EXPLORATORY SCHEME FOR THE RECRUITMENT AND MIGRATION OF THE MAIN PELAGIC SPECIES

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MEDIUM SEINER IN THE PEKALONGAN HARBOR

KAPAL PUKAT CINCIN SEDANG DI PELABUHAN PEKALONGAN

ABSTRACT

In order to obtain the catch frequency length of the species caught by the purse seiners fleet a sampling scheme was set at two main landing places. The present article covers the data collected from December 1991 to December 1993.

In the Java Sea there is a spatial stratification of the fish population, the juveniles staying more inshore than the adults, while the evolution of the average length of the fish caught by the seiners increases from West to East, following a West-East axis. Due to different fishing tactics, the large seiners tend to catch bigger sized-fish than the medium one do.

Dalam rangka mendapatkan komposisi hasil tangkapan berdasarkan species dan panjangnya, dari hasil tangkapan purse seine, cara-cara pengambilan contoh diterapkan pada dua pendaratan utama. Tulisan ini mencakup data yang dikumpulkan dari Desember 1991 sampai dengan Desember 1993.

Terdapat suatu stratifikasi berdasarkan tempat, dimana ikan-ikan muda tinggal lebih dekat ke pantai dari yang dewasa, sedangkan evolusi panjang rata-rata dari ikan-ikan yang tertangkap menunjukkan penambahan dari Barat ke Timur. Karena adanya perbedaan dalam taktik penangkapan, purse seine besar cenderung untuk menangkap ikan yang mempunyai ukuran lebih besar dari pada purse seine sedang.

Dua rekruitment tahunan tampak terjadi dalam perikanan, rekruitment utama terjadi dari Juni sampai Agustus dan rekruitment yang tidak begitu besar timbul pada periode musim Barat daya.

INTRODUCTION

The pelagic fishery in the Java Sea has developed sharply specially after the spreading of the purse seines in the 1970s. Improvement of the fishing boats design as well as changes in the fishing tactics have marked this development (Nurhakim *et al.*, 1987; Boely *et al.*,1992). The need of assessment (*e.g.*. equilibrium yield) for fishery regulation is obvious and it becomes very important to determine the regulatory scheme. Values of the maximum equilibrium yield have been estimated by investigators using landing statistics and other official data until 1976. After that the National Statistical data base collection system had been introduced .

The results tend to the conclusion that the maximum equilibrium yield is close to the highest catch used in the analysis (SCS, 1979; Sujastani, 1978). An attempt to use the same method with longer series of data without any modification will face some constraints due to the change of fishing pattern and the inter-annual variation of abundance in the Java Sea (Sadhotomo and Widodo, 1992).

The second approach, so called analytical model of Beverton and Holt (1957) includes biological population aspects and can give optimal values of the fishing mortality as well as other figures or parameters such as an average length at first capture. This model or others based on age structure based models can also be used with length structure, as it has been

done by Widodo (1988) and Nurhakim (1993) for respectively *Decapterus spp.* and *Rastrelliger kanagurta* . Nevertheless, when one applies the model it is impossible to include some phenomena (*e.g.* inter-annual change of environmental characteristics) or other disturbances that cannot be explicitly measured. We believe these latent characteristics could eventually make the assumptions underlying the model invalid.

The purpose of our analysis is to briefly illustrate the nature of the length composition data of the main pelagic species in the Java Sea, to see the insight of the data and the possibility to apply the data to suitable models.

1. MATERIAL AND METHODS

A length frequency sampling was carried out in Pekalongan and Juwana harbors as part of the operation of the project. The procedures have been described in details by Boely *et al.* (1990) and Potier and Sadhotomo (1991). The sampling scheme aims to get the most accurate data of length frequency, the species composition in the samples, as well as the statistical data. The compilation and study of these sets of data give the structure of the catch at length which will serve as input data to some model analysis for pelagic fish stock assessment in the Java Sea.

The length frequency data of the six main pelagic species sampled from December 1991 to December 1993 are used in the analysis. Informal exploratory data analysis such as simple summary of the data and graphical presentation are applied in order to interpret these data.

2. RESULTS AND DISCUSSION

2.1 Summary of length composition and migration

We use descriptive techniques, such as average length, as summary and histogram to indicate the central tendency and the shape of the length frequency distribution. We present the monthly evolution of average length to show the general tendency of geographic distribution by size (fig. 1 and 2).

As seen in that figure, the average size tends to increase following a "West-East axis". It can be shown that the average size for the six species from the Karimunjava samples is generally lower than those from Lumu-lumu (Makassar Strait). Young fishes enter the fishery, first in the West part of the Java Sea (*i.e.* Karimunjava Islands and coastal waters North of the central part of Java) from May to August (fig. 2a, p.17).

