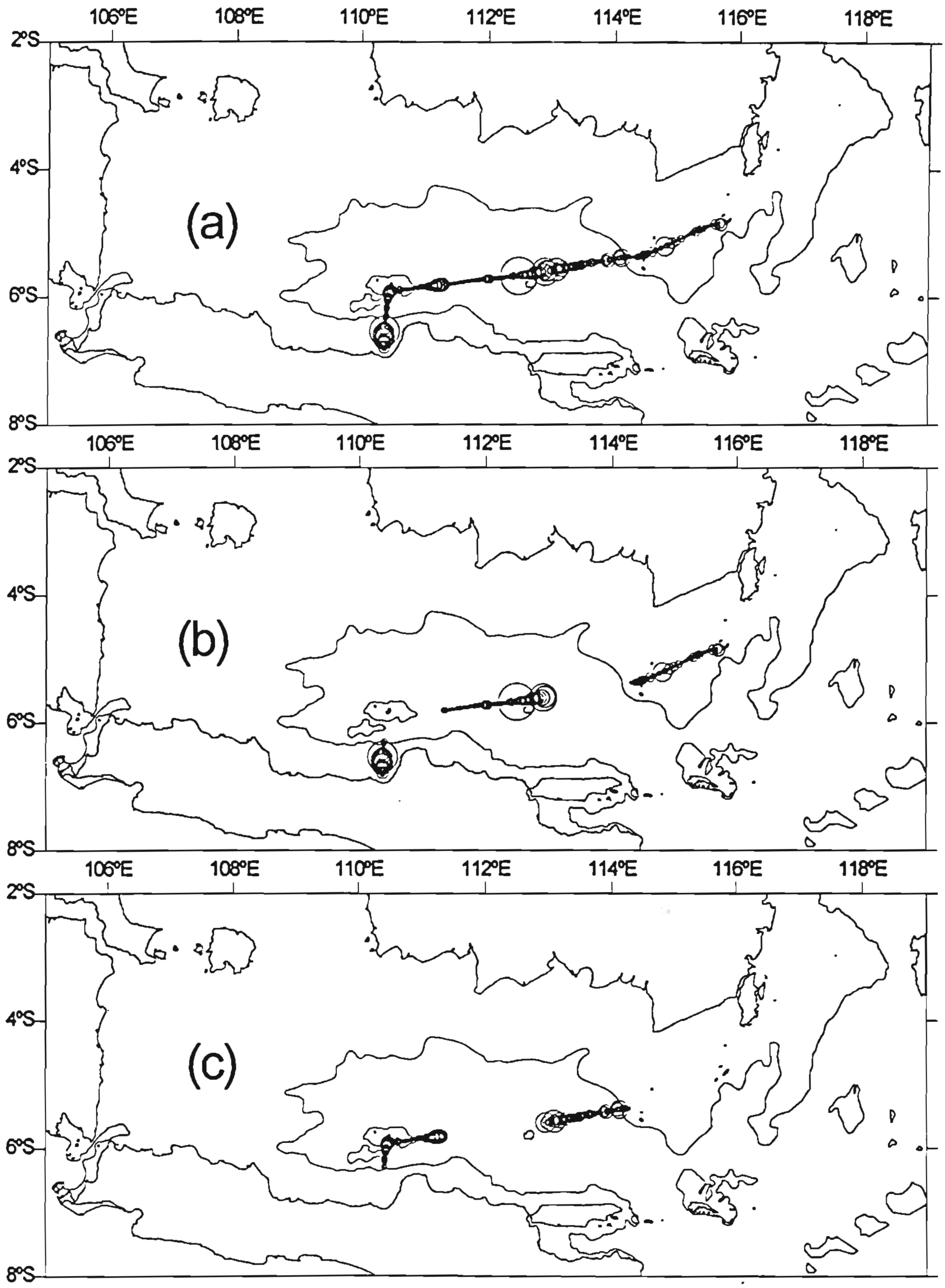


Figure 8 Proportional distribution of the fish density along the transect from Semarang to Matasiri in December 1992 (survey 27)

a) Total b) Day c) Night

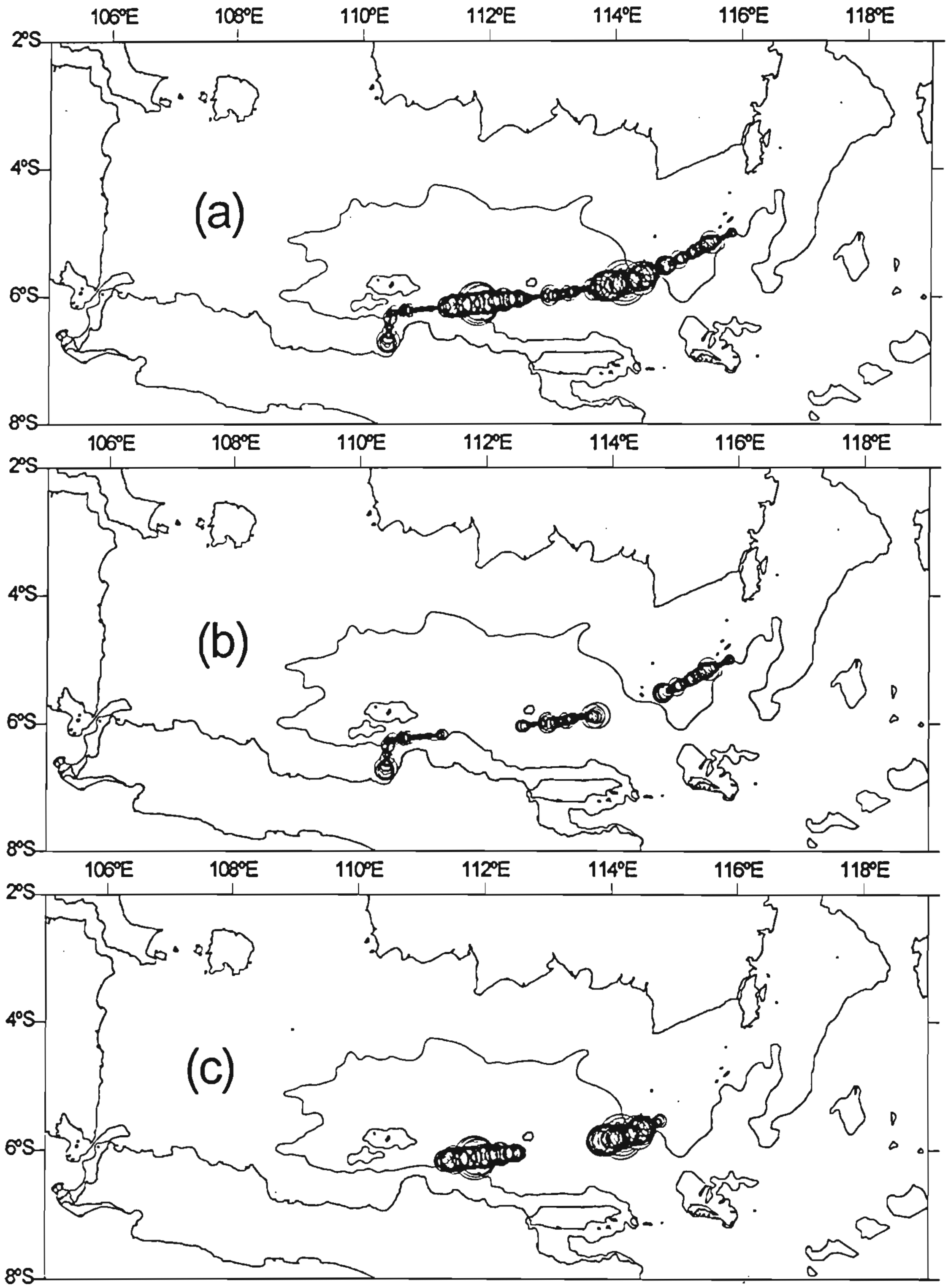


Figure 9 Proportional distribution of the fish density along the transect from Matasiri to Semarang in December 1992 (survey 27)

a) Total b) Day c) Night

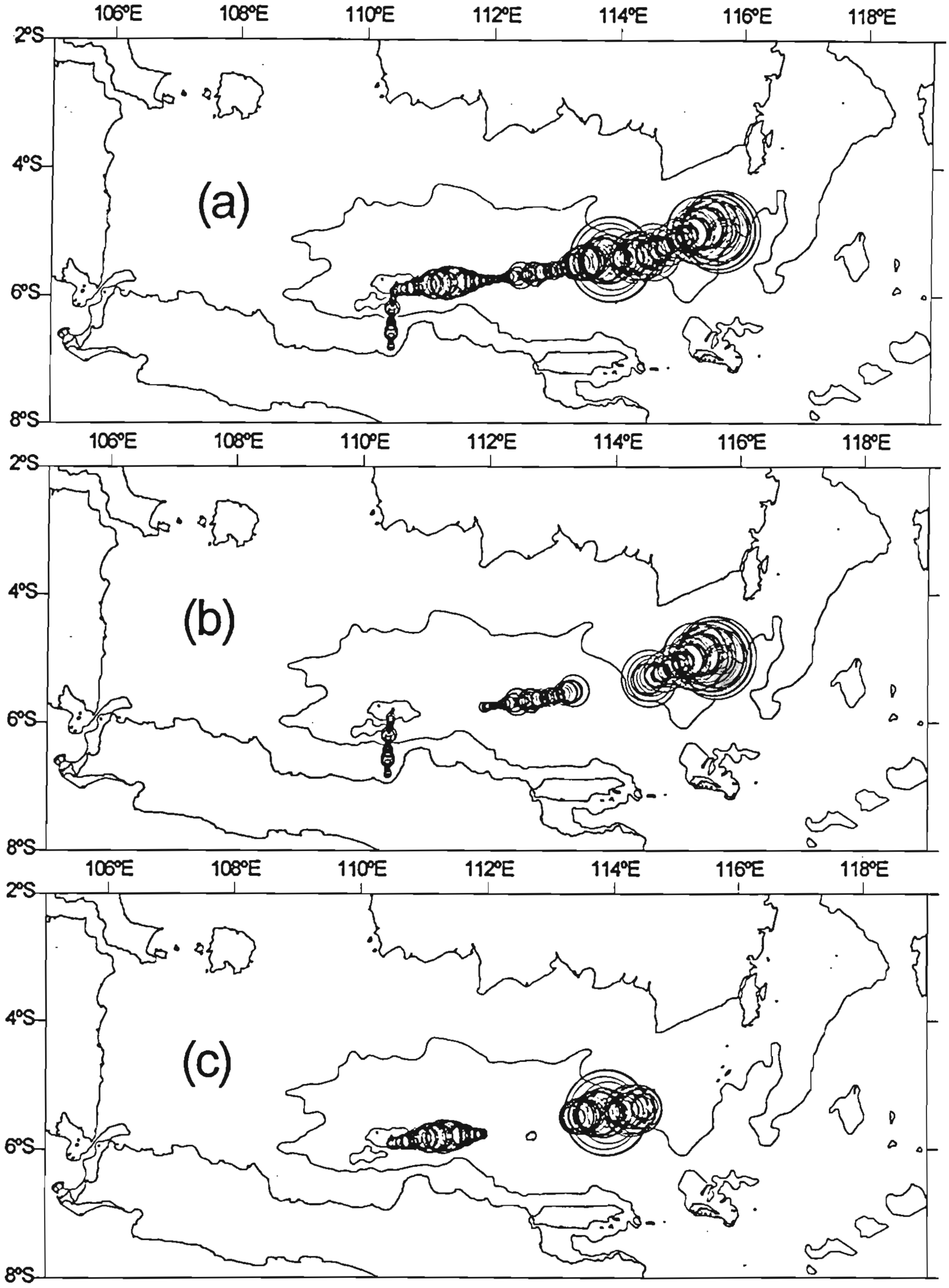


Figure 10 Proportional distribution of the fish density along the transect from Semarang to Matasiri in December 1993 (survey 36)

a) Total b) Day c) Night

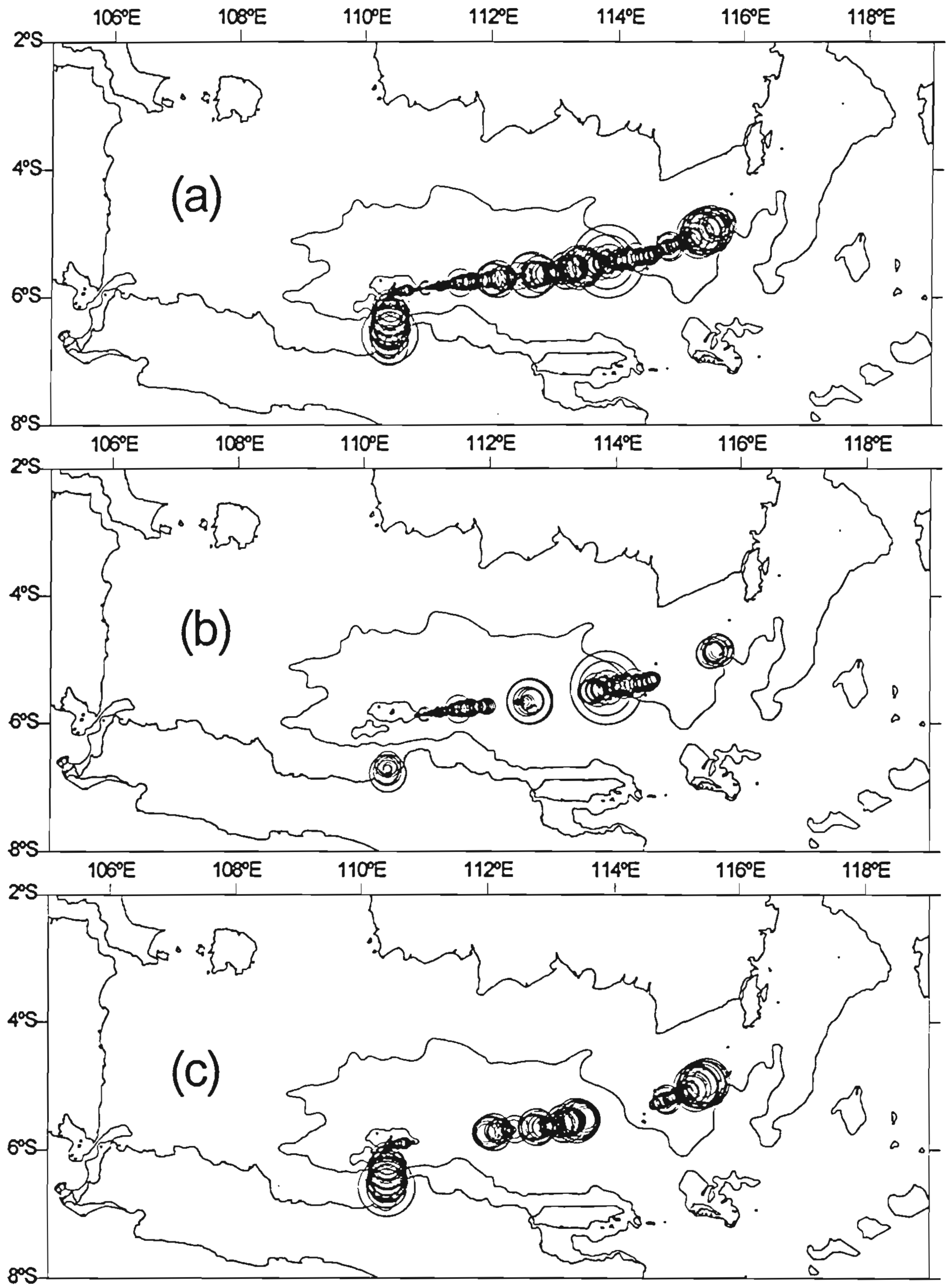


Figure 11 Proportional distribution of the fish density along the transect from Matasiri to Semarang in December 1993 (survey 36)

a) Total b) Day c) Night

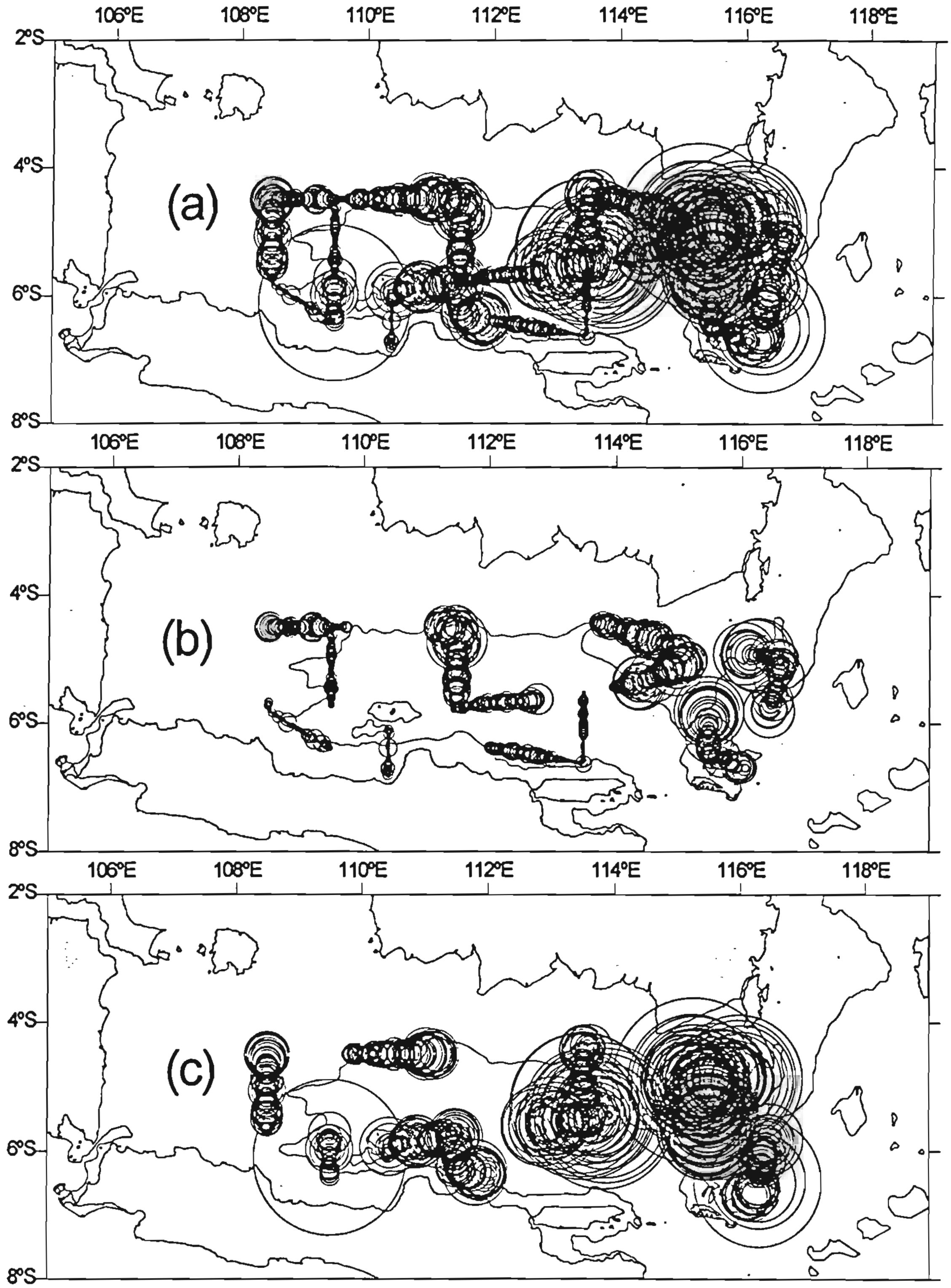


Figure 12 Proportional distribution of the fish density along the overall coverage route in October 1993 (survey 34)

a) Total b) Day c) Night

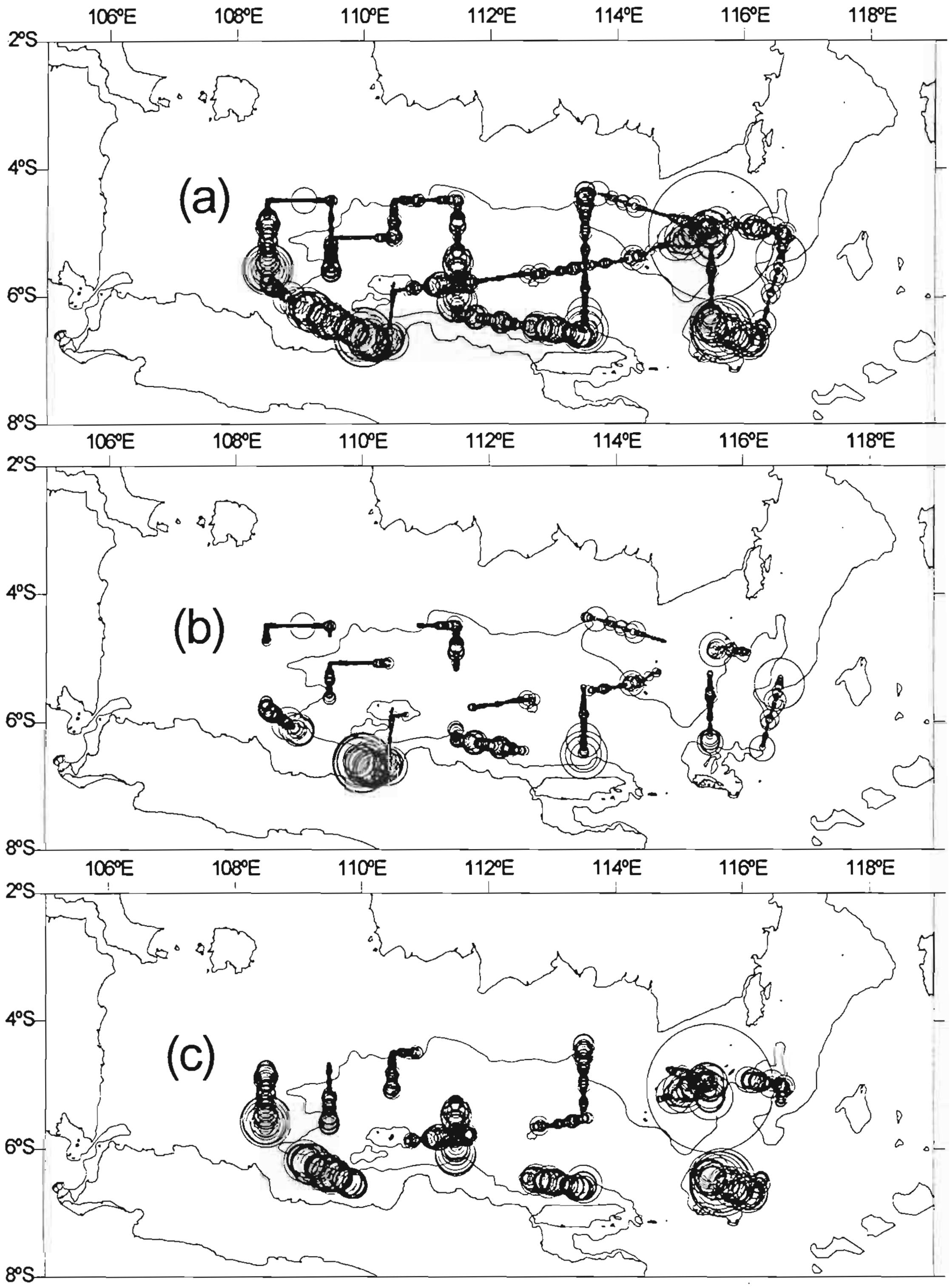


Figure 13 Proportional distribution of the fish density along the overall coverage route in February 1994 (survey 41)

a) Total b) Day c) Night

2). Considering then the two large coverage (October and February), several observation can be made :

- October : a general important gradient can be observed from west to east, the western data being lower. The central area data (within the 50 m deep area) are higher than the south coastal area. No gradient can be pointed out on the north-south direction (**Fig. 14**).
- February : no gradient in the west-east direction. Centre of the area with densities lower than in the south-north gradient (**Fig 15**).

2.2.4. Schools distribution

School data have been studied only for survey 34 (October 1993), and the main results cannot be extrapolated to the whole data set. Nevertheless interesting pieces of information can be obtained from these data. Different school parameters have been studied :

- their relative density (echo integration of a single school) ;
- the spatial distribution of the schools. Two categories were made: demersal and pelagic ;
- their vertical distribution in the water column.

From this data set several main conclusions have been listed :

- Benthic schools can be observed scarcely in the area, and obiously concentrated in the eastern part, east of 114°E (**Fig. 14b**).
- On the contrary, pelagic schools are mainly distributed in two areas. The first one appears at the western limit of the survey area, west of 111°E. The second one is observed at the east of the survey area, and particulary on the Matasiri bank and the 50m depth area (**Fig. 14a,c**). This second area is the most important.

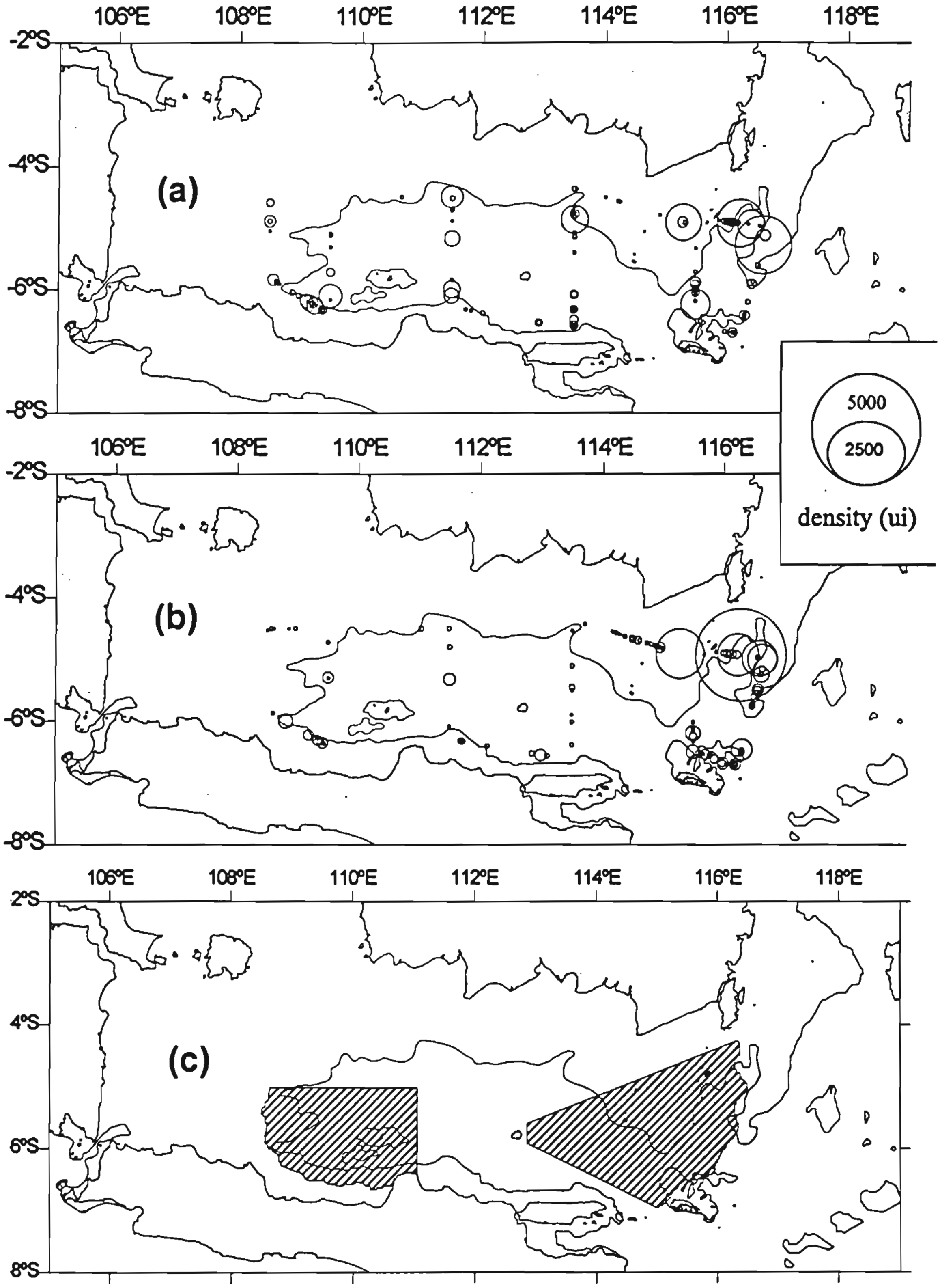


Figure 14 Schools in October 1994 (survey 34)

(a) Distribution of the Pelagic schools
(b) Distribution of the Demersal schools
(c) Areas of the main pelagic schools concentration

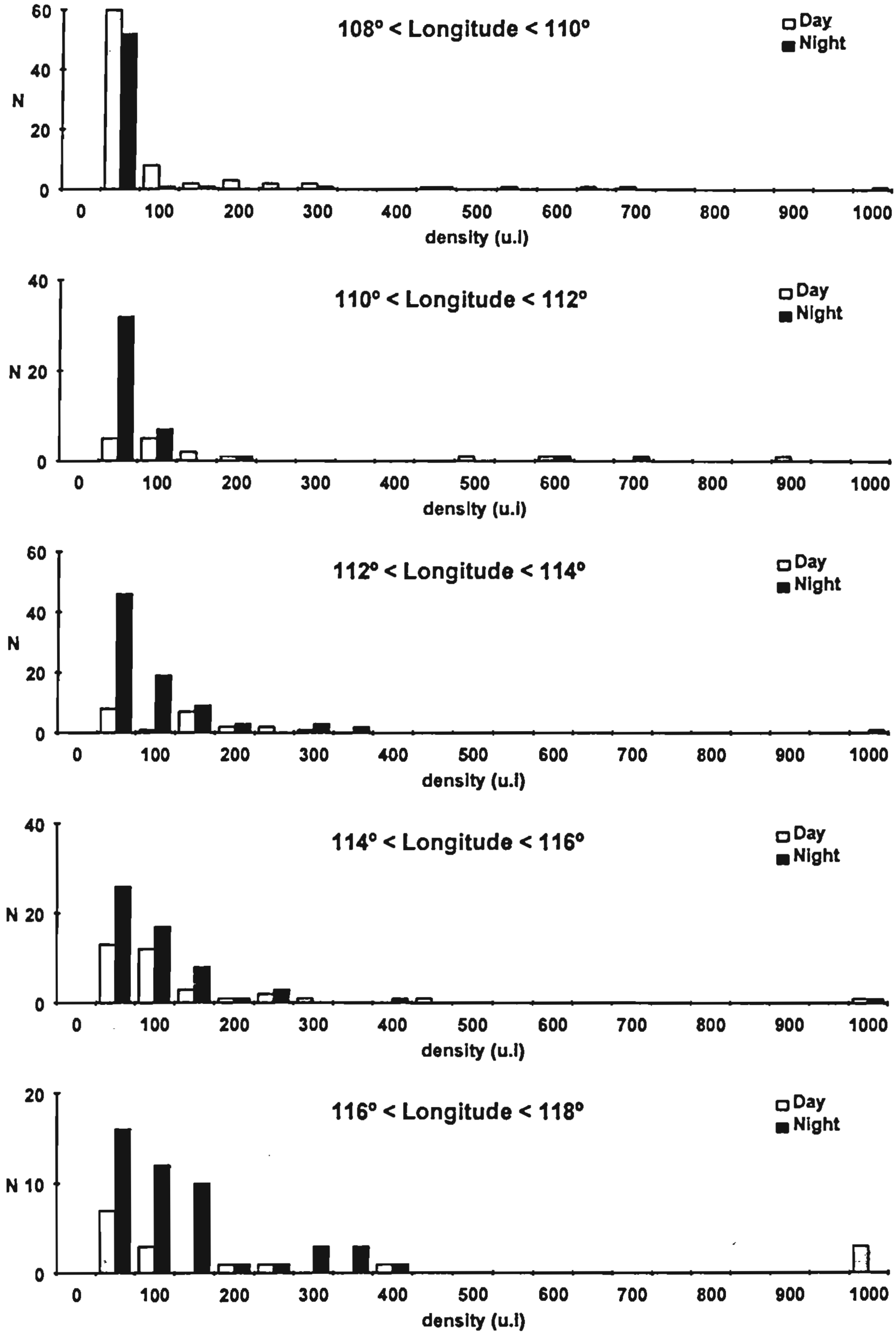
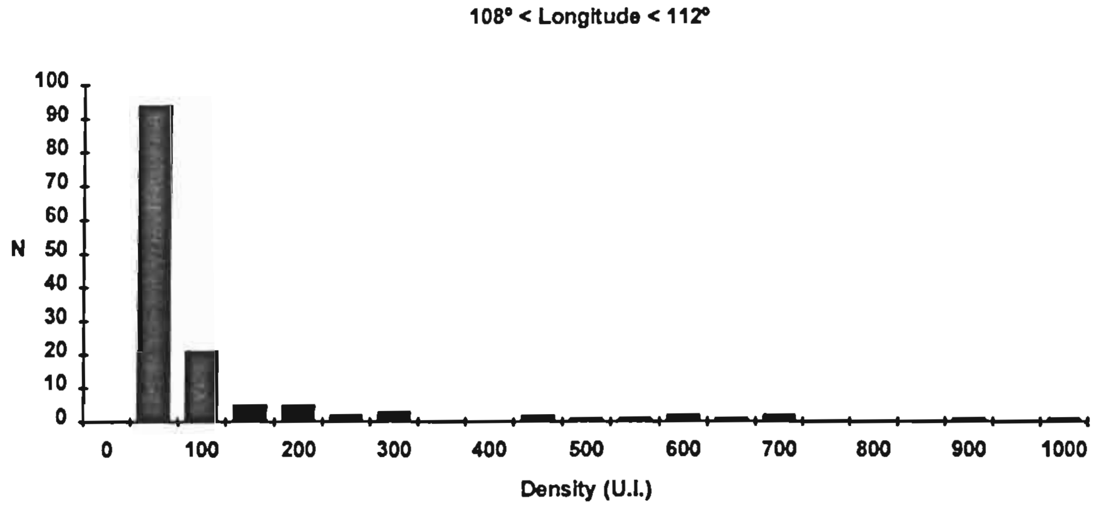


Figure 15 Day and night distribution of the number of fish schools (N) from 108°E to 118°E according to density, in October 1993 (survey 34)

- The histograms of density of the schools have been calculated for the five strata : 108-110°E ; 110-112°E ; 112-114°E ; 114-116°E (**Fig. 15**). The same distribution inside two main areas can be observed : the highest number of schools is present in the east. Dense schools can be observed both in the east and the west, but no dense school is present in the central area (from 112°E to 114°E).
- The histograms for two main areas (west and east of 112) are slightly different in their high classes (**Fig. 16**). A common mode appears all over the area between 50 and 150. A second mode is important in the east (mode 200-500). Although less important, it can be seen also at the west. On the contrary, a third mode of dense schools (above 1000 in relative units) is observed at the east of 112°E, and is absent in the west.
- The echo integration values for the schools only have been calculated in the ESDUs prior to the workshop. The variogram on this variable at this scale shows no spatial structure as it stays flat up to 50 nautical miles.

Concluding the study of schools, one can say that fish in schools are present in small densities all over the area, with some differences in the spatial distributions according to their nature (pelagic/demersal) or their densities. A general gradient from west to east can be noted as far as school number is concerned, but in the other parameters, the distribution is not so simple, some structures being concentrated in the west of 112°E, other at the east (**Fig. 16**). The 112°E line seems to be in some occasion a natural "border" between two kinds of structures.



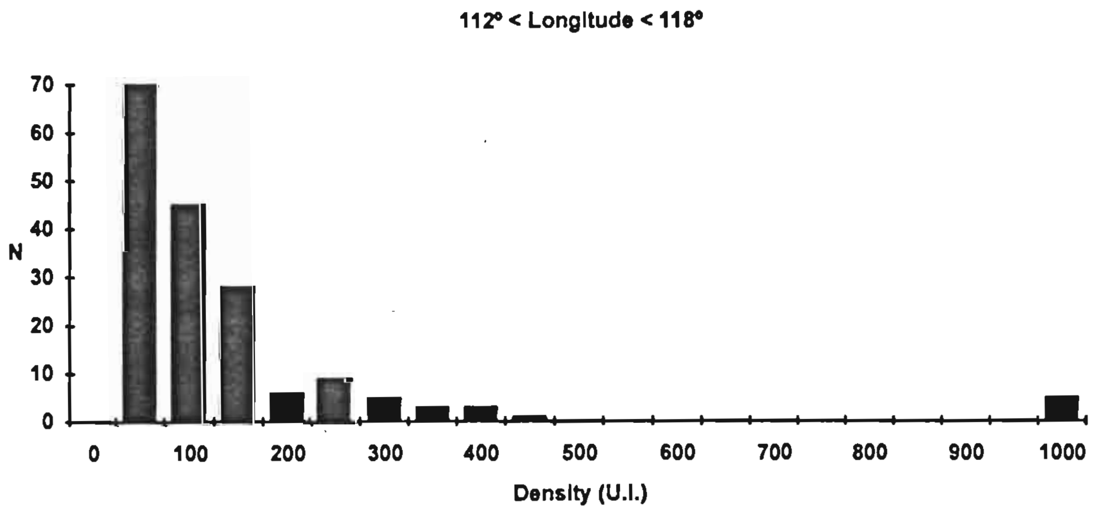


Figure 16 **Distribution on both sides of the longitude 112°E of the number (N) of fish schools according to density, in October 1993 (survey 34)**

2.2.5. TS distributions

The Target Strengths have been measured using a dual beam echo-sounder all along the surveys. The data of February (41) and October (34) have been studied in detail. The TS values represent the mean value of a large set of measurements during 1 to 3 miles along the transects. Thus their representativity is good, but the actual histogram of TS cannot be known for a particular area. The global histogram for survey 34 has been made (**Fig. 17**).

The transformation of the TS values in weight is not yet available inside the results of the Project, although methodological measurements have already been made. As an indication we give the values of fish length versus TS from the equation of Love (1974), and a point value measured within the Project (**Fig. 18** to **20**).

The following observations can be pointed out :

- The mean TS are higher in October than in February.
- The high TS are distributed all over the area in October, but almost all of them belong to the deep area (> 50m) or the Matasiri bank in deep sea (border of the shelf at 116°E, and in the center of the 50 meters area at 113°E) (**Fig. 18**).
- TS are higher in waters > 50 m in October as well as in February (**Fig. 18**).
- The day-night variability seems typical of surveys : the night TS are higher than the day TS in October, and seem similar in February (**Fig. 19** and **20**).

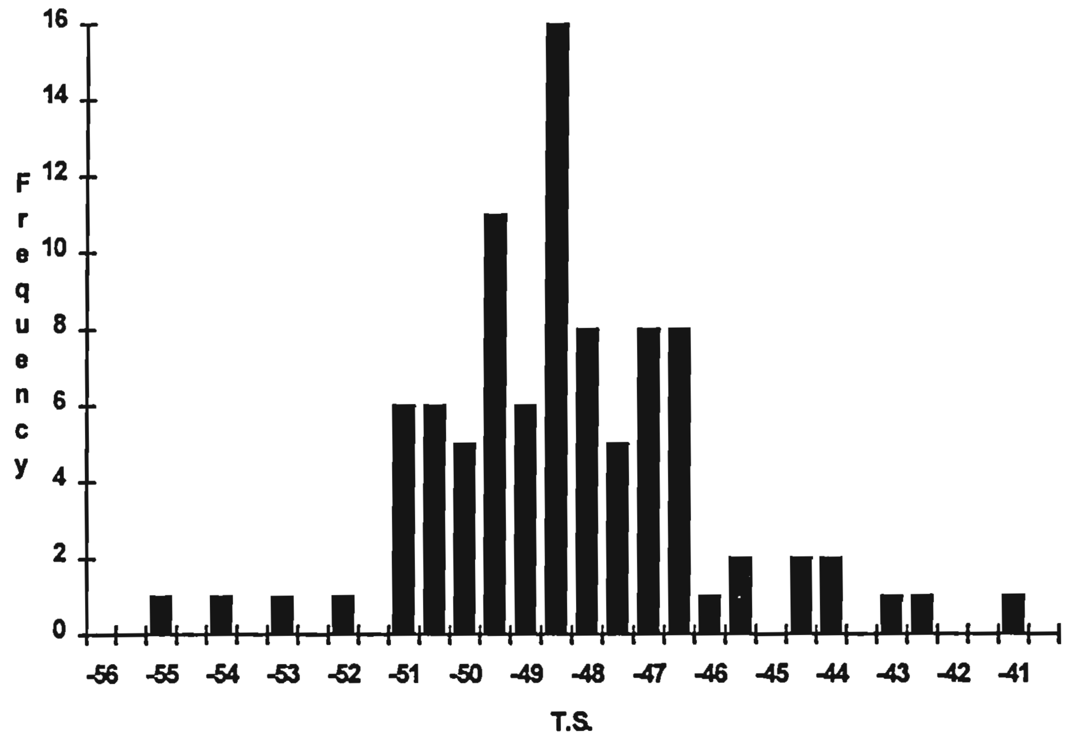


Figure 17 General histogram of the mean Target Strength in October 1993 (survey 34)