In this case the average size represents all cohorts. We present a rough average size estimation of the first (youngest) and the second cohorts (modes of distribution) of *D. russelli, D. macrosoma, R. kanagurta* and *A. sirm.* Based on the appearance of the young fishes, we determine three recruitment patterns (fig. 3 and 4). To clarify further explanation, we name "major young cohort" the young fish entering the fishery in June-August and "minor young cohort" the fish entering at other periods. The first one is the

type of *D. macrosoma* and *A. sirm*, for which young fishes only appear during June-August. For the second one, young fishes appear during the June-August period and during the North-West monsoon, as shown by *D. russelli* and *R. kanagurta*. In the third type, the appearance of minor ones occurs more than once a year while the major one appears during the June-August period. *S. crumenophthalmus* is an example for the last type. All pelagic fishes of this type are coastal inhabitants of which the seiner fishery never covers the entire distribution in the Java Sea waters. For this reason, we do not discuss it any further.

Assuming that the average age of the recruits is around six months, it can be indicated that the major recruitment originally comes from September-December spawning periods. On the other hand, the minor recruitment of *D. russelli* and *R. kanagurta* which occurs during the North-West monsoon period may result from spawning from March to July.

These recruits entered the fishery in the West part of the Java Sea (*i.e.* the North coast of Central Java and Karimunjava Islands in 1991 and 1992) while in 1993, they enter it in the Central part of the Java Sea (*i.e.* Bawean and Masalembo waters). However, these recruits never fully enter the fishery at that age, but sometimes at older ages. This is one of the reasons why some length classes are missing in the length distribution for some cohorts.

For all species, particularly for oceanic ones, the catch is made on part of the stocks, and more than 50% of it consists of immature fish. This may be attributed to the highly migratory behavior of the pelagic species. No data has been collected outside the fishing grounds of the seiners fleet, such as Flores Sea or the deepest part of the Java Sea (*i.e.* near the continental slope). Thus the hypothesis cannot be confirmed yet.

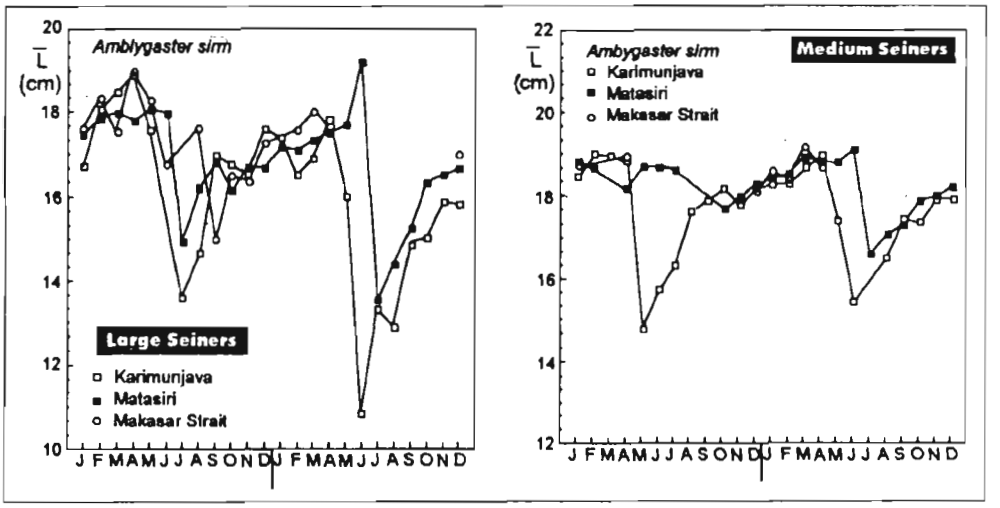
Meanwhile, cruises carried out by RIMF (Research Institute for Marine Fisheries) last year found the same species (*i.e. D. russelli, D. macrosoma* and *R. kanagurta*) caught by small ring nets (local name : "**gae**") in South-East Sulawesi in August and October. The fishing season occurs at the same period as in the Makassar strait waters for large seiners. The difference in length of adult fishes born during different spawning seasons is small and not obvious. An attempt to trace such cohorts will be difficult except if age data are available.