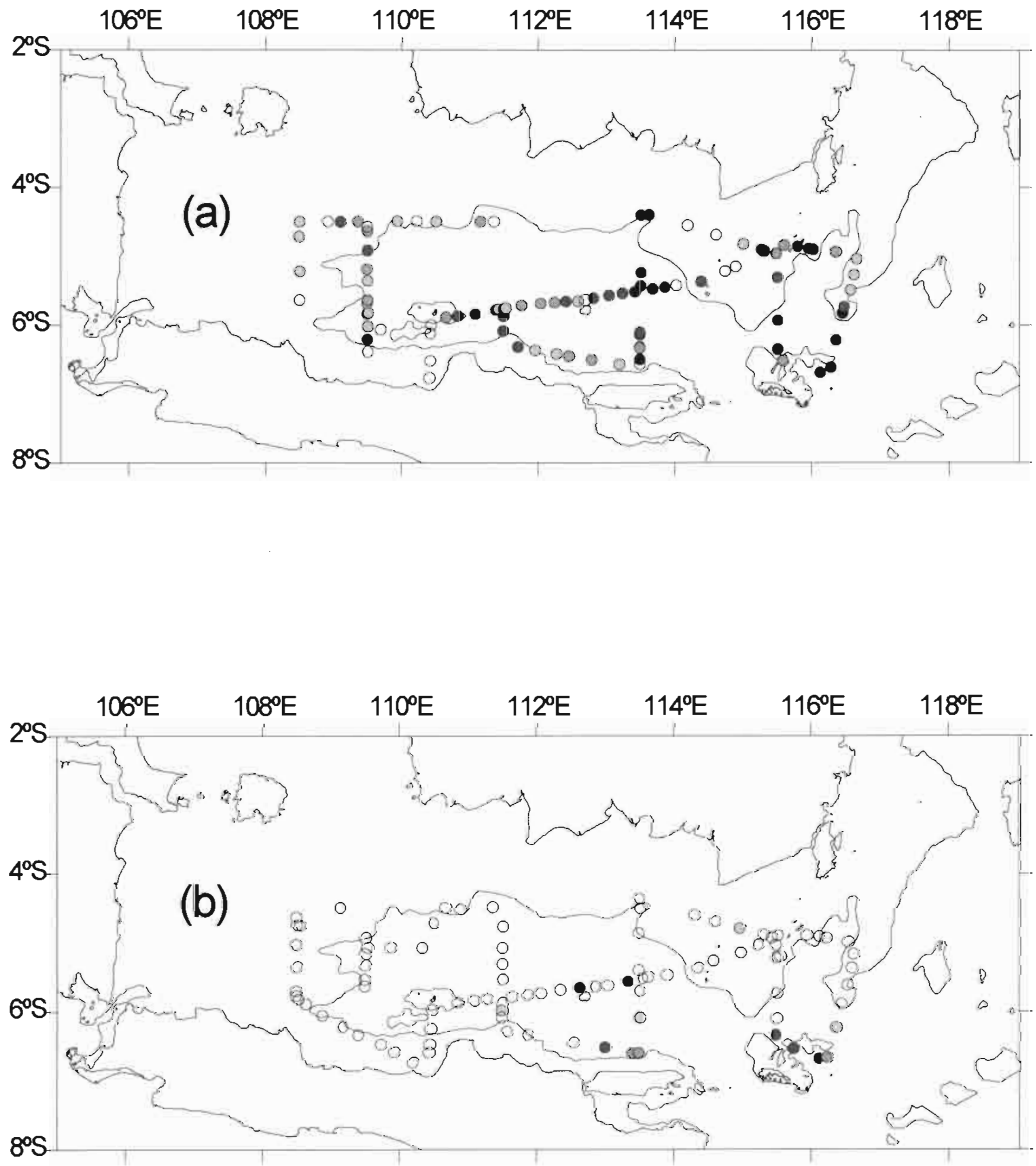


Figure 18 Repartition of the mean TS values in October 93 and February 94

-56.56 < ○ < -49.84 < ● < -48.63 < ● < -47.92 < ● < -46.53 < ● < -40.89

a) October 93 (survey 34) b) February 94 (survey 41)

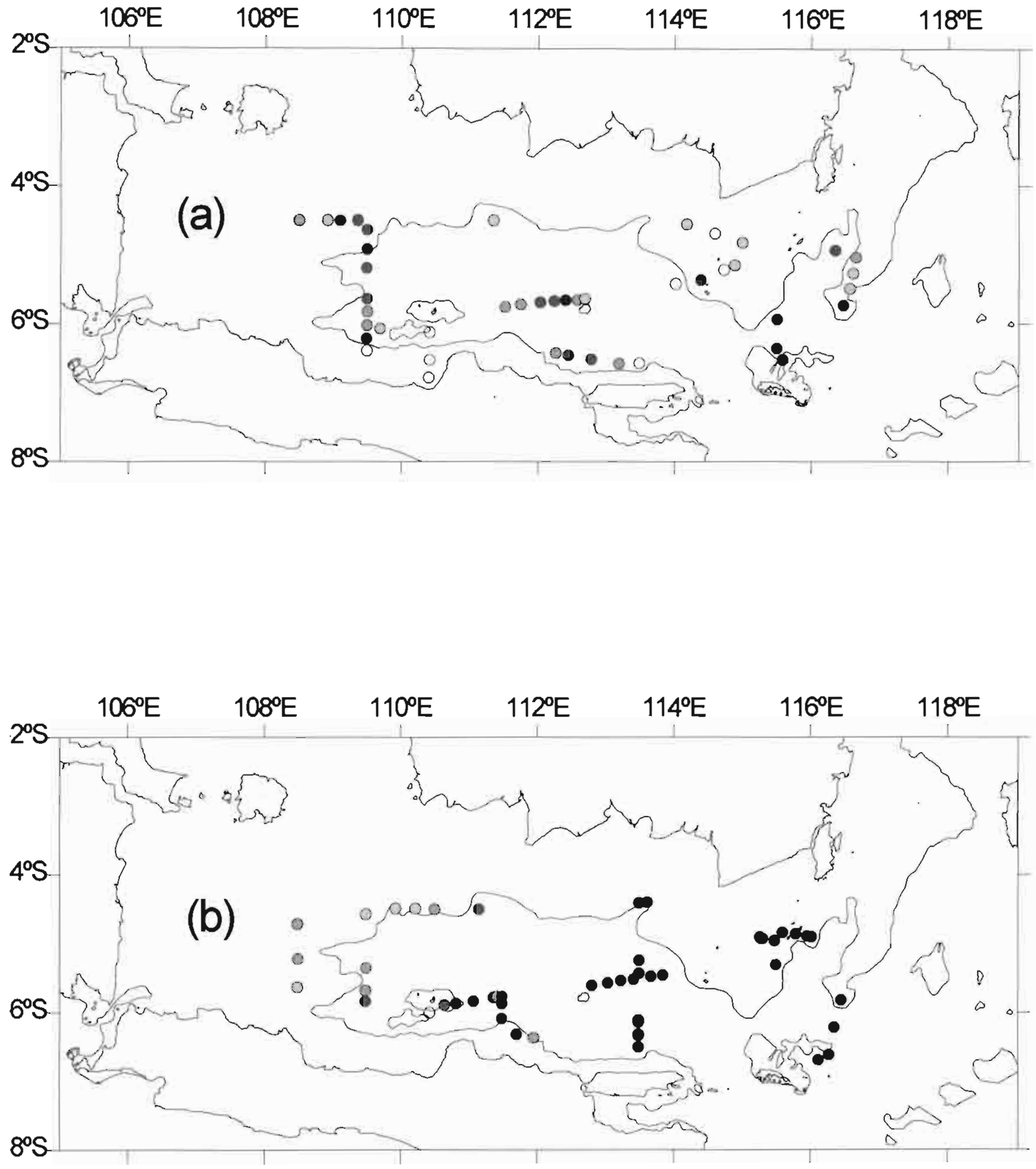
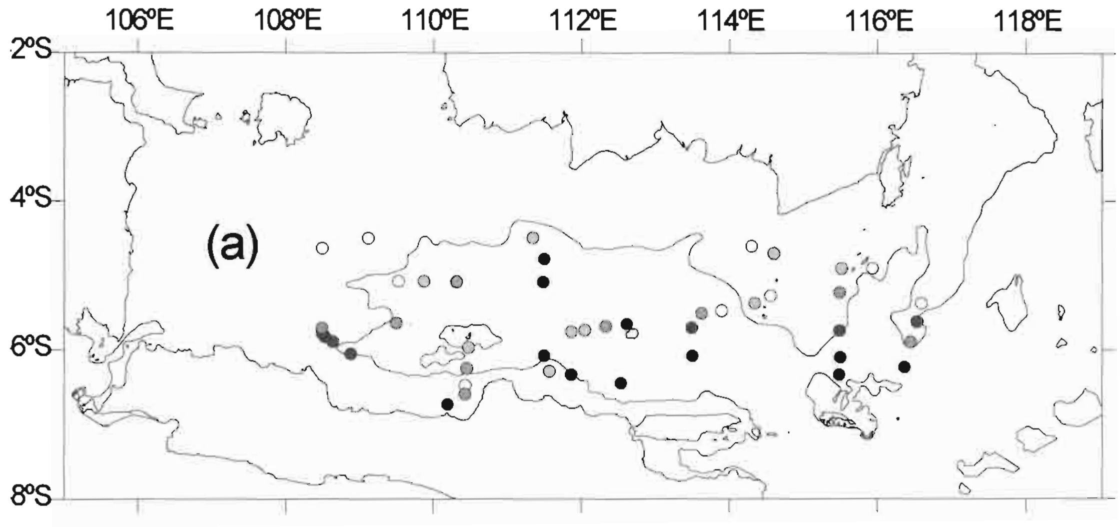


Figure 19 Repartition of the mean TS values in October 93 (survey 34)

-55.12 < < -50.55 < < -49.48 < < -48.45 < < -48.02 < < -46.21

(a) Day values only (b) Night values only



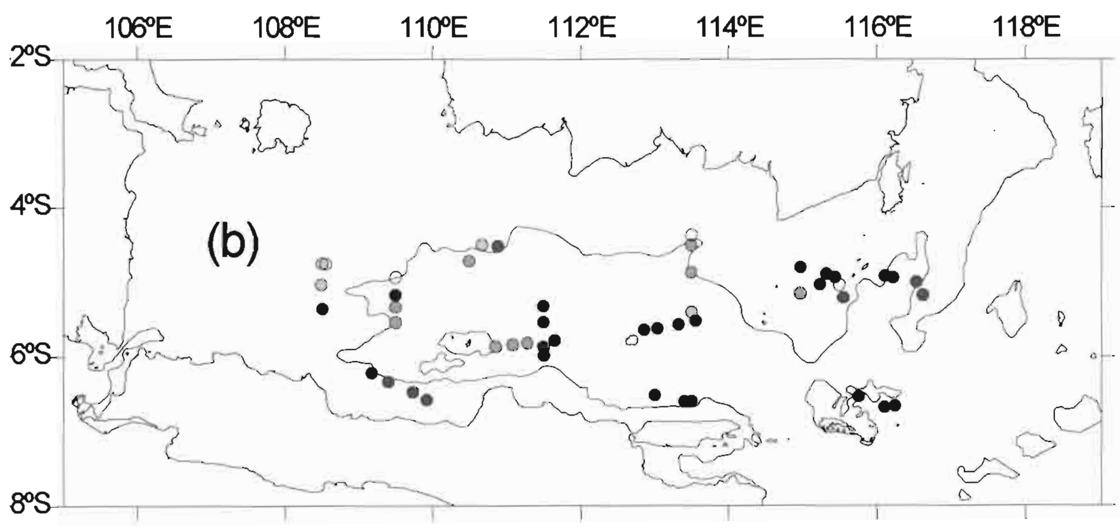


Figure 20 Repartition of the mean TS values February 94 (survey 41)

-55.12 < ○ < -50.55 < ● < -49.48 < ● < -48.45 < ● < -48.02 < ● < -46.21

(a) Day values only (b) Night values only

- when observing the variograms of the total mean TS data for surveys 34 and 41, one may note a long structure (between 60 and 100 miles, which seems closely related to the distribution of the big fish inside the waters more than 50m depth (approximately same dimensions). More detailed research is needed, in order to evaluate the time (day-night) effect.

The main conclusions on the TS analysis are :

- There is a trend in the fish length towards the longitude : TS are smaller in the west than in the east of the area.
- There is a probable trend towards the depth or latitude, fish remaining in the deep area of the Java Sea are bigger than fish outside of this area (except Matasiri bank in October).
- The fish migrate within the year, the big fishes being close to the eastern border of the shelf or outside the area in February, while they are present in a large portion of the area in October. The migration way could follow the movements of the water mass, inside the salted waters, i.e. along the deep area (more than 50 m depth).

2.2.6. Vertical distribution of the density

The vertical distibution has been difficult to observe using the data set, and a few preliminary works have been done along the west-east transect on several surveys (**Fig. 21**).

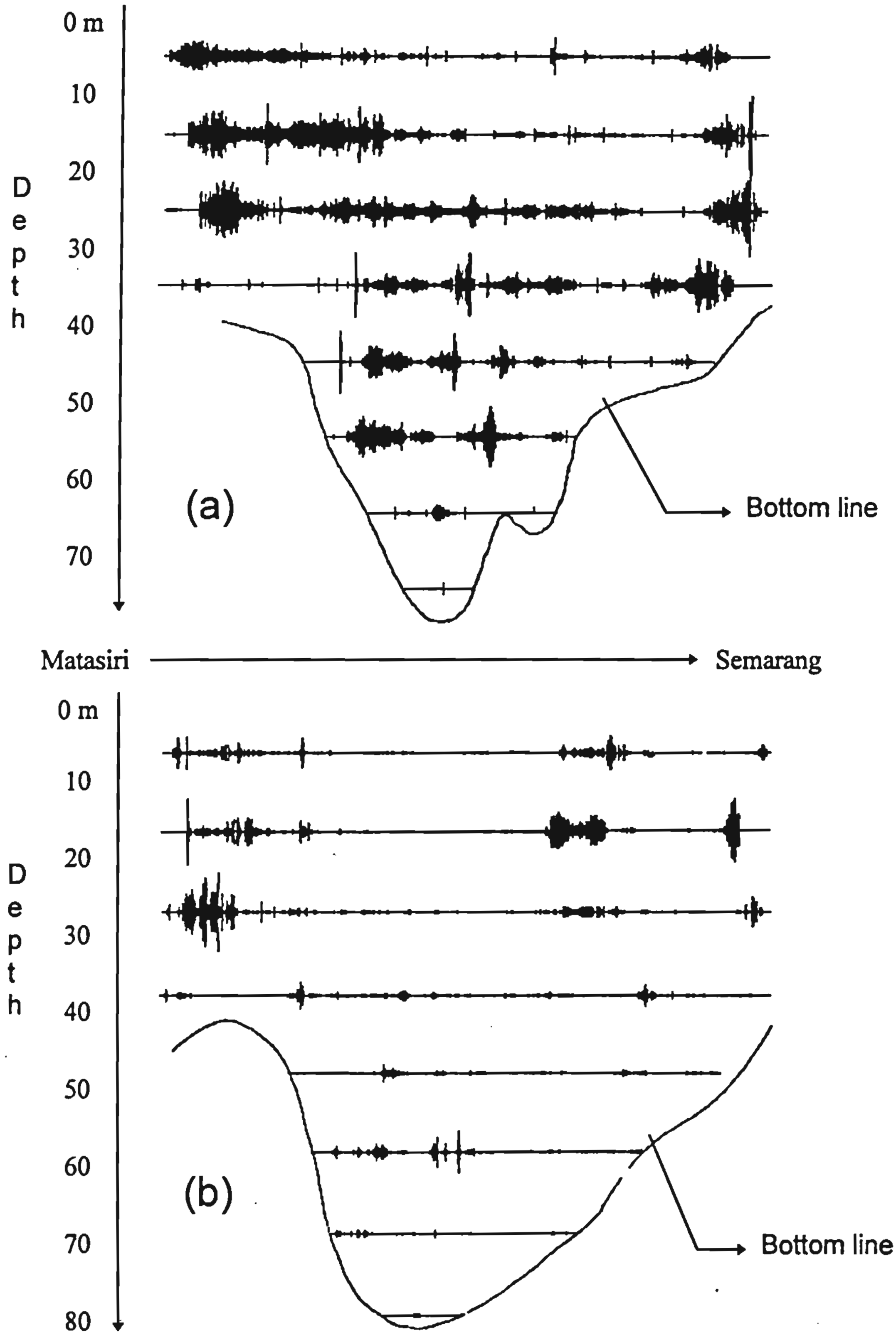


Figure 21 Vertical profil of fish density along the transect from Matasiri to Semarang

(a) December 93 (b) February 94

For several reasons vertical distribution is indispensable to study :

- the fishery exploits a "semi-demersal" population attracted with lights : the evaluation of the parts due to pelagic and demersal populations is important.
- the high difference between day and night data (densities, TS) makes it impossible to study together those data. An interpretation of the reasons producing these differences is needed.

The study of these distributions is difficult to do. Nevertheless some other observations show several points of interest that should be more documented :

- Two populations are present at the same place : one which remains pelagic more or less all the time (day and night) ; one which disappears during the day and is present as pelagic during the night.
- There is an important circadian cycle in the density measurements. The biomass increases suddenly at around 6:00pm and decreases at 5:00am. These short periods must be better known.
- The horizontal layers are traversed by the population which is moving upwards during the night : this population can be seen in the deepest layers at the beginning of the night and in the shallowest ones at the end.

2.2.7. Spatial structures

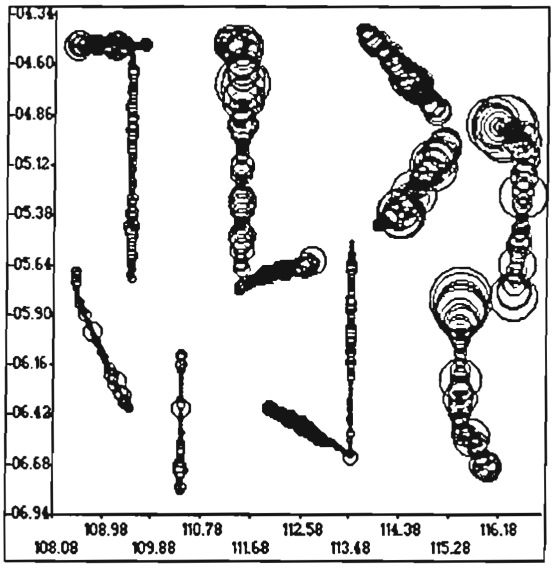
Spatial structures have been characterized by computed variograms. The variogram is the measure of variance between points which is function of the distance separating them. It enables to dissect the total data variance spatially into correlation variability occuring at different scales. The main parameters are :

- the sill : it is the maximum level of variability between points. It can be higher than the data variance.
- the range : it is the distance at which the sill is reached. it measures the average diameter of the area of influence around each point.
- the nugget : it measures a heterogeneity in the spatial distribution. For instance, if high and low values are very close neigbours, the nugget would measure the variance associated with this discontinuity.

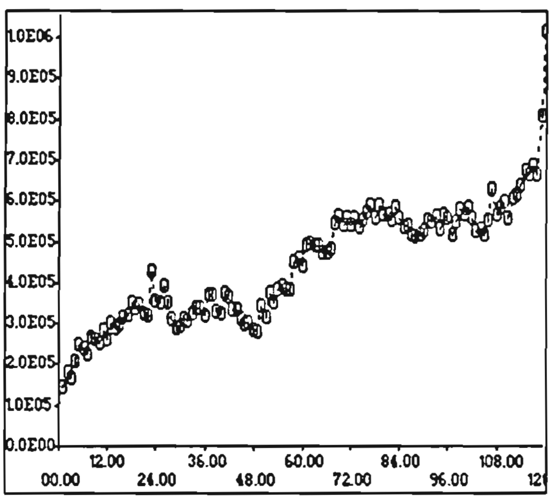
A structure is characterized on the variogram by an increase in the curve, i.e. closer points are more similar than distant ones. The experimental variogram may show different structures for different scales of distances. Each one corresponds to a partition of the data variance. The experimental variogram must cross the data variance.

Variograms have been computed on the surveys available for the workshop (**Fig. 22** to **29**). Day and night data have been separated and a variogram computed on each sub data set. Night data are on average higher than the day data. Thus, on the entire data set, the night data generate artefactual structures with a range equal to the distance sailed during the night time.

Some structural characteristics stay constant for all surveys. This means there is a structure which is constant from one year to the other, from one season to the other and during one season.

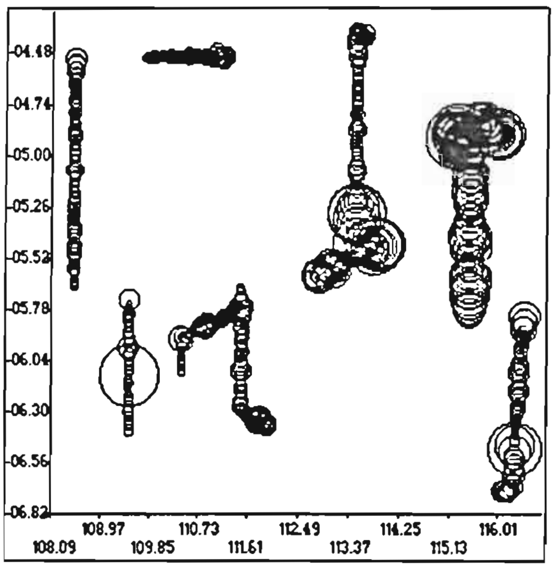


Data parameters
Number : 936
mean : 985
var : 6.1E5
std/m : 0.79

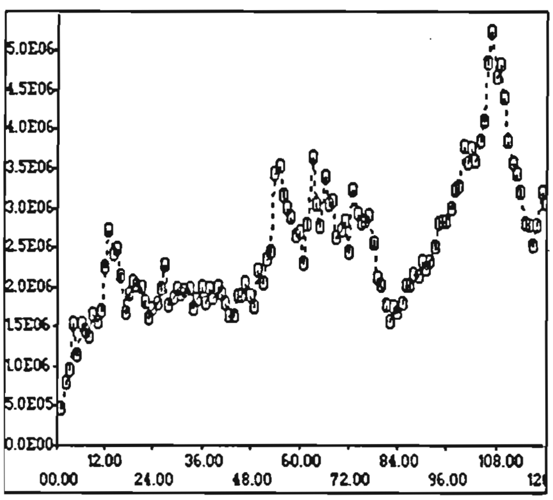


Variogram parameters
lag number : 120
lag : 1
tolerance : 0.5

Figure 22 Spatial distribution and variogram of the fish density during the day in October 93 (survey 34)

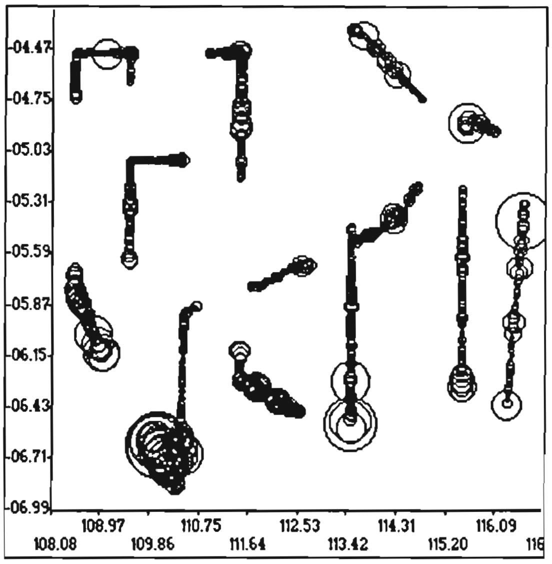


Data parameters
Number : 689
mean : 2744
var : 3.5E6
std/m : 0.68

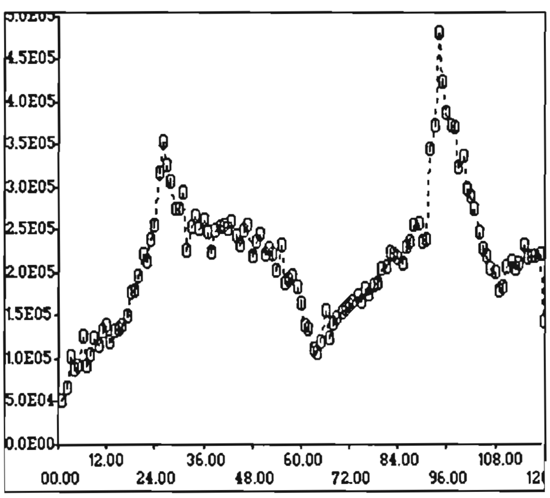


Variogram parameters
lag number : 120
lag : 1
tolerance : 0.5

Figure 23 Spatial distribution and variogram of the fish density during the night in October 93 (survey 34)

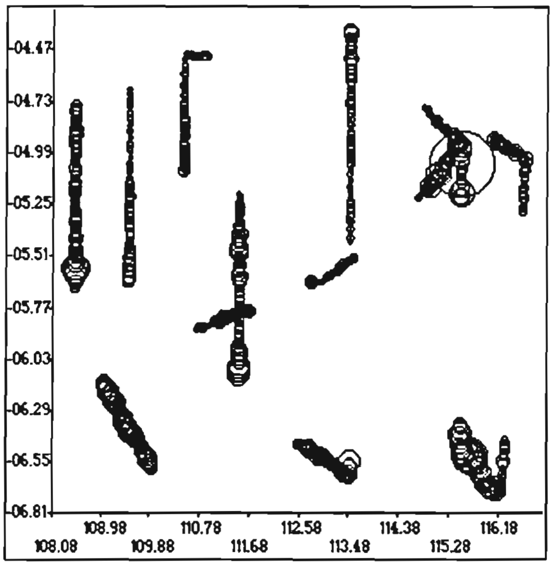


Data parameters
Number : 996
mean : 462
var : 2.5E5
std/m : 1.09

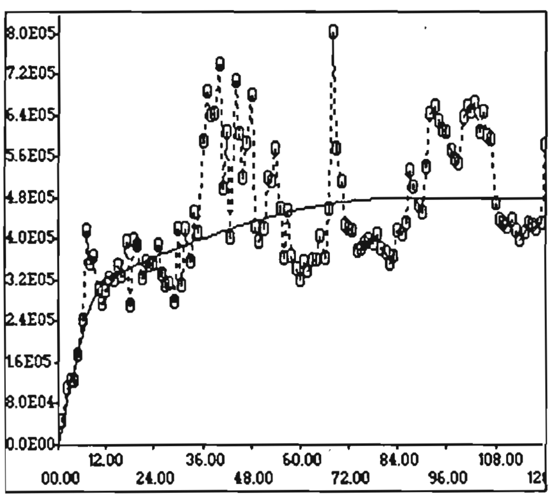


Variogram parameters
lag number : 120
lag : 1
tolerance : 0.5

Figure 24 Spatial distribution and variogram of the fish density during the day in February 94 (survey 41)



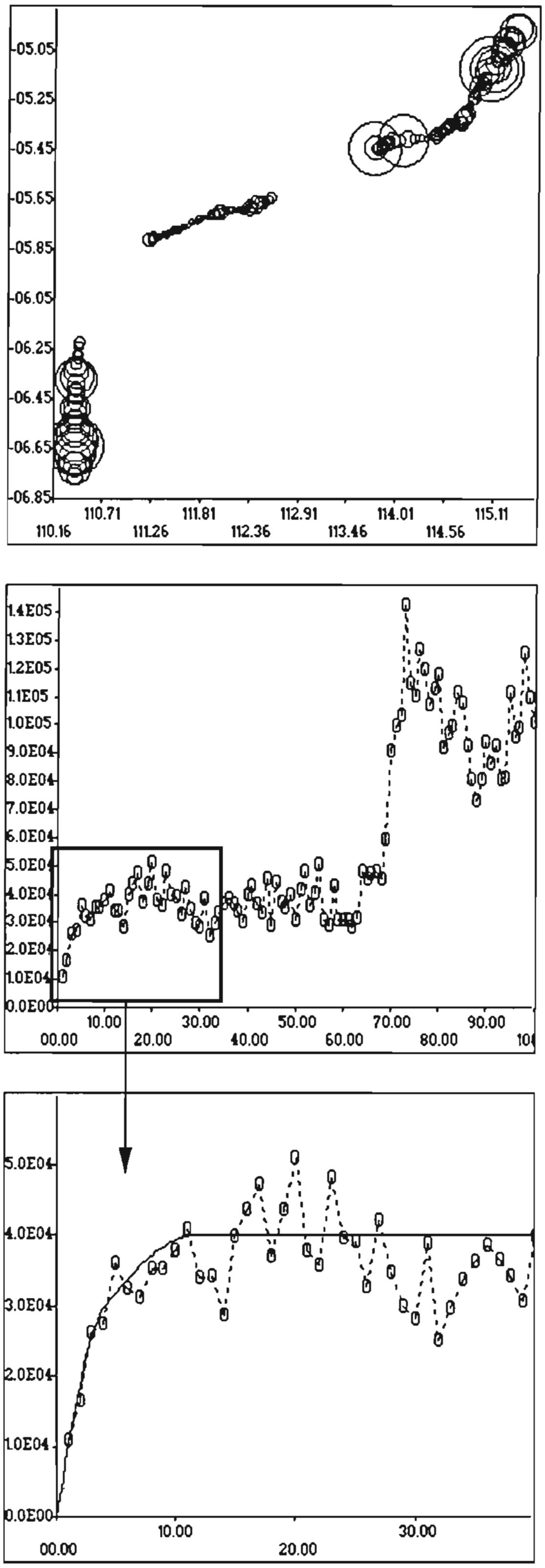
Data parameters
Number : 825
mean : 1040
var : 5.1E5
std/m : 0.69



Variogram parameters
lag number : 120
lag : 1
tolerance : 0.5

Model parameters
model 1
spherical (sill 2E5 ; range 84)
model 2
Spherical (sill 2.8E5 ; range 12)

Figure 25 Spatial distribution and variogram of the fish density during the night in February 94 (survey 41)

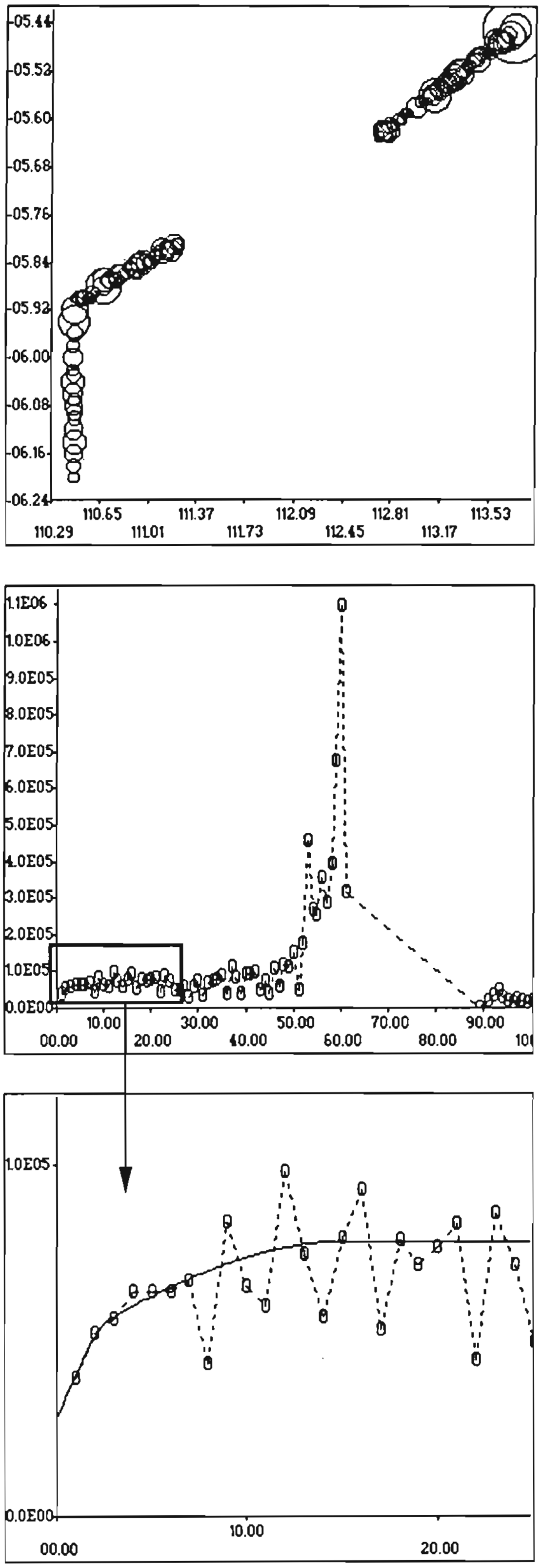


Data parameters
Number : 186
mean : 251
var : 6.1E4
std/m : 0.99

Variogram parameters
lag number : 100
lag : 1
tolerance : 0.5

Model parameters
model 1
spherical (sill 2E4 ; range 12)
model 2
Spherical (sill 2E4 ; range 4)

Figure 26 Spatial distribution and variogram of the fish density during the day in March 91 (survey 21)

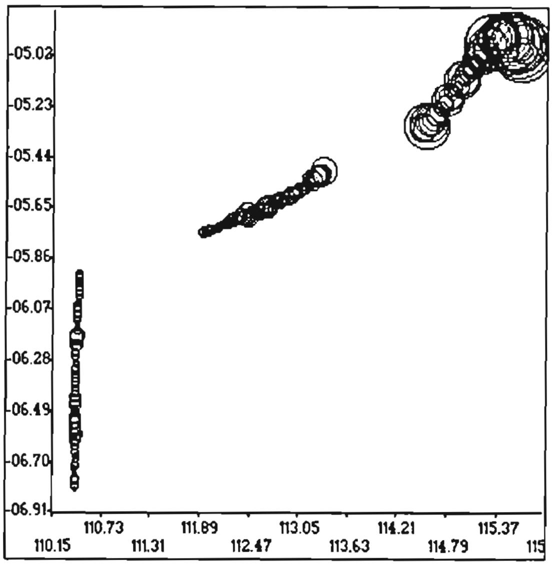


Data parameters
Number : 123
mean : 606
var : 7.3E4
std/m : 0.45

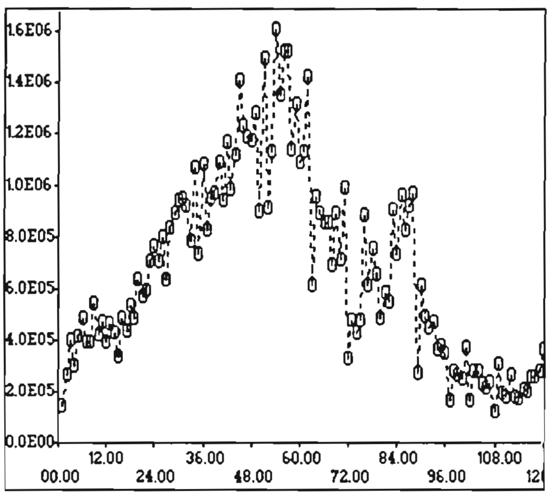
Variogram parameters
lag number : 100
lag : 1
tolerance : 0.5

Model parameters
nugget : 2.8E4
model 1
spherical (sill 3E4 ; range 15)
model 2
Spherical (sill 2E4 ; range 3)

Figure 27 Spatial distribution and variogram of the fish density during the night in March 91 (survey 21)

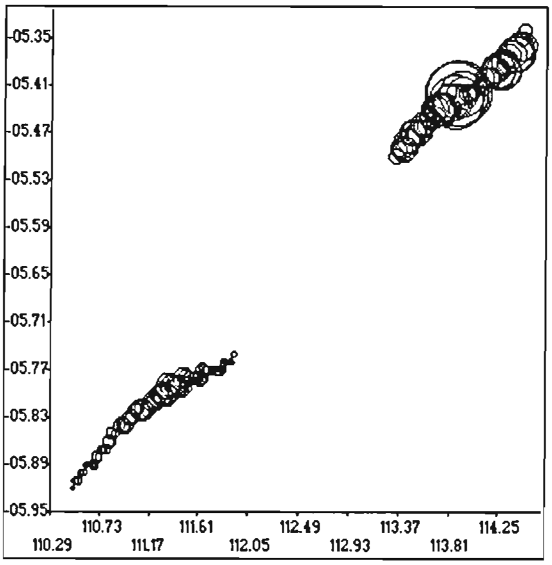


Data parameters
Number : 199
mean : 1326
var : 1.3E6
std/m : 0.87

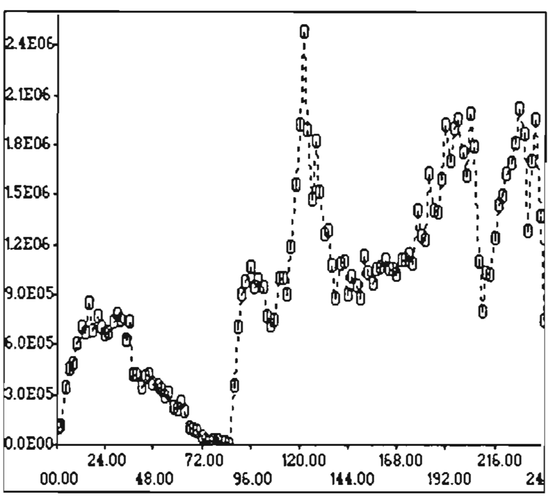


Variogram parameters
lag number : 120
lag : 1
tolerance : 0.5

Figure 28 Spatial distribution and variogram of the fish density during the day in December 93 (survey 36)



Data parameters
Number : 135
mean : 1784
var : 8.9E5
std/m : 0.53



Variogram parameters
lag number : 120
lag : 2
tolerance : 1

Figure 29 Spatial distribution and variogram of the fish density during the night in December 93 (survey 36)

- the coefficient of variation is very low, inferior to one generally
- the nugget effect is very low, always inferior to 10% of the data variance (low local variability)
- day and night structures are very similar
- a small scale structure with a range varying from 5 to 20 nautical miles is present on all surveys
- a trend in zone means at the regional scale generates an increase on the variogram at long distances, larger than 50 nautical miles. This trend is oriented west-east during October 1993, as higher densities stand on the Matasiri bank. This trend is oriented south-north during February 1994 during the day because of higher densities near the Java coast. The small scale structure has a varying range.

When the long range structure is not present in the data, variance is reached at the sill of the small scale structure. This is well seen in the survey 21 (March 91) because night sampling stayed in the middle of the Java Sea (**Fig. 27**).

The data variance can be split into variance due to the nugget (small), variance due to the small scale structure and variance due to the long range regional trend (or structure). On the average, half of the variance occurs at small range and the other half on the long range structure.

2.3. Stratification and evaluation

2.3.1. Stratification

The main interest of stratifying an area is to better describe each single strata and the decrease of the variance. When a stratification can be drawn, a particular knowledge of the biology and ecology of the population or community is obtained, and the variance due to the artificial link between two independent zones is not added anymore to the data.

The 5 surveys have given a large set of information that allows an attempt to stratify the area. We have seen in particular that three main groups were present in the area of study :

- a group clearly identified as a south coastal group, mainly recorded close to Semarang, and on which very few sampling has been done (group 1) ;
- a group scattered all over the area, with a permanent kind of structure at small scale (around 10 nautical miles), with pelagic schools and low dispersed densities (group 2) ;
- a dense group on the east, which suffers the most important part of the fishing exploitation, and may migrate from the area and thus, can disappear at some periods of the year (group 3).

In these conditions it seems reasonable to stratify the area in 3 strata, which have been defined as follows (**Fig. 30**):

- Stratum A : south of 6°20'S and west of 114°E
- Stratum B : north of 6°20'S and west of 114°E
- Stratum C : north of 6°20'S and east of 114°E

Once the stratification is defined, one can test whether the distributions inside each stratum are homogeneous and particular. This has been done by calculating means and standard errors in the strata by day and by night, by drawing the histograms of density distribution, and by calculating variograms in each of them (**Fig. 31** to **39**).

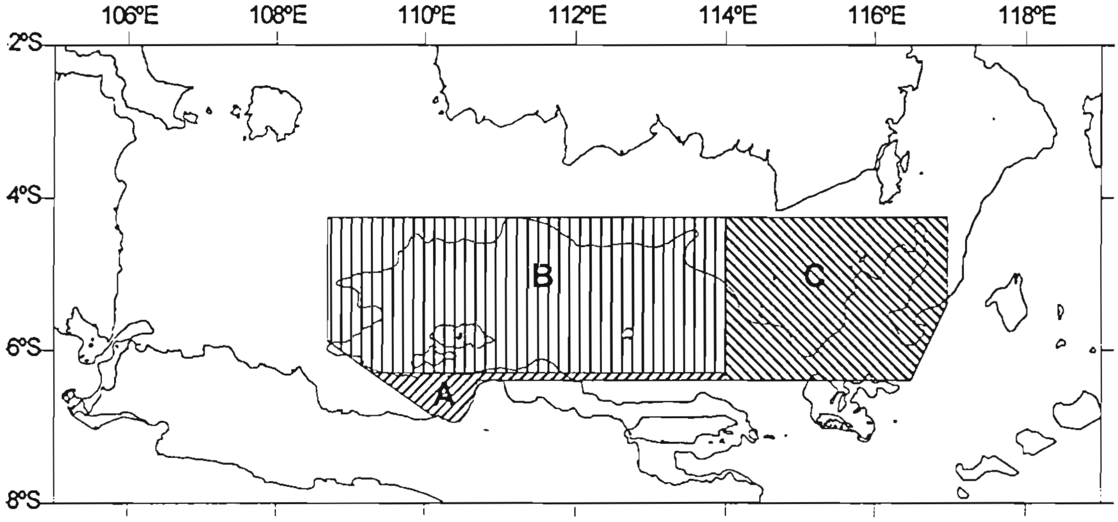


Figure 30 Stratification of the surveyed area

▨	Stratum A :	Coastal population
▥	Stratum B :	Neritic population
▧	Stratum C :	Oceanic population