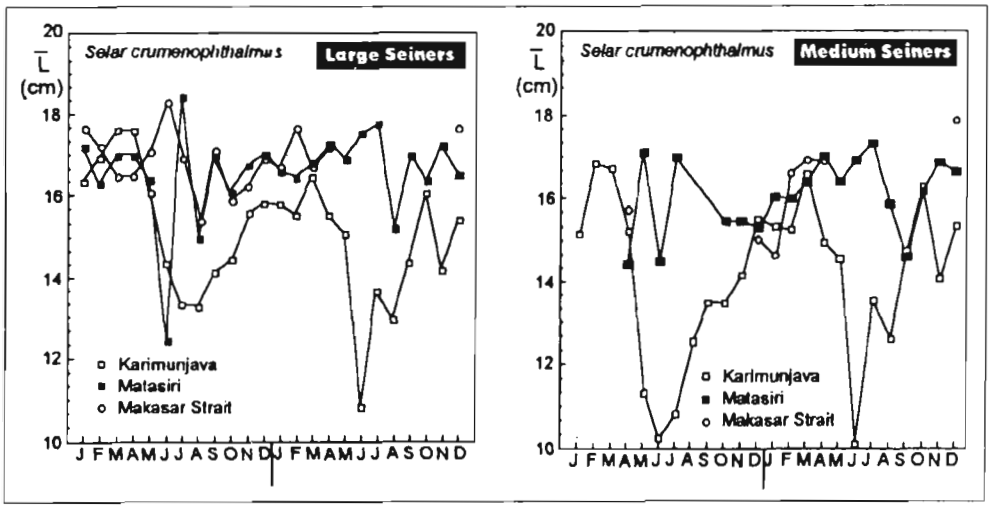
Change in occurrence for juveniles of oceanic species may be caused by the change in surface salinity profile in the Java Sea. High rainfall which occurred during 1993 can explain the pattern of recruitment for that year. During the peak season (September-November), when prevailing winds and currents come from the South-East, the range of the fish size is narrower than the previous quarter, when more oceanic species such as *D. macrosoma* dominate in the catch composition of the seiners. For instance, we can notice, the narrow range of length class of *A. sirm* that is found in almost all the samples.