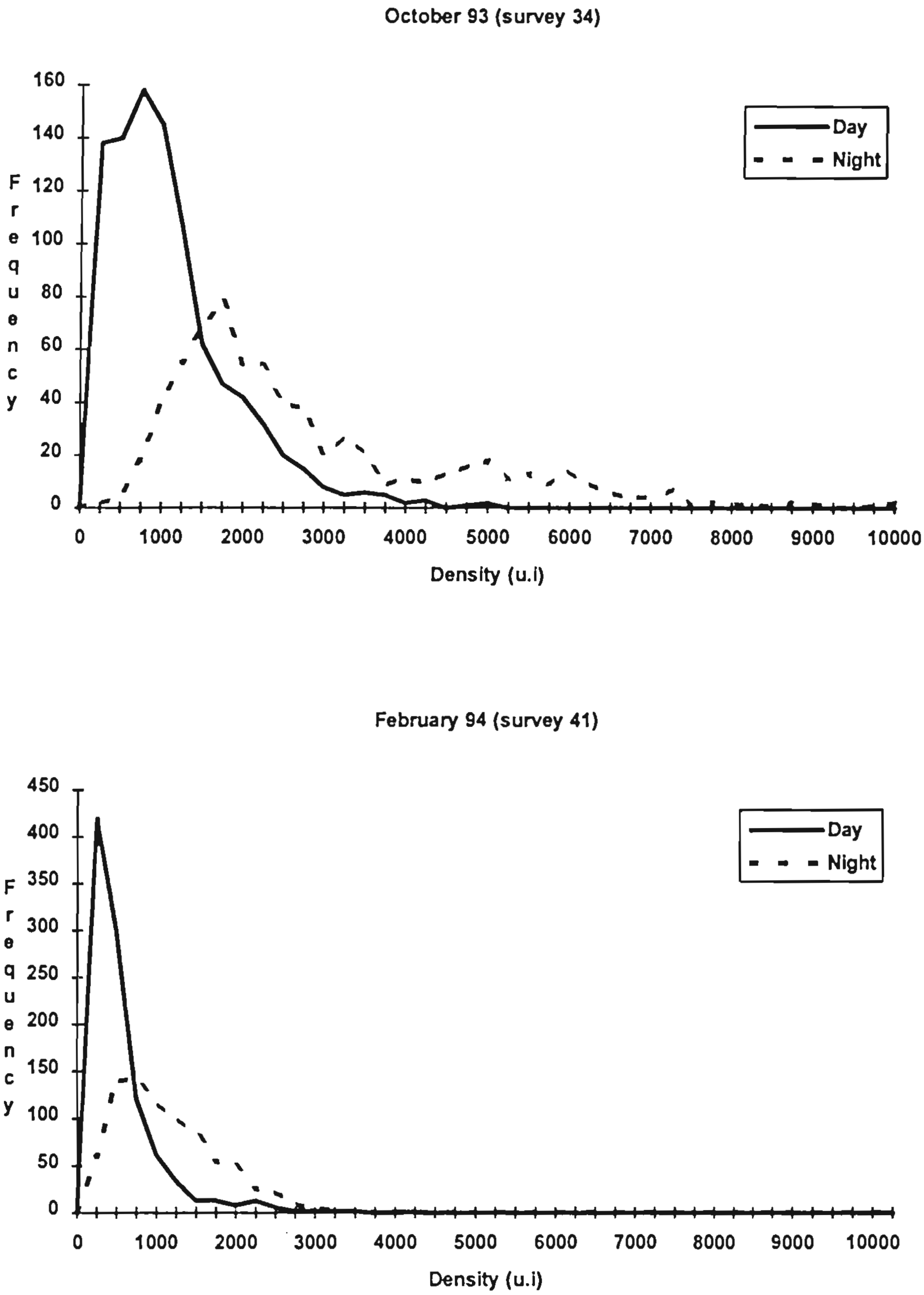
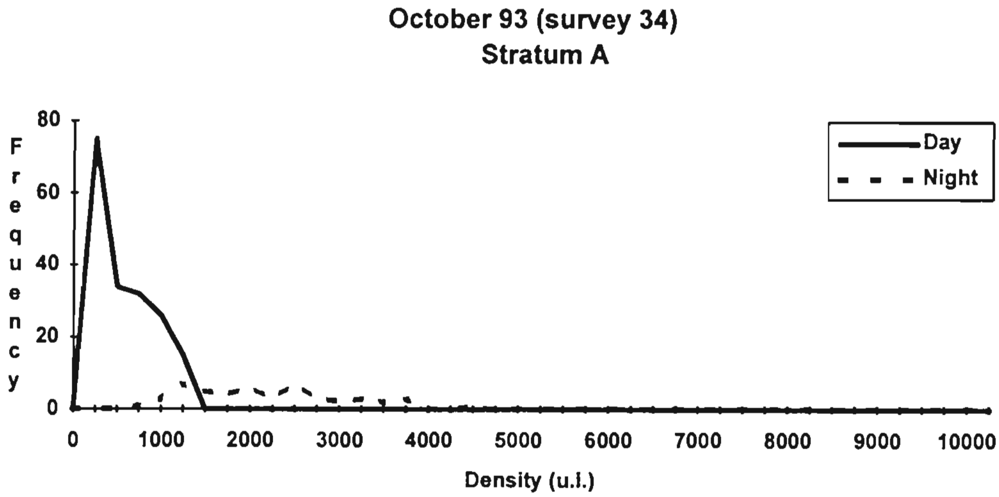
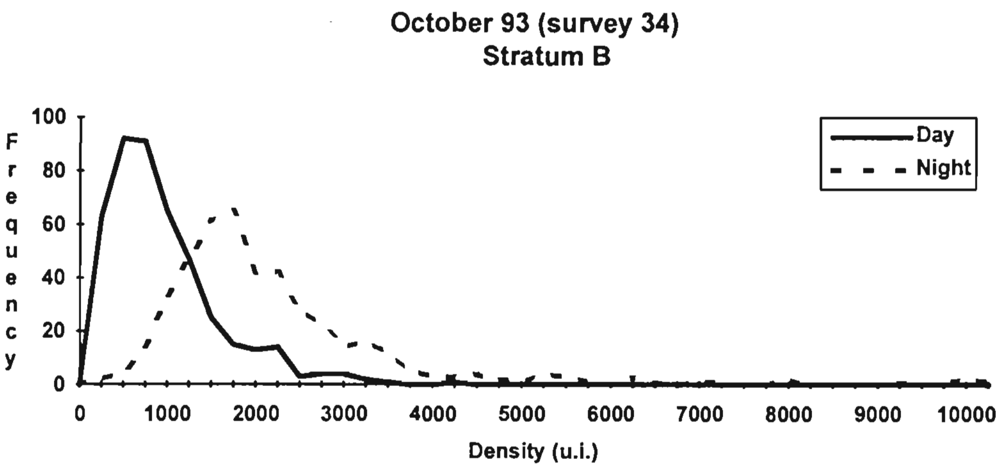


Figure 31 Curves of fish density distribution during the day and the night in October 93 and February 94





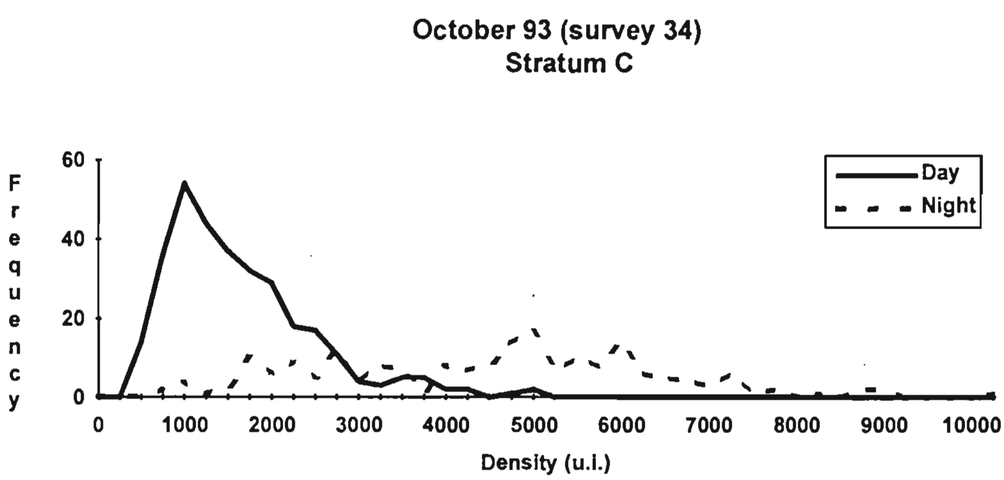


Figure 32 Curves of fish density distribution by strata (A, B and C), during the day and the night in October 93 (survey 34)

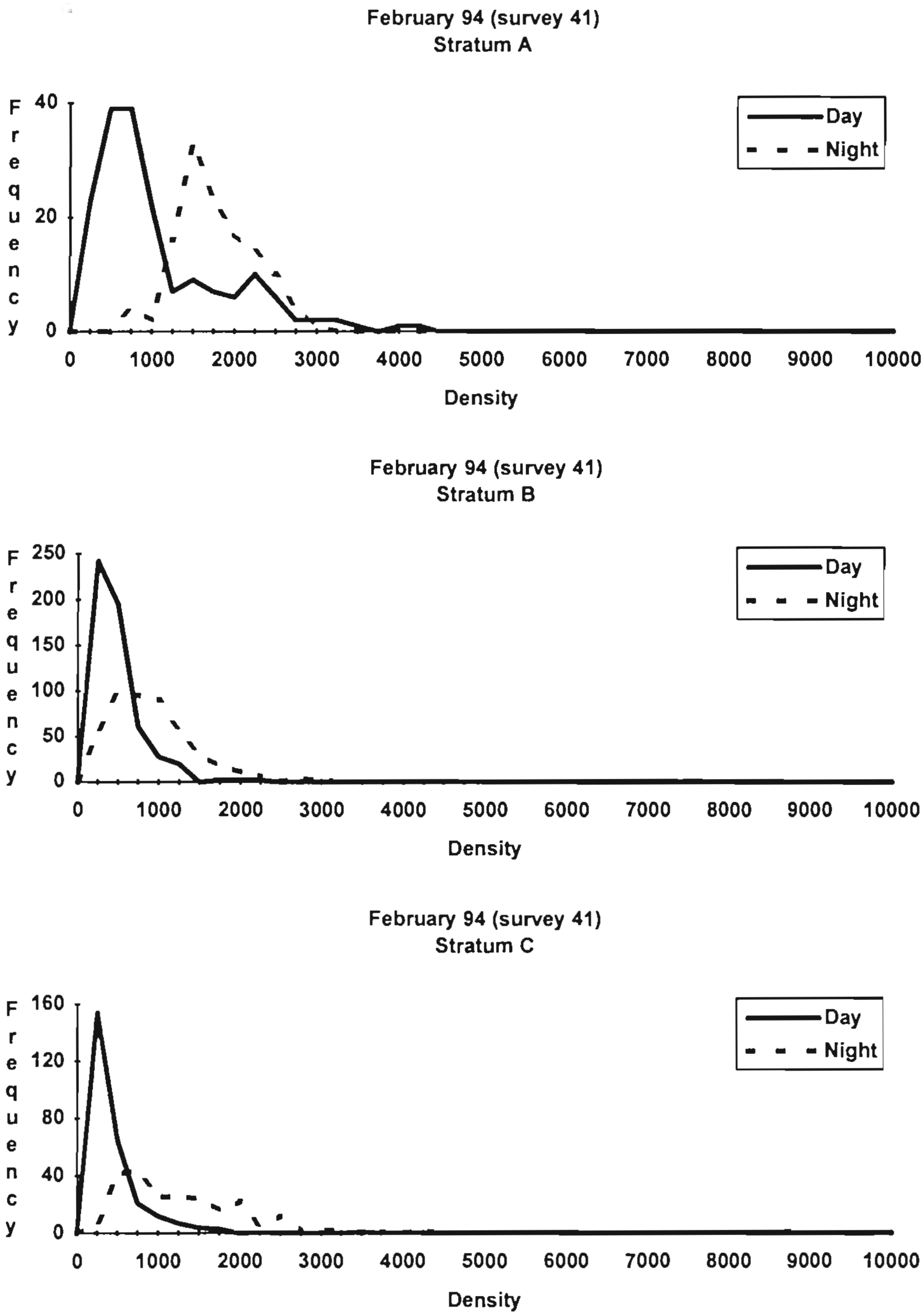
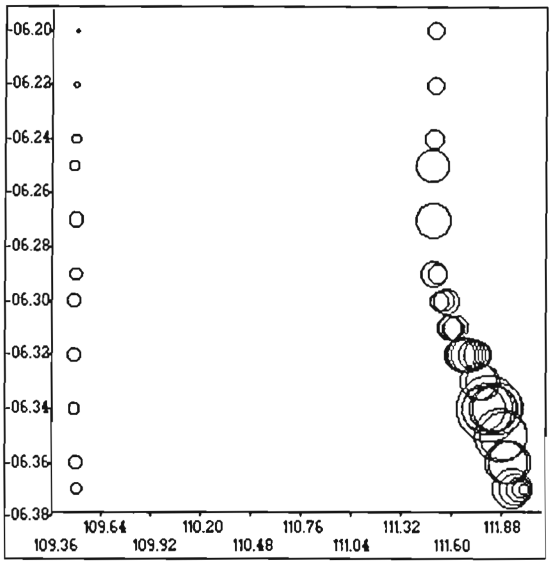
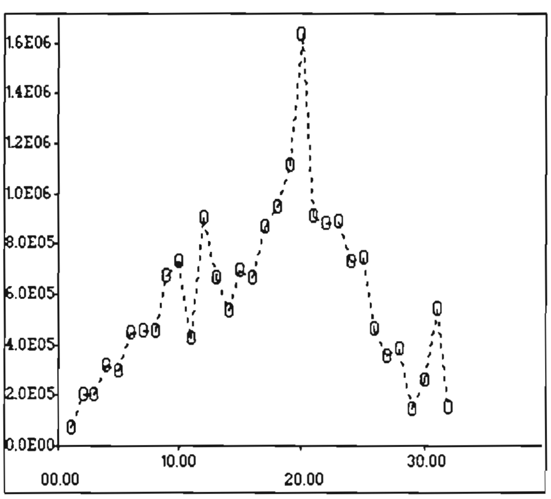


Figure 33 Curves of fish density distribution by strata (A, B and C), during the day and the night in February 94 (survey 41)

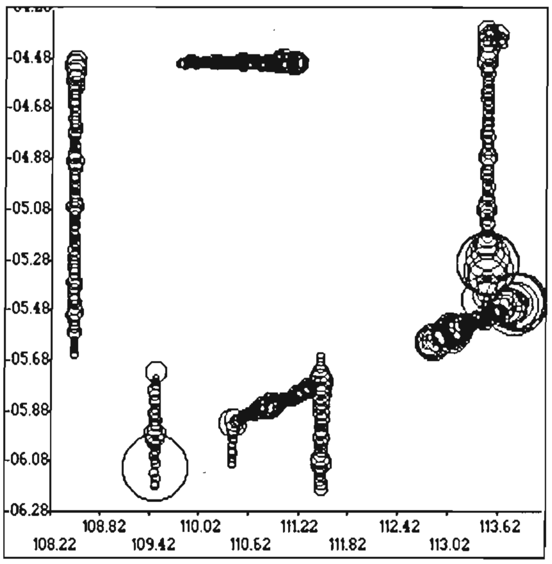


Data parameters
Number : 49
mean : 2069
var : 7.5E5
std/m : 0.42

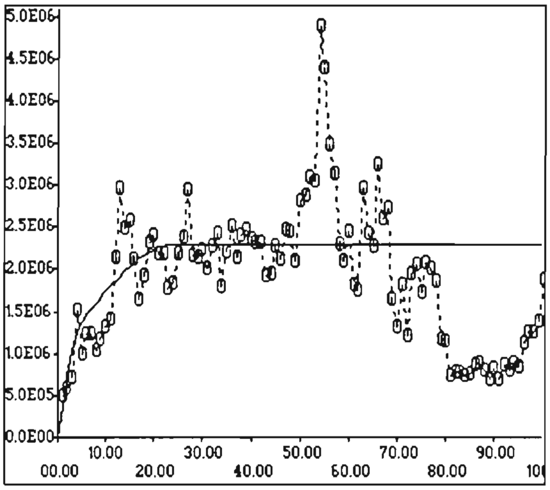


Variogram parameters
lag number : 100
lag : 1
tolerance : 0.5

Figure 34 Spatial distribution and variogram of the fish density in Stratum A during the night in October 93 (survey 34)



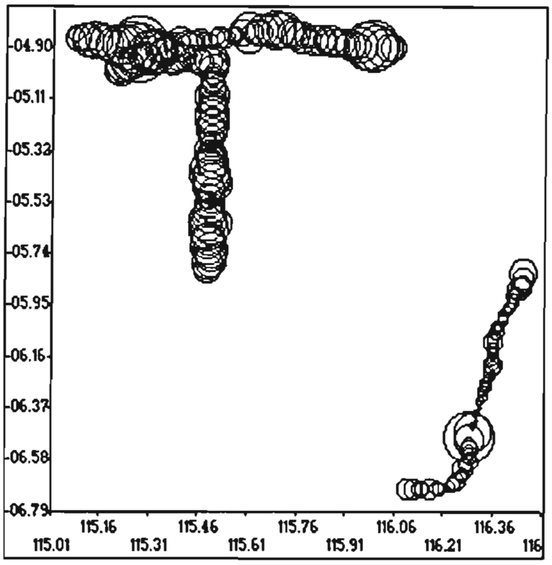
Data parameters
Number : 442
mean : 2111
var : 2.1E6
std/m : 0.69



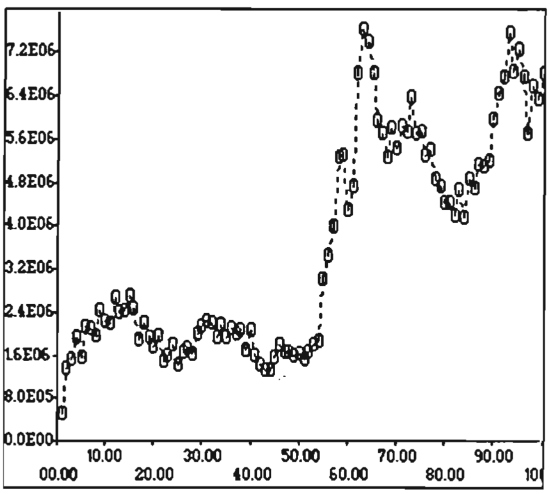
Variogram parameters
lag number : 100
lag : 1
tolerance : 0.5

Model parameters
model 1
spherical (sill 1E6 ; range 5)
model 2
Spherical (sill 1.3E6 ; range 25)

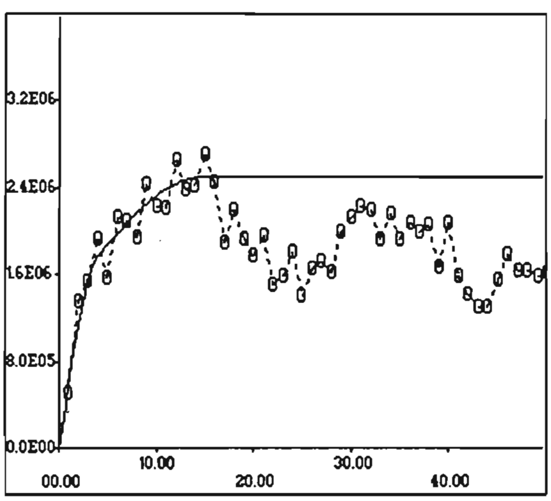
Figure 35 Spatial distribution and variogram of the fish density in Stratum B during the night in October 93 (survey 34)



Data parameters
Number : 196
mean : 4358
var : 3.6E6
std/m : 0.44

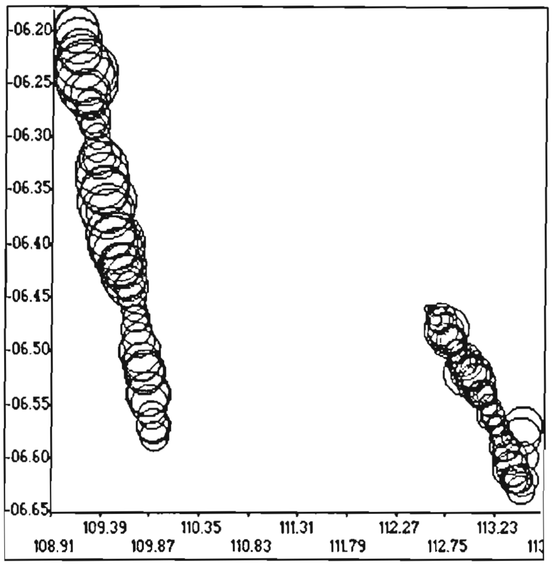


Variogram parameters
lag number : 100
lag : 1
tolerance : 0.5

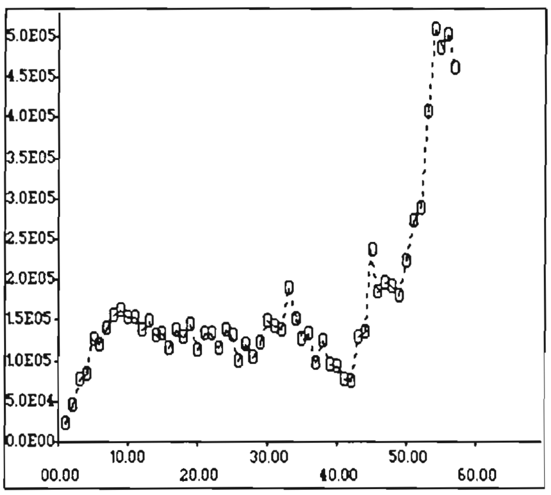


Model parameters
model 1
spherical (sill 1.3E6 ; range 4)
model 2
Spherical (sill 1.2E6 ; range 15)

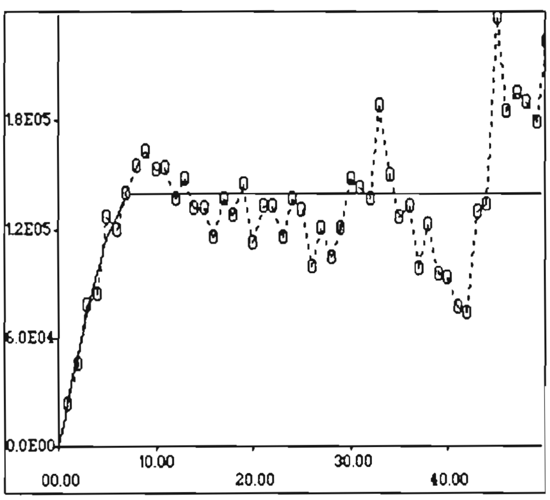
Figure 36 Spatial distribution and variogram of the fish density in Stratum C during the night in October 93 (survey 34)



Data parameters
Number : 123
mean : 1633
var : 2E6
std/m : 0.27

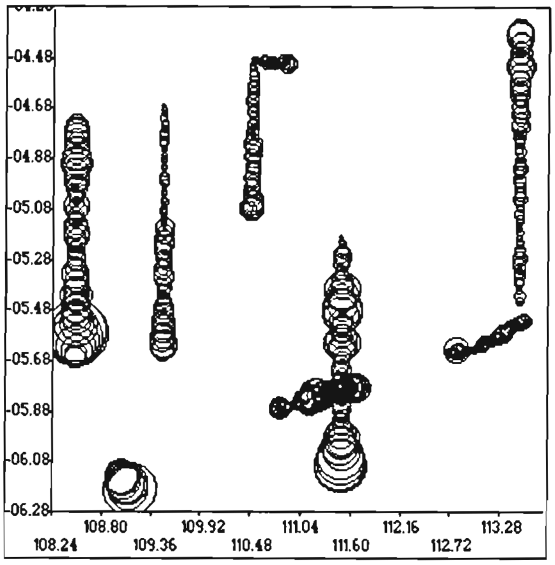


Variogram parameters
lag number : 100
lag : 1
tolerance : 0.5

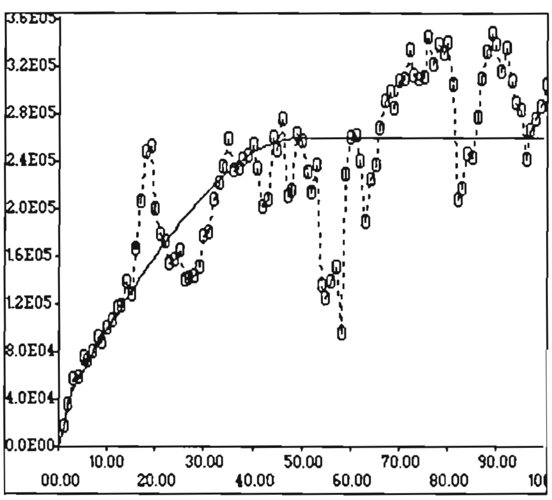


Model parameters
model 1
Spherical (sill 1.4E5 ; range 8)