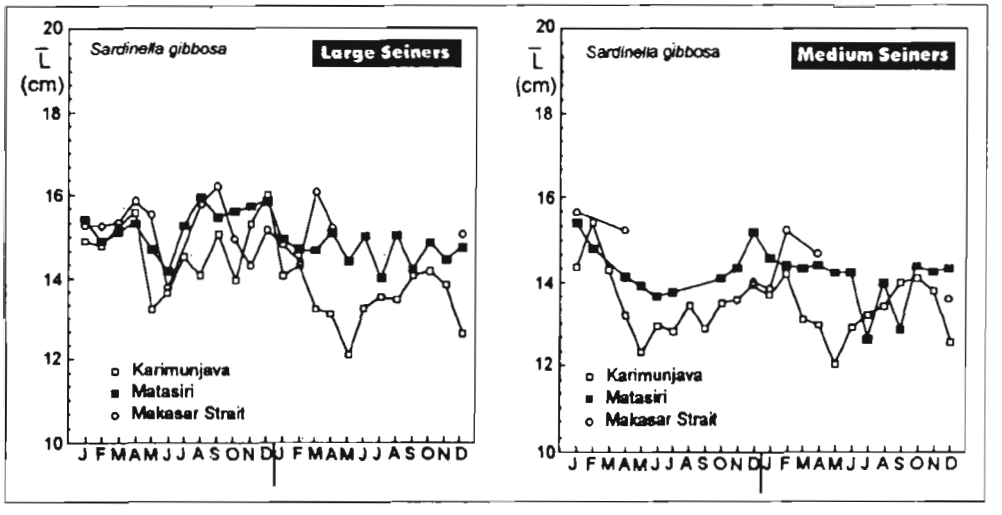
Figure 1

MONTHLY EVOLUTION OF THE JAVA SEA MAIN PELAGIC SPECIES AVERAGE LENGTH ($\bar{L}$, CM) FOR 1992-1993

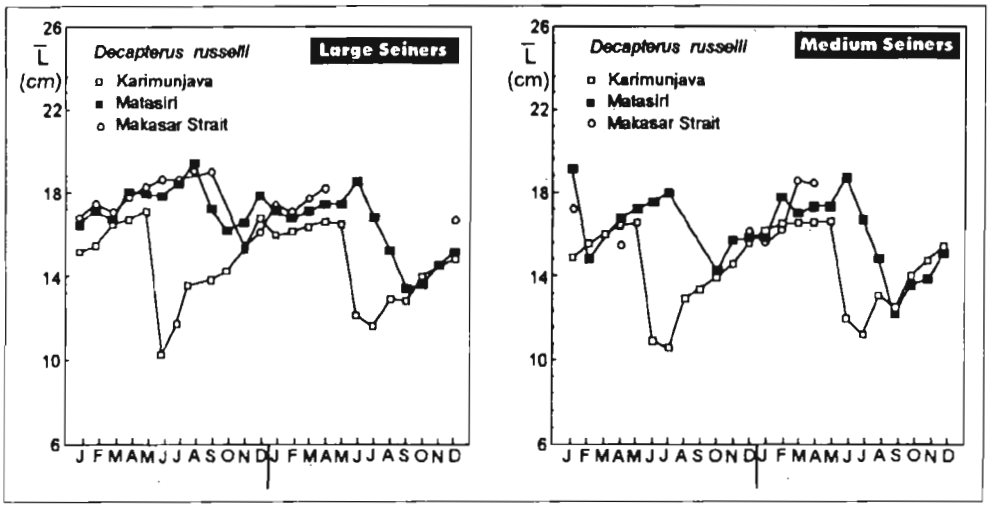
EVOLUSI BULANAN DARI PANJANG RATA-RATA IKAN PELAGIS KECIL DI LAUT JAWA ($\bar{L}$, CM) UNTUK 1992-1993

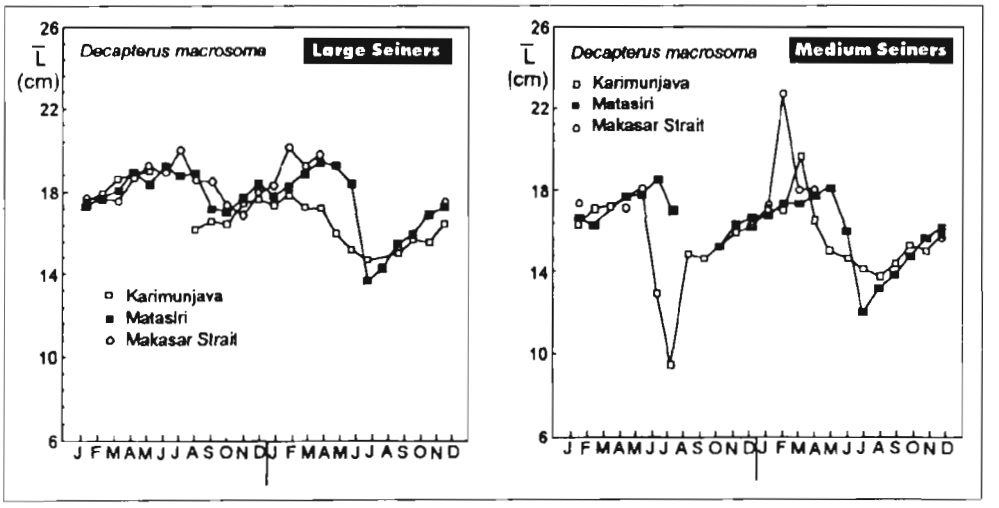






Exploratory Scheme for the Recruitment and Migration of the main Pelagic Species


Decapterus russelli
Large Seiners
Karimunjava
Matasiri
Makasar Strait
Decapterus russelli
Medium Seiners
Karimunjava
Matasiri
Makasar Strait
L̄ (cm)
26
22
18
14
10
6
J F M A M J J A S O N D J F M A M J J A S O N D


Decapterus macrosoma
Large Seiners
Karimunjava
Matasiri
Makasar Strait
Decapterus macrosoma
Medium Seiners
Karimunjava
Matasiri
Makasar Strait
L̄ (cm)
26
22
18
14
10
6
J F M A M J J A S O N D J F M A M J J A S O N D