Figure 37 Spatial distribution and variogram of the fish density in Stratum A during the night in February 94 (survey 41)



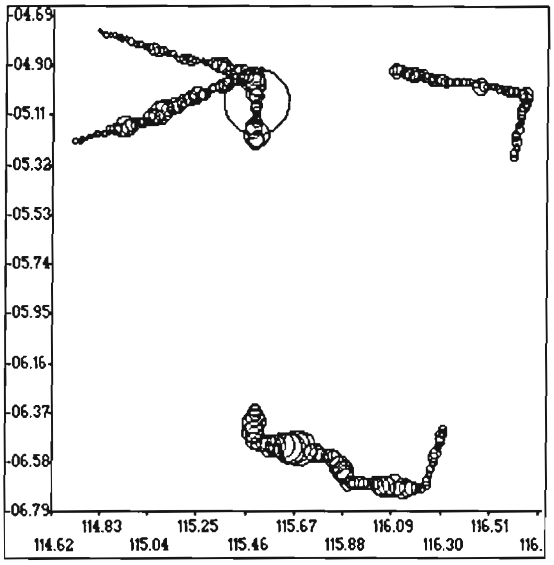
Data parameters
Number : 469
mean : 806
var : 2.7E5
std/m : 0.65



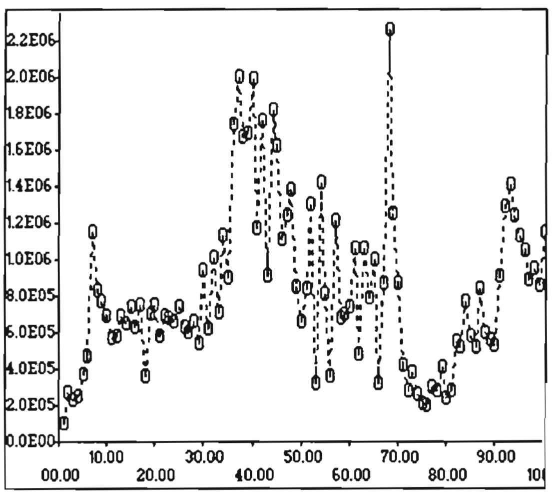
Variogram parameters
lag number : 100
lag : 1
tolerance : 0.5

Model parameters
model 1
spherical (sill 3E4 ; range 4)
model 2
Spherical (sill 2.3E5 ; range 50)

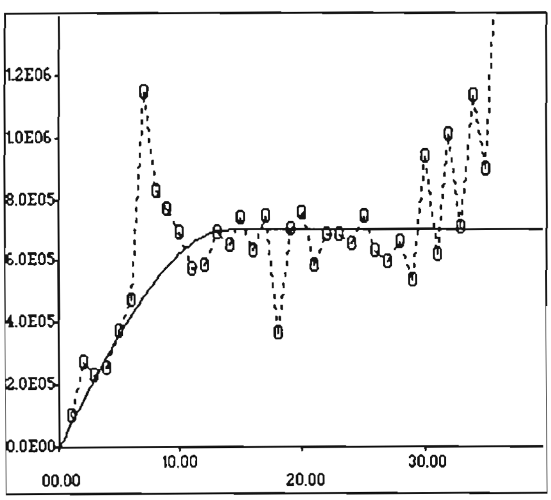
Figure 38 Spatial distribution and variogram of the fish density in Stratum B during the night in February 94 (survey 41)



Data parameters
Number : 231
mean : 1195
var : 8.3E5
std/m : 0.76



Variogram parameters
lag number : 100
lag : 1
tolerance : 0.5



Model parameters
model 1
Spherical (sill 7E5 ; range 14)

Figure 39 Spatial distribution and variogram of the fish density in Stratum C during the night in February 94 (survey 41)

From these pieces of information, several conclusions may be considered.

- The stratification seems reasonable, and the results inside each stratum correspond to what was expected : important difference between B and C in October (presence of the group 3 in C, **Fig. 32**) ; similarity in February (absence of group 3, **Fig. 33**) ; similarity of day values in all the strata ; strong differences between night values.
- The variograms show no nugget effect, but a structure which is very similar to those of the general variograms : that means that the small structure is observed everywhere (**Fig 34** to **39**)
- The histograms show again the specificity of the three strata and the representativity of the 3 main groups.

From these observations two facts have to be pointed out :

- The longitude border between the strata (114°E) is not very clearly defined, and as there is no front but only long range trends, no totally satisfactory limit will be drawn according to the longitudinal dimension.
- There is very few samples in the coastal area, which remains almost unknown, and needs some additional pieces of information.

2.3.2. Evaluation

Acoustic surveys of fish populations enable to derive instant estimates of biomass. These values cannot, alone, be helpful for fishery management. Acoustic biomass estimates have two major sources of uncertainty : spatial error and conversion error.

The spatial error is the error made by interpolation between the samples and thus applying it to the entire Java Sea on the data average. The conversion error lies in the relation between acoustic back scattered signal and fish weight (or length). The workshop focused on the spatial error.

The estimation of the variance of the spatial error requires here the use of spatial structural model because the acoustic data are sampled in a correlated manner. Geostatistical approach is thus used. The biological model is made of 3 groups that overlap and summed up. This justifies the construction of a continuous quantitative model for the entire Java Sea.

The 2 surveys covering the entire area are used. The data show 2 structures:

- one at small scale. it characterizes patches in the densities and accounts for half of the total variance
- one at large scale. it is best described as a trend in the mean densities from one area to the other (west to east gradient in October or south to north gradient in February) and accounts for the other half of the total variance. Each structure contributes an error term to the spatial estimation error made from the surveys. Each term has been estimated.

The estimation variance writes : $\sigma_E^2 = 2\gamma(A,S) - \gamma(A,A) - \gamma(S,S)$ where each term is the integral of the variogram for all distances in the area (second term), for all distances between samples (third term), for all distances between samples and areas (first term). The numerical algorithm used to estimate the two first terms requires a discretization of the area with a mesh that is smaller than the range of the small structure, i.e. a mesh smaller than 10 miles. This is not possible to do so because of the very large W-E dimensions of the areas. But as each structure contributes to the total estimation error, each term can be approximated here separately.

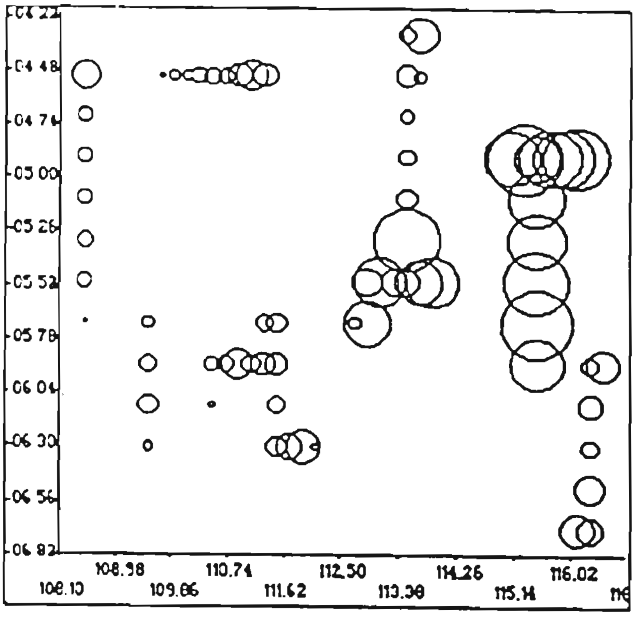
The estimation of the variance is twofold. The area is discretized with a mesh of 0.2. degrees (12 nautical miles). First we approximate the error made when estimating the squares mean then the error made when estimating the region mean. The variances add : $\sigma_E^2 = \sigma_S^2 + \sigma_R^2$.

The discretization grid has a mesh of 0.2 degrees, contains 45 squares in longitude and 15 in latitude. Its origin is 108°E and 7°S. This grid is superposed to the survey design. The transects traverse some of these squares. The mean in these squares is estimated by taking the simple average of the data collected in them. The average number of samples in the squares is 10.

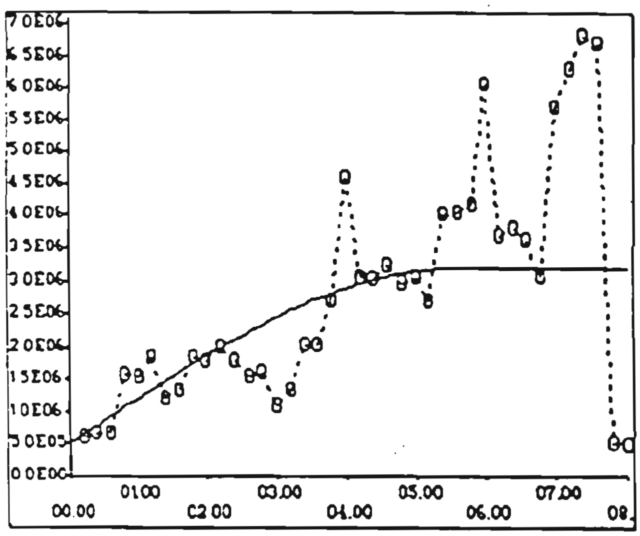
σ_S^2 is approximated by considering that the samples are random in the small squares is estimated by the difference in variance between raw data and square averages. The total variance in area A can be decomposed as follows :

D2(*/A)=D2(*/square)+D2(square/A).

The component σ_R^2 is estimated using the discretization grid and integration algorithm of the variogram. The variogram used is the variogram of the square means. This variogram was modeled from one of the data. The spatia l distribution of the square average and the variograms have been drawn (**Fig. 40** to **44**) and results are shown on the evaluation table (**Tab. 2**).



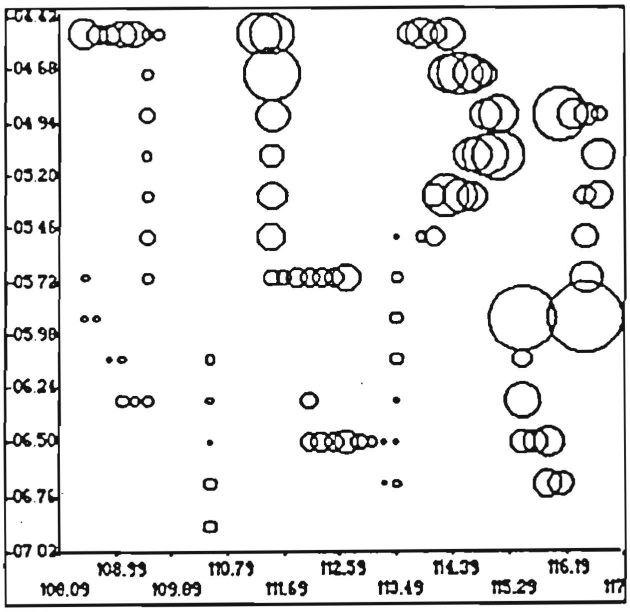
Data parameters
Number : 68
mean : 2576
var : 2.2E6
std/m : 0.58



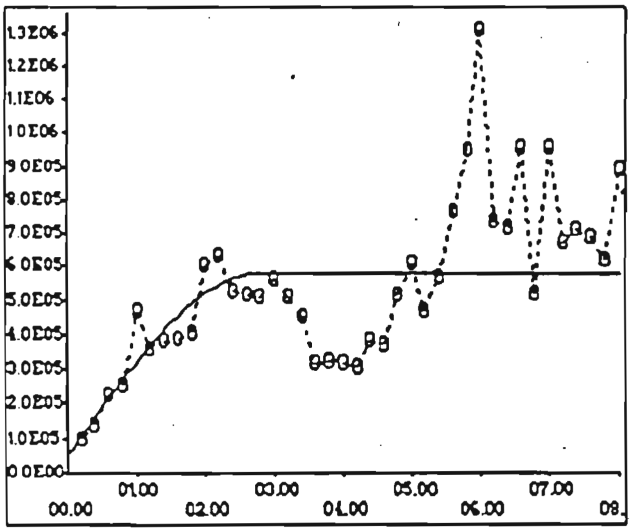
Variogram parameters
lag number : 40
lag : 0.2
tolerance : 0.1

Model parameters
nugget = 5E5
spherical (sill 2.7E6 ; range 5.7)

Figure 40 Spatial distribution and variogram of the square averages of the fish densities during the night in October 93 (survey 34)



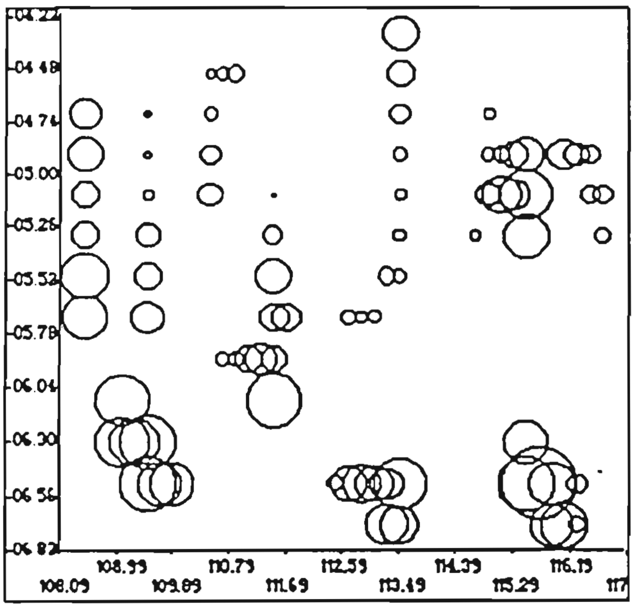
Data parameters
Number : 93
mean : 993
var : 4.9E5
std/m : 0.71



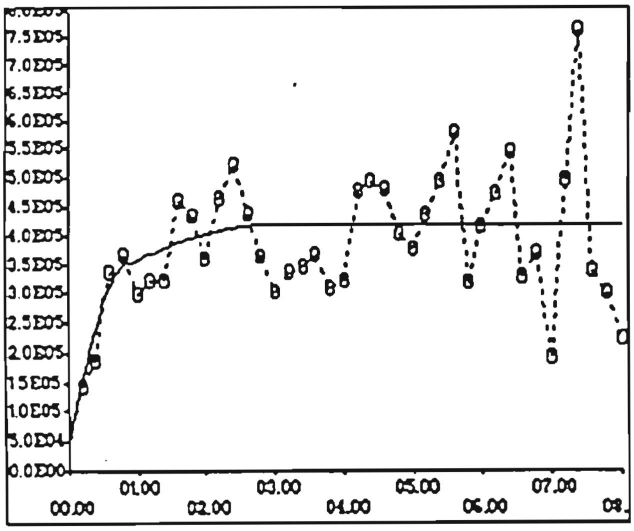
Variogram parameters
lag number : 40
lag : 0.2
tolerance : 0.1

Model parameters
nugget = 5E5
spherical (sill 5.3E5 ; range 2.8)

Figure 41 Spatial distribution and variogram of the square averages of the fish densities during the day in October 93 (survey 34)



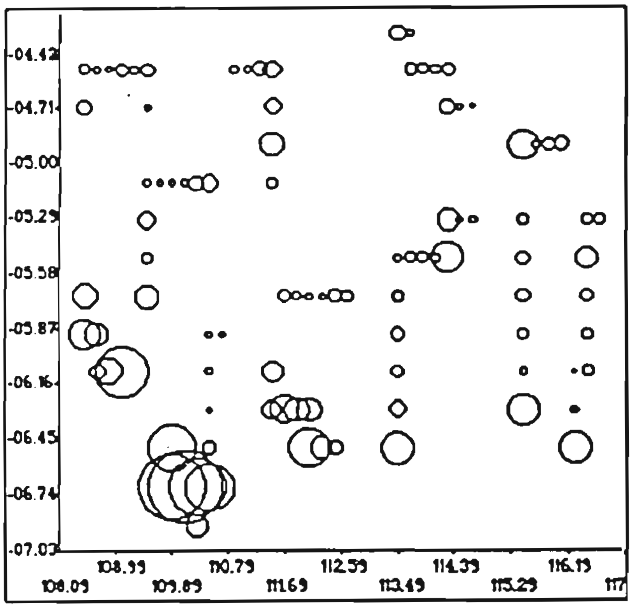
Data parameters
Number : 80
mean : 1083
var : 3.8E5
std/m : 0.57



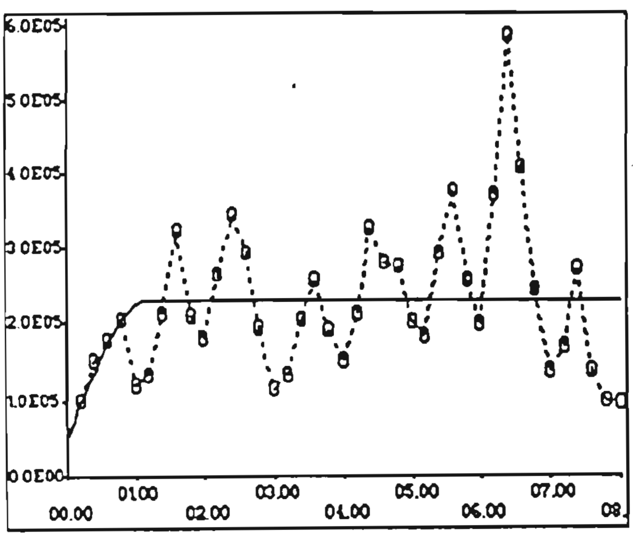
Variogram parameters
lag number : 40
lag : 0.2
tolerance : 0.1

Model parameters
nugget = 5E4
spherical (sill 2.5E5 ; range 0.8)

Figure 42 Spatial distribution and variogram of the square averages of the fish densities during the night in February 94 (survey 41)



Data parameters
Number : 96
mean : 515
var : 2.2E5
std/m : 0.91



Variogram parameters
lag number : 40
lag : 0.2
tolerance : 0.1

Model parameters
nugget = 5E4
spherical (sill 1.8E5 ; range 1.2)

Figure 43 Spatial distribution and variogram of the square averages of the fish densities during the day in February 94 (survey 41)

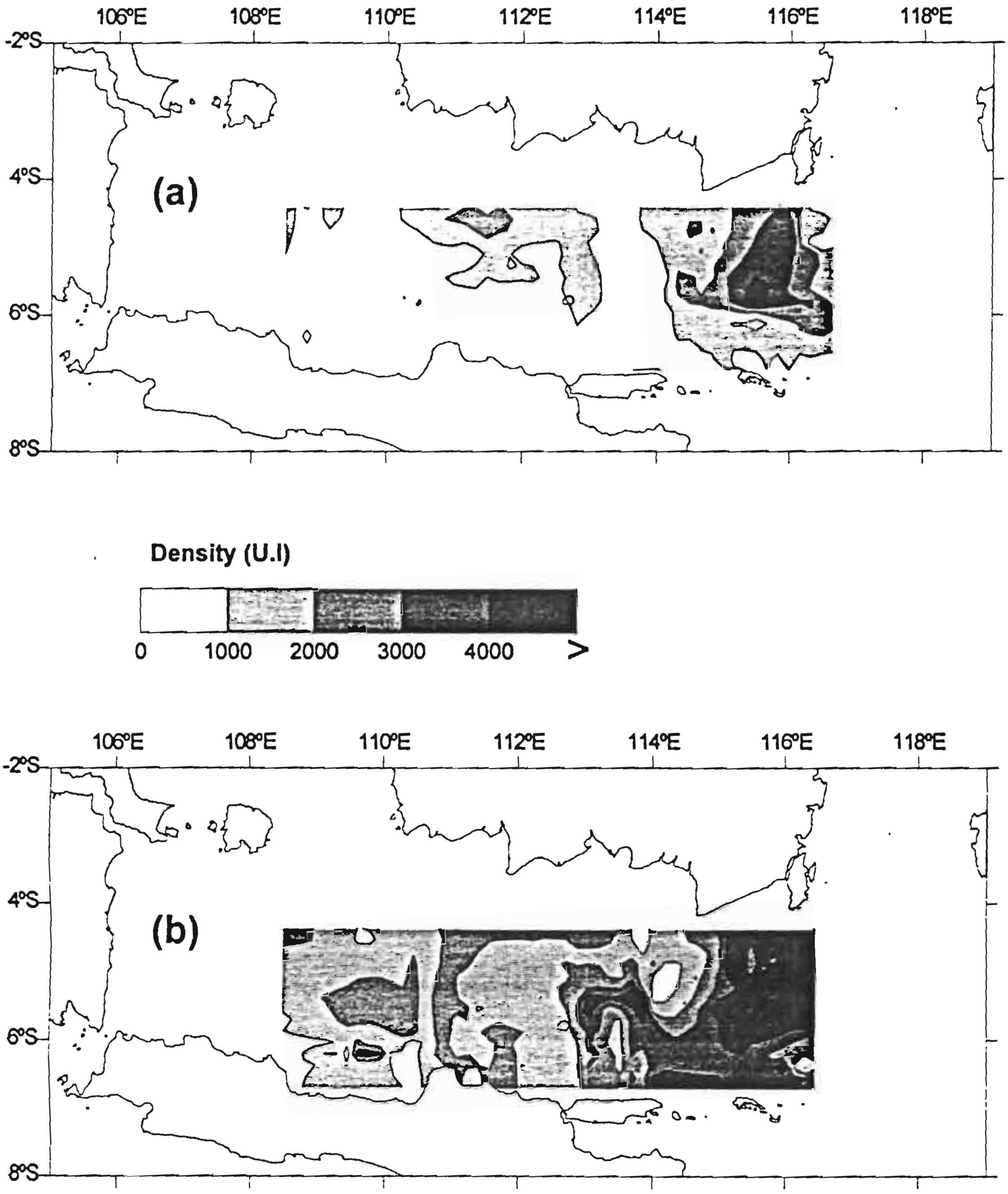


Figure 44 Interpolation (krigging method) of the fish density in the area of the cruise made in October 93 (survey 34)

(a) Day (b) Night

Table 2 Evaluation table

Survey	34 Night	34 Day	41 Night	41 Day
Squares	4000	13,000	12,000	120,000
Region	4754	7679	10,110	20,454
Relative error	18.20%	13.20%	15.00%	14.10%
Mean / survey	515	1083	993	2576

The precision of the surveys is satisfactory. Although the inter distance transect is very large, the statistical homogeneity and spatial regularity of the data make the estimation possible with such survey design.

The variance values can be slightly underestimated due to the fact that the samples in the squares are not random.

Maps of the square averages, i.e. maps of the long range structure have been derived by krigging (**Fig. 44**). The neighbourhood parameters used are :

- radius of circular neighbourhood : 3 degrees
- maximum and minimum number of samples used : 5

2.4. Conclusions

The synthesis of these observations leads us to the main conclusions that follow.

<u>Biological description</u> : it is possible to describe a biological model of the fish distributions in the Java Sea, at least inside the survey area. This area is inhabited by three groups of fish :

- a coastal group, linked with continental waters, limited in the shallow water area, This group presents high densities, numerous schools, but little is known about it (**Fig. 45a**).
- a widely distributed group, observed all over the survey area (group 2), with very constant characteristics. This group seems more strictly pelagic than the others, and is visible by day as well as by night (**Fig. 45b**)
- a dense eastern group, the only one with important migrations during the year and even during the day. This group is suffering the most important fishing effort from the large purse seiners (**Fig. 46**)

Evaluation : the sampling methodology has proved that it is usable for acoustic stock evaluation, with a good precision, through the use of the large surveys (i.e. February or October). The distribution presents two kinds of gradients :

- a gradient West-East, during the dry season, with the main densities at the east.
- a gradient North-South, during the wet season. This gradient may exist during all the year, but is not important enough to be observed when the high eastern densities are present in the area.

The structures of the distribution are of two kinds :

- a small structure, with a dimension approximately 5 to 20 nautical miles, all over the area ;
- a larger structure, which representents the gradient on the whole area.

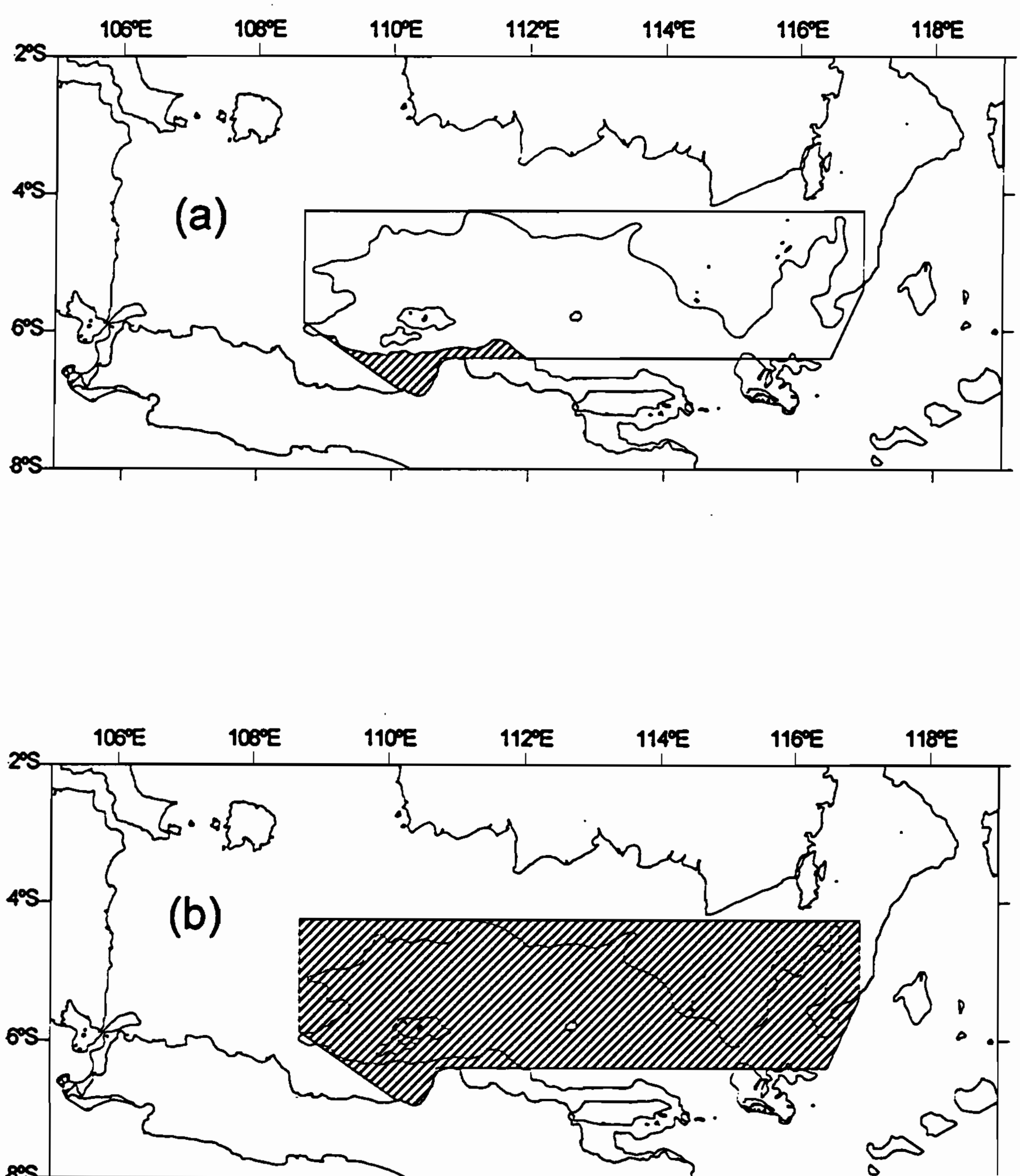


Figure 45 Repartition all over the year for (a) group 1 and (b) group 2

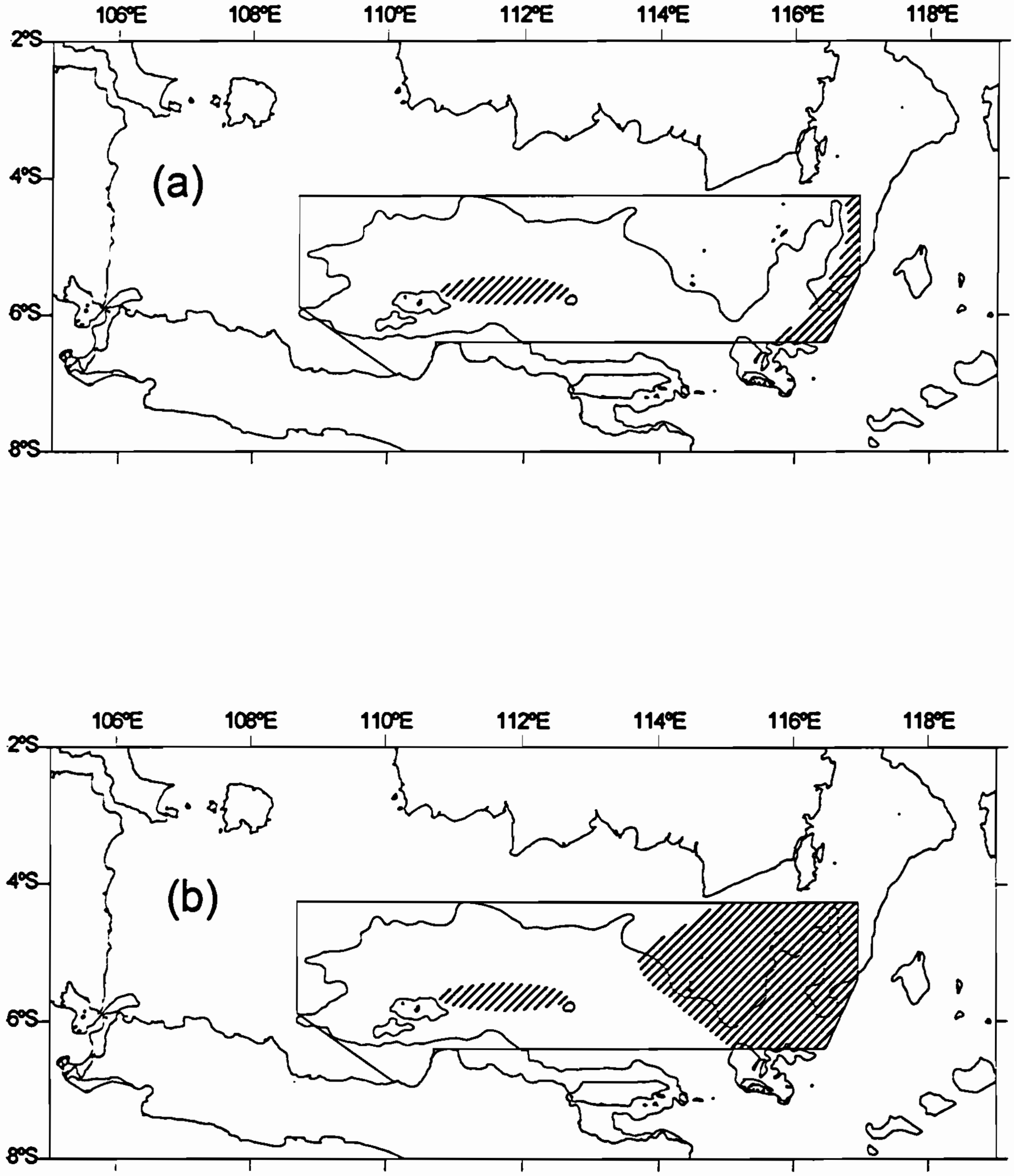


Figure 46 repartition for group 3 (a) in February and (b) in October

Considering these structures, the transects west-east covered during the short surveys sample correctly the small structures all over year. They sample also correctly the west-east gradient when this one is present, i.e. in the dry season. In this season, they sample probably well the density histogram in the area. Neither they do not sample the N-S gradient, nor the histogram in this period, but if we consider the first aim of the surveys, which was to evaluate the density of the population exploited by the purse seiners, i.e. the group 3, one may consider that they represent a valuable tool for that evaluation. Neverthless a test on this conclusion has to be performed before to consider it as demonstrated.

When considering the large surveys, it has been shown that the expected precision of the evaluation could be around 15% on the density evaluation. This low value compared to the relatively small sampling is due to the great regularity of the structures observed in the area.

From these results of the Workshop, we may define the future works needed. The first one will be to have a confirmation of the biological models that are presented in this document, particularly considering more in details the information available on the fishery and the fishing experiments made during the acoustic surveys (Fig. 47 and 48). The species proportion could help to define the biological meaning of the three groups. The measurements of TS and its interpretation will be made necessary.

One of the key points to be studied is the fish migrations and movements. The vertical daily migrations would help to discriminate groups 2 and 3, thus to make easier the stratification.

The area of the survey does not allow one to extrapolate outside of the central Java Sea. It would be important to have at least an idea on the structures of the coastal populations, on the south as well as on the north. What is

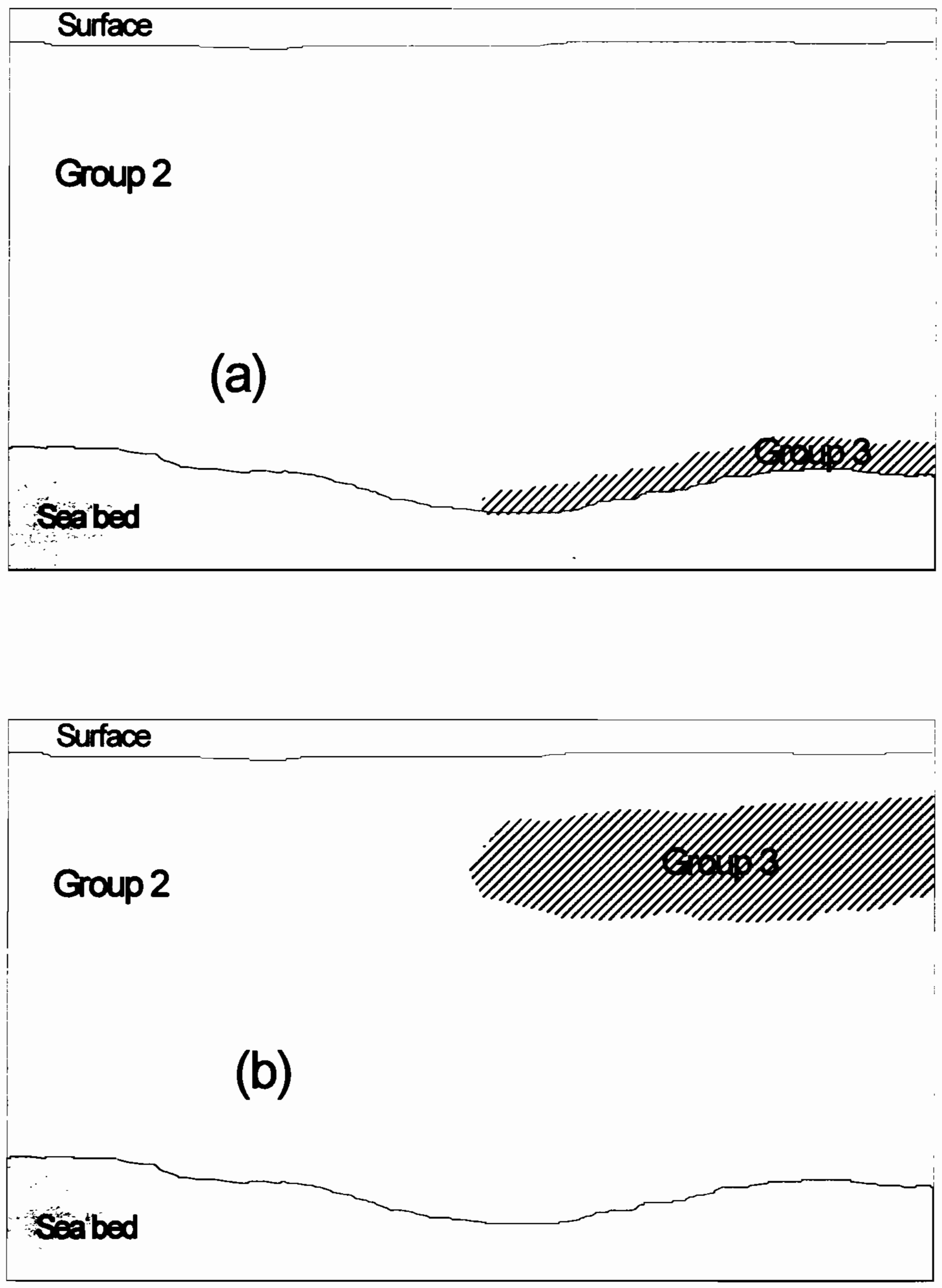


Figure 47 Circadian distribution of fish along the West-East transect (October)

(a) Day (b) Night

(During the day, group 3 is too close to the bottom to be observed throught acoustics)

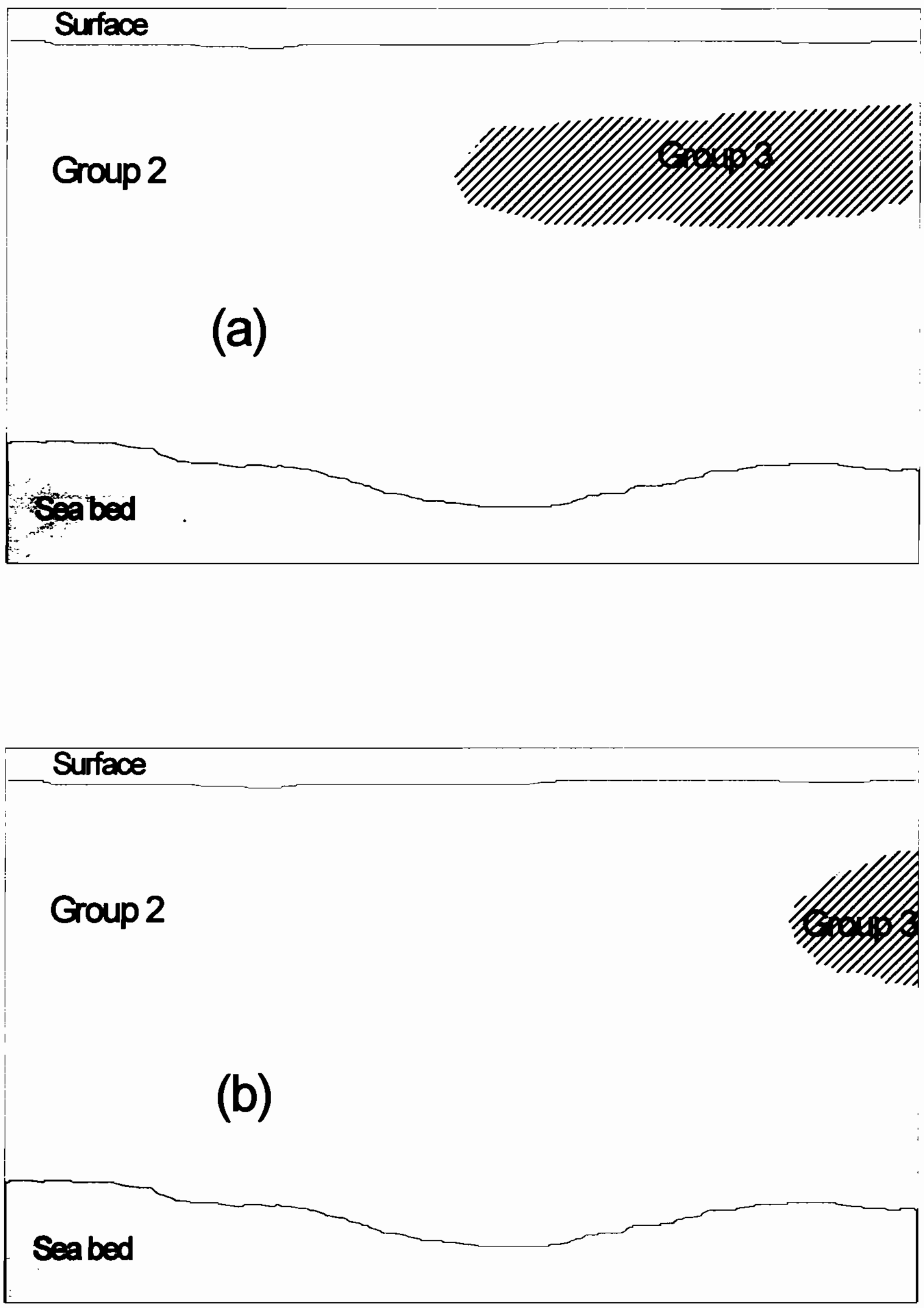


Figure 48 Night annual distribution of fish along the West-East transect

(a) October (b) February

happening on the west is also not described. Some larger surveys all over the Java Sea could give valuable information on this point.

The discrimination between the group 2 and the plankton biomass would also help to understand the behaviour of that group present in all the Java Sea. As the surveys have been recorded using a very low threshold, a playback with other threshold adjustements will give a good idea of the group 2. In the same idea, the plankton patch could be observed through the different mappings using different thresholds, and maybe to explain the small structure present everywhere.

The relationship between the structures of the fish distribution and the fishing strategy is interesting to study

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3. ROUND TABLE

INTRODUCTION

At the end of the AKUSTIKAN I Workshop, a round table on fishery acoustics took place in SubBPPL Ancol meeting room, on December 12, 1994. The main topic of this round table was to discuss the results obtained in the workshop with people which where not directly involved in PELFISH and/or acoustics. Beyond it was the opportunity to enlarge the discussion upon the uses and the needs for acoustics fishery science in Indonesia.

The Round Table participants (**ANNEX 2**) and Workshop objectives were presented by J.R. DURAND, Director of the PELFISH Project.

J.R. DURAND :

Thank you for being in this round table. Some of you were present last March at the first PELFISH seminar on biology, dynamics and exploitation : BIODYNEX. The publication regarding this event will be sent to you before mid 95. The objective of the Pelfish Project is to draw a general frame for the management of the Java Sea small pelagic resources. Acoustic sciences offer an invaluable tool to achieve this goal. This first workshop AKUSTIKAN I allowed some processing, mapping and reporting of the data collected by the research vessel Bawal Putih I since the beginning of the Project.

From the synthetical abstract which we are able to draw now, we can initiate a discussion on the workshop results and the future of fishery acoustics in Indonesia as well as issue some recommendations for the next cruises and the next workshop AKUSTIKAN II which is planned for January 1996. D. PETIT, in charge of the Pelfish acoustic studies, will present the means used to collect the data, then, F. GERLOTTO will give you some of the results achieved by the workshop team.

D. PETIT

The data processed during the workshop AKUSTIKAN I concern a number of parameters such as the fish density, its location, species and environmental conditions. They have been collected during six cruises on transects from Semarang to Pulau-Pulau Kecil of Matasiri and two surveys covering the deepest area - more than 50 m - of the Java Sea. The cruises were carried out by using the Research Vessel Bawal Putih I. To cover the whole Java Sea, we would have needed cruises lasting 1 to 2 months aboard a vessel of 10 knots speed. The Bawal Putih I is capable only 12 days sailing with an average speed of 6 knots. This is why we had to adopt much more simple surveys. The equipment used is presented in **Figure 2**.