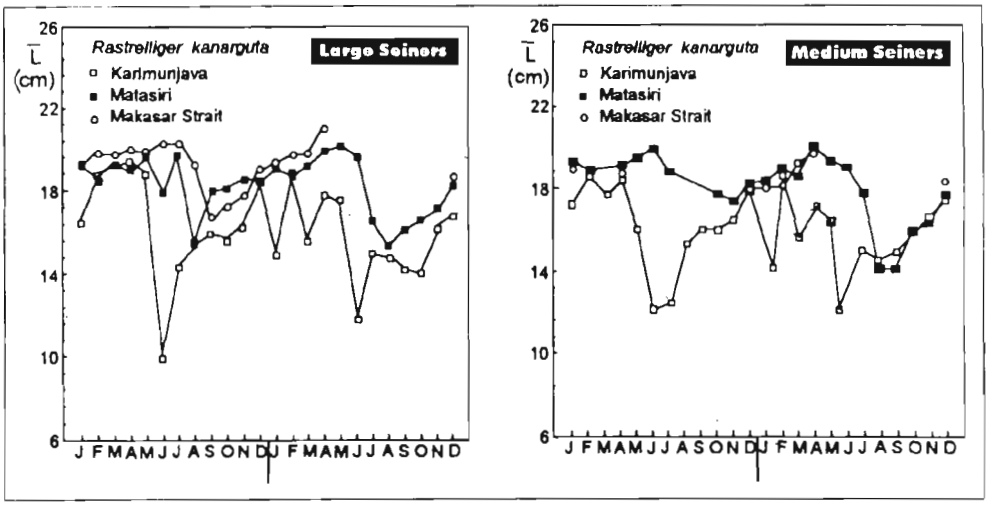

Rastrelliger kanarguta
Large Seiners
Karimunjava
Matasiri
Makasar Strait
Rastrelliger kanarguta
Medium Seiners
Karimunjava
Matasiri
Makasar Strait
L̄ (cm)
26
22
18
14
10
6
J F M A M J J A S O N D J F M A M J J A S O N D

Figure 2 (left page)

MONTHLY EVOLUTION OF THE JAVA SEA MAIN PELAGIC SPECIES AVERAGE LENGTH ($\bar{L}$, CM) FOR 1992-1993

EVOLUSI BULANAN DARI PANJANG RATA-RATA IKAN PELAGIS KECIL DI LAUT JAWA ($\bar{L}$, CM) UNTUK 1992-1993

For all species the appearance of the same length class every month during the year can be interpreted as a result of the spatial distribution pattern and differences among ecological needs between juveniles and adults due to the prolonged major spawning season or to the existence of a minor spawning season.

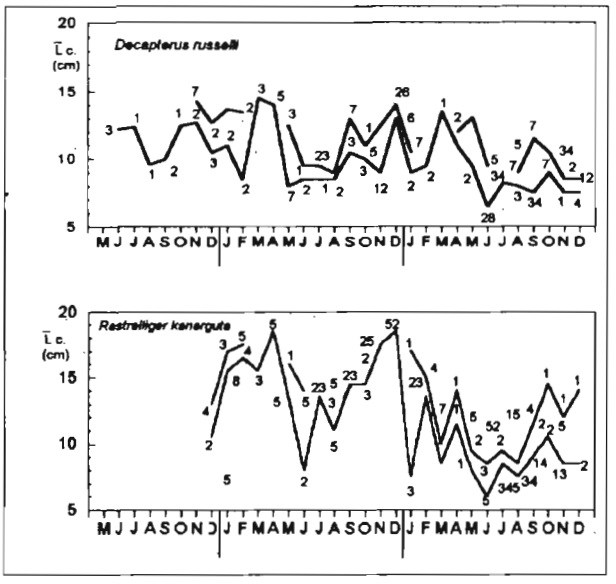


Figure 3

MODAL EVOLUTION OF THE YOUNGEST COHORT FOR *D. RUSSELLI* AND *R. KANAGURTA*

EVOLUSI DARI MODUS KELOMPOK UMUR YANG TERMUDA DARI *D. RUSSELLI* DAN *R. KANAGURTA*.

1 = North coast of Central Java
2 = Karimunjava
3 = Bawean
4 = Masalembo
5 = Matasiri
6 = Makassar Strait
7 = Kangean

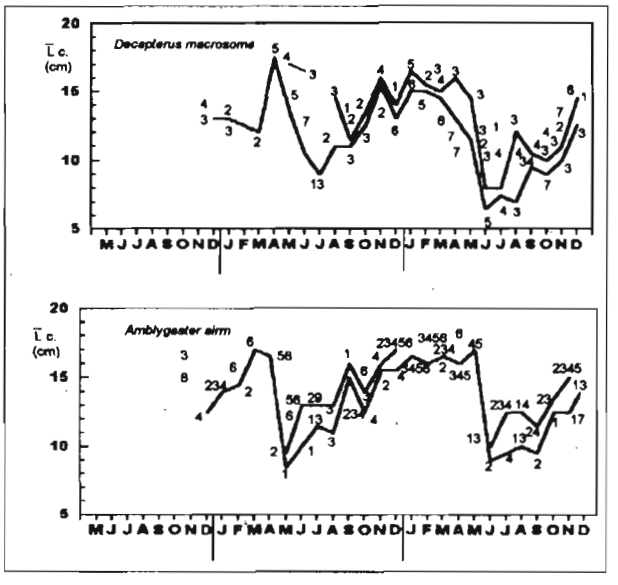
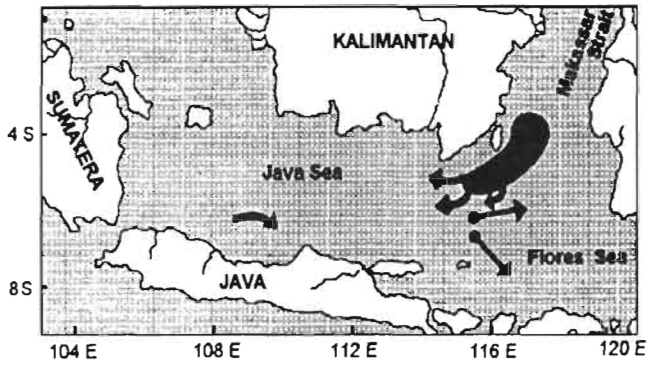