F. GERLOTTO

Since the transects did not cover the whole Java Sea, the area studied is shown in **Figure 1**.

The sets of data we used during the workshop were related to :

- Salinity : which varies according to the seasons
- TS measurements : The values of TS measurements vary according to the length of the fish, the alternate day and night, and seasons. We can observe bigger fish at night.
- Schools : The schools have a very original behaviour in the Java Sea which affects the stock. We can notice on **Figure 16** that school concentrations in the east part of the Java Sea are of medium density while in the west they are of a higher density.
- Density : The density data are of the most importance and lead to interesting questions such as :
    - Is the low density observed in February proving a migratory behavior?

- Why in October the density is higher in the eastern part than in the western part of the transect ?
- Why day values are half of the night values ?

Particularly, the topic was to know if the spaced surveys (or transects only), were satisfactory to describe the phenomena, evaluate the density and its location. The use of geostatistics during the workshop showed us that on the whole of the Java Sea, the density is structured at very small scale (some miles); but a large scale structure is superimposed on this later. It is the large scale structure that interest us. The survey strategy with large transects, chosen by the Project, is well adapted to the structure pattern of the Java Sea. Using geostatistics, the large surveys allow us to evaluate the density with an accuracy of about 20%, that is very satisfactory.

The conclusions of the workshop, on the six cruises studied, agree with the biological conclusions given in the last BIODYNEX seminar. We can build a model with three zones as shown on **Figure 30** :

- zone A, with a coastal population
- zone B, with a neritic population
- zone C, with an oceanic population,

and it appears that these three zones are related to the fisheries. This is a good match with the biological zonations.

DISCUSSION

In order to give some clarification to the question/answer process, we have tried to give a more logical form to the discussion. So the order has been changed and we put together related topics without changing the original material.

Methodology

CHOLIK : Why did you select only 6 surveys for your workshop?

PETIT : Cleaning the raw data then process them, takes much longer time than the workshop itself. The workshop validates only some data as a beginning. One of the conclusions of this week is that we need more people to validate the data. We hope that this workshop will give place to work proposals with Bogor Agriculture University (West Java) and Sam Ratulangi University (North Sulawesi)

DURAND : The Java Sea is probably the only place in the world where so much information has been gathered and where the information is so original. Yet Indonesian acousticians are too few.

CHOLIK : Would it be better to process data just after each cruise?

DURAND : The principle is a good one but practically it is very difficult.

PETIT : At the beginning we had only three weeks between each survey. It is not enough time to start any work on data.

DE VISSCHER : It is not unusual to analyse data later. Acoustic planning depends on boat availability as well as computer availability. In the consolidation phase it is important to collect data.

DURAND : We face a lack of time and people. We also need more equipment and more coordination.

AMIN : Why did you use INES-MOVIES in place of the Biosonics software?

PETIT : With INES-MOVIES you can store numerical data. It also provides outputs echograms in color. Now Indonesia has a very important database.

GERLOTTO : The most interesting phenomenon of the Java Sea is that its structures are regular. Mapping the information would take a long time but it should not be difficult to obtain indexes.

NURZALI : Would this allow remote sensing management?

GERLOTTO : Satellites can monitor environmental structure and several works of this type have been financed by the EU. But they still present some limits. Tools are not yet very usable and they have not yet overcome the problem of clouds.

DURAND : We need more data on primary production.

Specific results

FATUCHRI : Pelfish should furnish information on the movements and size of the biomass but also on its magnitude. We should have data not only on salinity but also on food organisms like plankton . An ecological management plan is an easier path for recommendation.

WIDODO : A research on food organisms would be time consuming. Moreover it is not our primary task. There is a number of weaknesses in using indirect approaches for biomass estimation.

NURZALI : What does the difference in depth of the schools locations between day and night mean ? Does it vary according to the species ?

GERLOTTO	: One of the limits of echo integration is that the system can not integrate down the surface (from 0 to 4m) and near the bottom of the sea. This makes it difficult for us to describe the change of behaviour between day and night. We assume that at day time the fish stay very near the bottom of the sea.
PETIT	: The density peaks take place twice a day, around 5 AM then between 5 and 6 PM.
POTIER	: Even from the biological point of view it is difficult to be sure that the fish stay at the bottom of the sea : due to currents, the seines never go straight the bottom.
GERLOTTO	: The fishery tactics with light affects the relation between the seine parameters and the natural behaviour of the fish.
PRIONO	: How can we use the information we have on spawning seasons to optimize the management ?
SADHOTOMO	: We recognized two spawning seasons : one from January to April, the other one from August to October. Which means two recruitments periods, a major one from May to August and a minor one from December to January during the north west monsoon.
DURAND	: Can we observe spawning concentrations ?
POTIER	: It is difficult to observe as 80% of all fish caught are immature ones, fish that have not yet spawned.
GERLOTTO	: To answer the question we need more information about the north of the Java Sea but not about the west.
NURZALI	: Is the Hardenberg theory proven true or not?
DURAND	: Up to now we haven't proven any connection between the Java Sea and the South China Sea. But we plan to start genetic studies on some common species of the regions.

DURAND : Could it be there a continuation of the neretic system?

POTIER : Salinity on the west is low.

DURAND : Are there fisheries on the west part of the Java Sea?

NURZALI : Not very developed.

DURAND : Maybe because there are not enough fish.

CHOLIK : This is something the project Pelfish needs to prove.

DURAND : Do we? Is it pelagic? We need your recommendation to investigate this topic.

DE VISSCHER : If acoustic is needed for the future we need a proposal from indonesian authorities. It should be a long-term proposal.

Management

DE VISSCHER : How can acoustics studies contribute to management on the long term?

NURZALI : What is the use of more Pelfish cruises for the resource management?

PRIONO : In your conclusions will you take into account economical analysis, depletion of the stock, critical situation of other stocks such as the "lemuru" in Bali?

DURAND : We plan to publish three books, one on Biology, Dynamics and Exploitations (BIODYNEX) one on Acoustics, and one on Social Sciences and Technological Innovation.

NURZALI : Is there not already enough data for management planning ?

DURAND : We have a global knowledge which is now backed up by the acoustic results. We can already start working on management.

PRIONO : I have impression that my department is left behind with the information coming from the Project. We need information specially on stock assessment !

POTIER : And specially because your own statistics are incomplete.

PRIONO : We have no complete statistics yet on stock assessment but we will have logbooks on data.

DURAND : The quality of governmental statistics is variable among fisheries and landing places. For Central Java, the region that we are concerned with, we have no major difficulties.

DURAND : The collaboration between Pelfish and the DGF is a priority. We plan the arrival of an expert in management who will be working with the DGF and well trained scientists.

De VISSCHER : This is the goal of the consolidation phase which has been signed last week in Brussels. It is too early to know if the EU will finance another Project. However translating the management plan into practice will be a higher priority than further research.

Perspectives

PASARIBU : What is the aim of the Project? It just gives a general view of the pelagic fishes in the Java Sea, don't you have made enough transects already ?

DE VISSCHER : Do we need more campaigns ? Several or just one ?

GERLOTTO : We are talking in the frame of 18 months consolidation phase.

POTIER : We need several other cruises to establish comparisons and define the importance of environment between the years.

DURAND : From **Figure 30**, we can see where should be the complementary cruises during the consolidation phase : in Makassar Strait (north of Area C), in South Kalimantan waters (north of Area B), and in West Java Sea waters (west of Area B). We are also planning to have a joint program with Bogor Agriculture University in order to better survey Area A.

DE VISSCHER : What is the priority of PELFISH in the Java Sea ?

POTIER : It seems that there are more pelagics to catch on the eastern part than on the western part of the Java sea.

DURAND : But interest can change priorities. And we should get on the western part to realize if this region is of interest or not.

DE VISSCHER : What is the cruise plan for the consolidation phase?

DURAND : The next transects will be different from the previous ones, they will be outside the areas already checked :

1. Lumu-Lumu in Makassar Strait.
2. We expect a program with Bogor Agriculture University on North Java coastal waters.
3. West Java. We recommend two cruises of 10 days respectively.
4. We will collect landings data in South Kalimantan.

GERLOTTO : The Research Vessel Bawal Putih I, is not useful in shallow waters less than 25m depth. The fish goes away.

DURAND : It would be useful to organize a cruise with two vessels.

AMIN : Maybe you should organize smaller cruises at other seasons, specially in May-June.

POTIER : Fishermen say that there are no fish in May and June in the Java Sea

GERLOTTO : The strategy is not to make a lot of transects : the Java Sea structures are regular enough to not shorten the distance.

CHOLIK : Can PELFISH Project provide training. ICLARM invited some CRIFI experts already but we need more training programs.

DURAND : We do have programs for the PELFISH national scientists. You will just acquire a new research vessel, the Baruna Jaya IV. This vessel should be dedicated to acoustic surveys and develop the future of acoustics in Indonesia. This boat will have a lot of equipment, as well acoustic equipment as fishing devices for sampling. The prospection of the EEZ needs to be planned carefully with trained people.

4. ANNEXES

4.1. Annex 1 : Workshop announcement

WORKSHOP ANNOUNCEMENT

The Java Sea Pelagic Fishery Assessment Project ALA/INS/87/17, a project mainly financed by the European Union, is carried out by ORSTOM France and BPPL Indonesia.

Since 1991, it has conducted a research program aimed to the knowledge and management of the Java Sea Pelagic Fisheries. Many stock evaluation cruises have been undertaken using the acoustic echo integration method. The exploitation of the collected data has already started out and the Project has decided to set up a week workshop on these observations.

"AKUSTIKAN"

The theme of the workshop is :

The Stratification of The Data,

a subject which is of major importance for the spatial and temporal quantitative evaluation. Possibly, a second theme of study could be selected according to the general interest of participants.

This workshop will be of primary interest to scientists specialized in echo integration and who wish to emphasize their experience through the Pelfish data. Apart from Pelfish scientists we can already count on the participation of Doctors F. GERLOTTO and P. PETITGAS, well known as ORSTOM specialists. Some young scientists or students could also participate to the event but in order to maximize the efficiency of the work the total number will be limited to sixteen participants.

The 16 participants will be divided in four groups, every one using a computer with the following softwares : OEDIPE, EVA, EXCEL, SURFER ESPTS, LOTUS and STATGRAPHICS.

The data available for this workshop have been collected during 4 echo integration cruises (with a DUAL BEAM 120 kHz BIOSONICS echo sounder). Two of these cruises concern the three quarters of the Java Sea surface during the two opposite seasons; a third one concerns two transects from Java up to the south of the China Sea. During this one, observations were made on a median transect throughout the Java Sea and at small spatial scale, by day and by night in three different sectors of the Java Sea. Data include also environmental measurements (temperature and salinity by station) and results of identification catches (pelagic and bottom trawls, or purse seiners sampling).

The corresponding files contain :

- the temperature/salinity measurements by meter at stations,
- the inventory of species (weight) by trawl catch,
- the relative abundance of fish (total or by layer) by mile,
- the number of echo-reverberating elementary samples (total or by layer),
- the number of elementary samples insonified,
- the spatial and bathymetric location of aggregations and their relative reverberation,
- the TS in situ measurements by station (average value and distribution).

This workshop will take place at

BPPL ANCOL JAKARTA

FROM DECEMBER 5TH TO 12TH, 1994

The sessions will start at 9.00 A.M. every day. The event will close on the 12th with :

- In the morning, a presentation about **the conclusions of the common investigations and some recommendations** for the prolongation of the Project's research.
- In the afternoon, starting at 2.00 P.M. a **"round table"** including personalities from outside of the Project in order to mention the problems concerning the development of echo integration in terms of equipment, users and organisation in Indonesia.

4.2. *Annex 2 : Lists of participants*

4.2.1. Workshop " AKUSTIKAN 1"

Name	Present Activity	Organism, Address
PASARIBU Bonar	Doctor, Senior Lecturer on Fishery Acoustics	IPB (Bogor Agriculture University), BOGOR Fac. of Fisheries Jl. Rasamala, BOGOR 16670 Tel (0251) 322157
ARNAYA Nyoman	Doctor, Senior Lecturer on Fishery Acoustics	
SIMBOLON Domu	Junior Lecturer of Fishery Acoustics	
MUNANDAR Henry	Junior Lecturer of Fishery Acoustics	
SIHOTANG Syafruddin	Junior Lecturer of Fishery Acoustics	UNIV. of HASANUDDIN Jl. Perintis Kemerdekaan UJUNG PANDANG Tel. (0411) 510107
LATUMETEN Jacobus	Junior Lecturer of Fishery Acoustics	UNIV. of PATTIMURA Fac. of Fisheries AMBON
PATTY Wilhelmine	Postgraduate student on Fishery Acoustics (Nantes - France)	

Name	Present Activity	Organism, Address
MUBARAK	Junior Lecturer of Fishery Acoustics	UNIV. of RIAU Fac. of Fisheries Kampus Bina Widya Km. 12.5 PEKAN BARU 28293
LIMBONG Daniel	Doctor, Lecturer on Fishery Acoustics	UNIV. of SAM RATULANGI Dept. of Marine Sc. Education MANADO Tel. (0431) 62486
NAINGGOLAN Chandra	Doctor, Lecturer on Fishery Acoustics	STP (College of Fisheries) P.O. Box 7239/JKPSM Jl. AUP Pasar Minggu JAKARTA Tel. (021) 7805030
GERLOTTO François **PETITGAS Pierre**	Doctor, Fishery Acoustician Doctor, Geostatistician	ORSTOM MONTPELLIER BP 5045 34032 MONTPELLIER Cx 1 Tel (001.33) 67 67 74
PETIT Didier **COTEL Pascal** **LUONG Nicolas** **NUGROHO Duto**	Fishery Acoustican Engineer Acoustician Engineer Junior, Acoustics Biology	ORSTOM PELFISH Jl. Pasir Putih 1 Ancol Timur Jakarta 14430 Tel. (021) 68 98 97

4.2.2. Round table

Institution representatives and invited scientists	
Mr. Vincent DE VISSCHER	Representation of the E.U.
Dr. Fuad CHOLIK	Director, CRIFI
Dr. Fatuchri SUKADI	Director, RIFF
Dr. Nurzali NAAMIN	Director RIMF
Dr. I Gde SEDANA MERTA	Senior Scientist, RIMF
Mr. Edy MULYADI AMIN	Senior Scientist, RIMF
Dr. Bambang EDI PRIONO	Living Resource Management, DGF
Mr. Gomal TAMPUBOLON	Living Resource Management, DGF

ORSTOM Scientists	
Dr. François GERLOTTO	Expert in fishery acoustics who animated the workshop
Dr. Pierre PETITGAS	Expert in Geostatistics

Participants to the workshop	
Dr. Bonar PASARIBU	Senior Lecturer on Fishery Acoustics
Dr. Nyoman ARNAYA	Senior Lecturer of Fishery Acoustics
Mr. Domu SIMBOLON	Junior Lecturer of Fishery Acoustics
Mr. Henry MUNANDAR	Junior Lecturer of Fishery Acoustics
Mr. Syafruddin SIHOTANG	Junior Lecturer of Fishery Acoustics
Mr. Jacobus LATUMETEN	Junior Lecturer of Fishery Acoustics
Mrs. Wilhelmine PATTY	Postgraduate Student on Fishery Acoustics
Mr. MUBARAK	Junior Lecturer of Fishery Acoustics
Dr. Daniel LIMBONG	Lecturer on Fishery Acoustics
Dr. Chandra NAINGGOLAN	Lecturer on Fishery Acoustics

The Pelfish Scientists	
Dr. Jean René DURAND	Director
Dr. Johanes WIDODO	Co-Director
Dr. Didier PETIT	Bio-Acoustician
Mr. Michel POTIER	Biologist
Mr. Bambang SADHOTOMO	Biologist
Dr. Subhat NURHAKIM	Biologist
Mr. Duto NUGROHO	Junior Acoustics Biology
Mr. Nicolas LUONG	Agronomist Engineer
Mr. Pascal COTEL	Acoustician Engineer

4.3. Annex 3 : Cruises, main characteristics

Abbreviations used :

Meteorology	G = good ; M = medium (force 2-3 Sea) ; B = bad (force 3-5 Sea)
Moon	0=new moon ; 1=first quarter ; 2=full moon ; 3 =last quarter
Log, radar, GPS	G = good functioning ; M = average functioning; N = absent or malfunction
Navigation	G = precise positioning ; M = average or occasional positioning, N = estimated positioning without electronic equipment
Engines	G = good (speed around 7 knots) ; M = medium (≈ 6 knots) ; B = bad (≈ 5 knots or less with occasional stops)
Environnement	Y = operational ; N = not operational
Sampling	Y = samples realized ; N = no samples realized
Transect SMG ->	Transit from Semarang to ... / and from ... to Semarang: Matasiri (**Mat**), Masalembo (**Mao**), Bawean (**Baw**), Tambelan (**Tam**), North Semarang (**Nsm**)
Gridding, transect	ND = routes repeated during the day and the night ; N = only one route during the night ; A = only one route during the day and the night
Slope	Y = route along the slope of the continental shelf
PS-PS	O = random route by night from seiner to seiner
Attractions	Number of light attraction realized
TS while anchored	Y = TS measurement made at the anchorage on fish in cage
TS during transect	Y = TS measurement made on the way
Calibration	Y = Equipement calibration
Various	**A/E** = route with illumination phase **Maco** = coastal route around Matasiri **PPS** = positioning of purse seiner **RU** = Attraction under rumpon **BPper** = route around Bawal Putih while attracting by light

Survey	21	22	23	24	25	26	27
Year	1992						
Month	Mar.	May	Jun.	Sep.	Oct.	Nov.	Dec.
Meteorology	G	M	G/M	G	G	G	M
Moon	4	0-1	4	1	0	4	4
VESSEL							
Log	M	M	N	M	M	M	M
Radar	M	M	N	N	G	G	G
GPS	N	N	N	G	G	G	G
Navigation	M	M	M	G	G	G	G
Engines	G	G/M	G	M	G	G	M/B
ENVIRONMENT							
Thermosalino	N	Y	Y	Y	Y	Y	Y
Profiles	N	N	Y	Y	Y	Y	Y
Quantameter	N	N	N	N	N	N	Y
SAMPLING							
Pelagic trawl	N	N	N	N	N	N	N
Bottom trawl	N	N	N	N	Y	Y	Y
Purse Seiner	Y	Y	Y	Y	Y	Y	N
ECHO INTEGRATION							
Transit SMG ->	Mat/Mat	Mat/Mat	Mat/Mat	Mat/Mat	Mao/Mao	Mao/Mat	Mat/Mat
Gridding	2*ND	ND		ND	2*A	A	A
Transect	ND					N	
Slope	A						
PS-PS	0						
Attraction		3				2	2
TS							
Anchored				Y			Y
On the way	Y	Y	Y	Y	Y	Y	Y
CALIBRATION	Y			Y	Y	Y	Y
VARIOUS		A/E	Maco	PPS	PPS	PPS	

Survey	31	32	33	34	35	36	41	42
Year	1993						1994	
Month	Apr.	May	Jun.	Oct.	Nov.	Dec.	Feb.	Apr.
Meteorology	G	B	B	B	G	B	B	G
Moon	0	0	0	O	O	O	O	O
VESSEL								
Log	M	M	M	G	G	G	G	G
Radar	G	G	G	G	G	G	G	G
GPS	G	G	G	G	G	G/N	G	G
Navigation	G	G	G	G	G	G/N	G	G
Engines	M	M	B	G	G	M	B	G
ENVIRONMENT								
Thermosalino	Y	Y	Y	Y	Y	N	Y	Y
Profiles	Y	Y	Y	Y	Y	Y	Y	Y
Quantameter	Y	Y	Y	Y	Y	Y	Y	Y
SAMPLING								
Pelagic trawl	Y	N	Y	Y	Y	Y	Y	Y
Bottom trawl	Y	N	N	Y	Y	Y	Y	Y
Purse Seiner	Y	Y	N	Y	Y	Y	Y	N
ECHO INTEGRATION								
Transit SMG ->	Tam/Tam	Baw/Baw	Baw/Baw	Mat/Mat	Mat/Mat	Mat/Mat	Mat/Mat	Nsm/Ns
Gridding	ND	N		A	N	N/D	A	
Transect				N/D			N/D	N/D
Slope	N		N	Y			Y	
PS-PS				0			0	
Attraction	1	8	1	1	7	5		
TS								
Anchored								
On the way	Y	Y	Y	Y	Y	Y	Y	Y
CALIBRATION						Y		Y
VARIOUS	PPS	RU	BPper	PPS	BPper/RU	RU	PPS	

AGENCY FOR AGRICULTURAL RESEARCH AND DEVELOPMENT
RESEARCH INSTITUTE FOR MARINE FISHERIES

ORSTOM

JAVA SEA PELAGIC FISHERY ASSESSMENT PROJECT

(ALA/INS/87/17)

COMMISSION OF THE EUROPEAN COMMUNITIES

Jalan Pasir Putih I. Ancol Timur. JAKARTA 14430, Indonesia, Tel./Fax. (62.21)-689897

Jakarta 1 August 1995

Dear Reader,

Concerning the report on the Workshop "AKUSTIKAN 1", Scientific and Technical Document No 21, June 1995, the Table 2, page 87, includes an inversion of column. It has to be read as joined. We are sorry for this error...

The Editors

ERRATUM: The Table 2,page 87,has to be changed as follow:

Table 2 : Evaluation table

Survey	34 Night	34 Day	41 Night	41 Day
Squares	120,000	12,000	13,000	4,000
Region	20,454	10,110	7679	4754
Relative error	14.10%	15.00%	13.20%	18.20%
Mean/survey	2576	993	1083	515