Figure 4

MODAL EVOLUTION OF THE YOUNGEST COHORT FOR *D. MACROSOMA* AND *A. SIRM*

EVOLUSI DARI MODUS KELOMPOK UMUR YANG TERMUDA DARI *D. MACROSOMA* DAN *A. SIRM*.

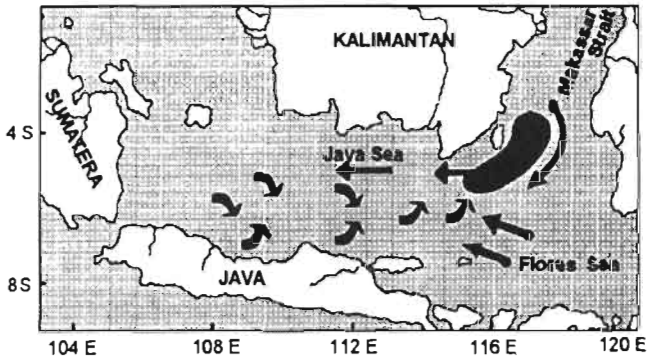
1 = North coast of Central Java
2 = Karimunjava,
3 = Bawean
4 = Masalembo
5 = Matasiri,
6 = Makassar Strait
7 = Kangean



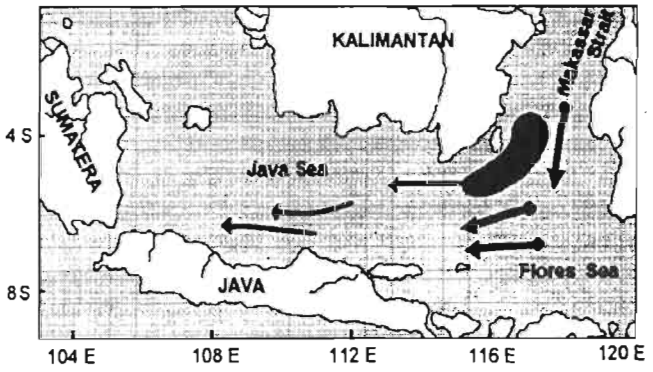
Quarter 1 : *March-May*

Spawning grounds

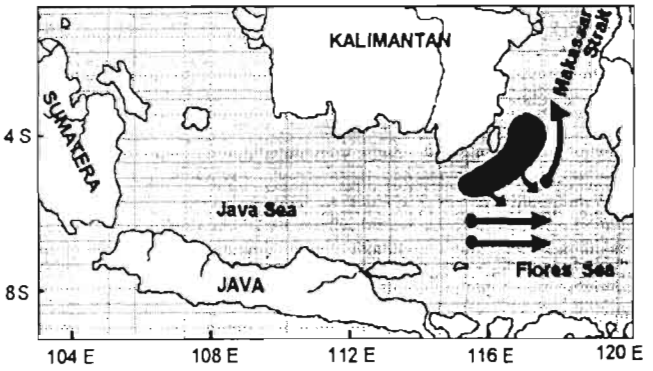
Direction of the migrations



Quarter 2 : *June -August*



Quarter 3 : *September-November*



Quarter 4 : *December-February*

Figure 5

MOVEMENT OF FISH "TYPE ONE" (*D. MACROSOMA* AND *A. SIRM*) IN THE JAVA SEA

PERGERAKAN DARI IKAN-IKAN "TIPE SATU" (*D. MACROSOMA* DAN *A. SIRM*) DI LAUT JAWA

Based on these informations, the hypothetical movement of the fish in the Java Sea would be as follows (fig. 5 and 6):

Quarter 1: March-May

- TYPE 1: *D. MACROSOMA* AND *A. SIRM*
  a. Minor spawning probably still occurs around Masalembo and Matasari
  b. Emigration of adult fish to the Flores Sea and Makassar Strait, or disperse migration in the Java Sea
  c. Minor recruitment in the West part of the Java Sea
- TYPE 2: *D. RUSSELLI* AND *R. KANAGURTA*
  a. Minor spawning probably occurs around Masalembo, Matasiri and Karimunjava
  b. Same pattern as Type 2, point b.

Quarter 2: June-August

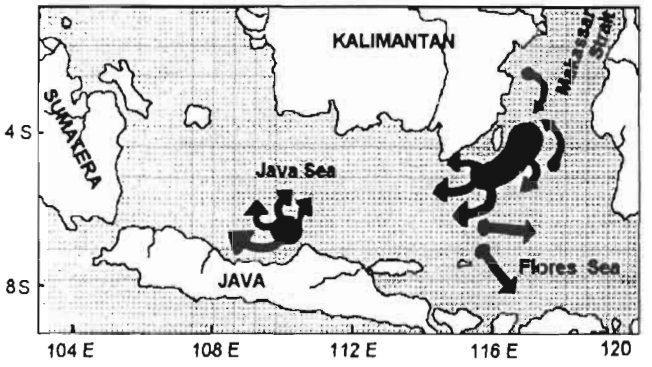
- TYPE 1.
  a. Major recruitment
  b. Immigration from the Flores Sea
  c. Minor spawning
- TYPE 2. Same as Type 1.

Quarter 3: September-November

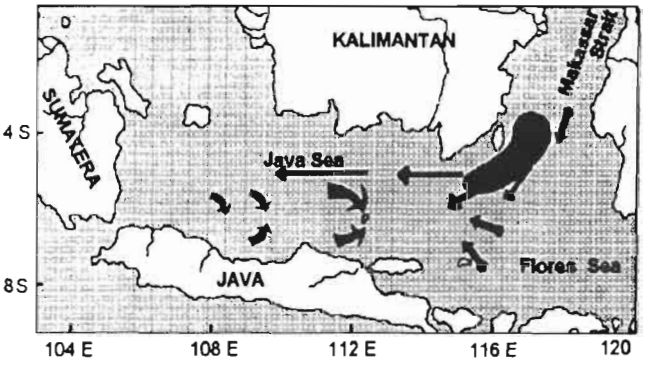
- TYPE 1
  a. Immigration from the Flores Sea
  b. Major spawning
- TYPE 2
  a. Same as above
  b. Minor spawning
  c: Beginning of minor recruitment in the East part of the Java Sea (November)

Quarter 4: December-February

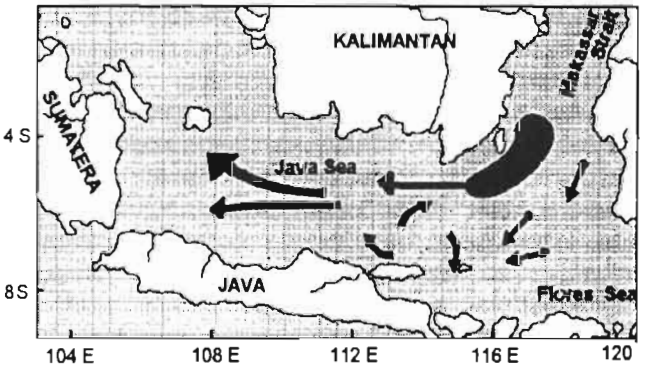
- TYPE 1
  a. Emigration to the Flores Sea
  b. Major spawning in the East part of the Java Sea
- TYPE 2
  a. Emigration to the Flores Sea
  b. Major Spawning in the East part of the Java Sea
  c. Minor recruitment in the West and East parts of the Java Sea



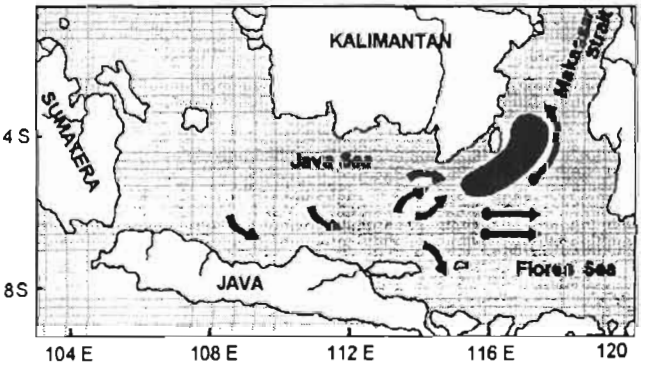
Quarter 1 : *March-May*



Quarter 2 : *June -August*



Quarter 3 : *September-November*



Quarter 4 : *December-February*

Figure 6

MOVEMENT OF FISH "TYPE TWO"(*D. RUSSELLI* AND *R. KANAGURTA*) IN THE JAVA SEA

PERGERAKAN DARI IKAN-IKAN "TIPE DUA" (*D. RUSSELLI* DAN *R. KANAGURTA*) DI LAUT JAWA

2.2 Average size of the catch

To clarify the background we decided to smooth the presentation of the data from a monthly to a quarterly basis by setting June-August period as a quarter. Also, this way enabled us to reduce errors caused by the differences in fishing dates of the sampled boats and gave a more real biological description.

We apply this procedure on the six species caught by the two types of seiners. Length at which the cumulative catch reaches 50 % is determined from the graph. Proximity values are presented in annex I.

Fifty per cent of the seiners catch consist of juveniles approximately less than one year old and still immature. The low values of the probability of capture are mainly caused by two factors.

- First, the entering of a huge recruitment occurs in the fishery from June to August which significantly influences the shape of the distribution.
- Second, the presence of young fish from June to December 1993, probably caused by changes in the salinity profile in the Java Sea.

This method gives rough estimates because some graphs are plotted from a mixture or asymmetric distribution data. Nevertheless, the non gaussian type of the distribution is believed to be the real one and is found in nature. Statistically, the polymodal distribution would raise some problems in estimation, but, in the context of the application to Virtual Population Analysis model those can be ignored.

Due mainly to fishing tactics the large seiners catch bigger fish than the medium seiners do.

CONCLUSION

The spatial distribution of the size of the main pelagic species in the Java Sea is related to hydrographic conditions and to life cycle of the species. The gradient observed in the average size is related to physiological characteristics common to almost all pelagic species. If fishermen knew this pattern and would not select the size of fish in fishing grounds, the length composition would represent the length composition of the population in the sea.

The boundaries of the stocks units, at least for the oceanic pelagic species caught in the Java Sea, extend eastward beyond the Java Sea until South-East Sulawesi.

However, to apply the analytical model with the catch at length, the total number of the same unloaded species, from fisheries exploiting the same stocks outside and inside the Java Sea, should be considered.

Annex I (next pages)

LENGTH (FL : FIRST LENGTH) PROXIMATE AT 50 % OF THE PROBABILITY OF CAPTURE
DUGAAN PANJANG PADA PELUANG 50% TERTANGKAP

Left page :

Top *: Decapterus russelli,* ***Middle*** *: Decapterus macrosoma,* ***Bottom*** *: Rastrelliger kanagurta*

Right page :

Top *: Amblygaster sirm,* ***Middle*** *: Selar crumenophthalmus,* ***Bottom*** *: Sardinella gibbosa*

SEINERS TYPE	LARGE			MEDIUM		
ZONES	JAVA SEA	MAKASSAR STRAIT	SOUTH CHINA	JAVA SEA	MAKASSAR STRAIT	SOUTH CHINA .
QUARTERS						
Dec.91-Feb.92	14.50	15.75	-	14.25	15.75	-
Mar.92-May92	16.00	17.50	15.00	15.20	14.75	-
Jun.92-Aug.92	13.50	18.25	16.30	12.30	-	-
Sep.92-Nov.92	14.50	17.75	-	13.50	-	-
Dec.92-Feb.93	15.75	15.75	15.75			
Mar.93-May 93	16.25	16.75	16.00	15.75	17.25	12.75
Jun.93-Aug.93	12.50	-	15.25	11.75	-	16.50
Sep.93-Nov.93	12.75	-	13.75	12.75	-	12.25

SEINERS TYPE	LARGE			MEDIUM		
ZONES	JAVA SEA	MAKASSAR STRAIT	SOUTH CHINA	JAVA SEA	MAKASSAR STRAIT	SOUTH CHINA .
QUARTER						
Dec.91-Feb.92	15.75	16.20	-	15.75	16.75	-
Mar.92-May92	17.00	17.75	15.00	16.75	16.75	-
Jun.92-Aug.92	13.75	18.75	15.00	12.75	-	14.30
Sep.92-Nov.92	15.75	15.50	-	14.75	-	-
Dec.92-Feb.93	16.75	16.75	15.75	16.75	17.00	-
Mar.93-May 93	17.60	17.75	13.75	16.25	17.60	14.25
Jun.93-Aug.93	12.75	-	15.50	12.00	-	13.50
Sep.93-Nov.93	15.25	-	14.25	14.75	-	13.75

SEINERS TYPE	LARGE			MEDIUM		
ZONES	JAVA SEA	MAKASSAR STRAIT	SOUTH CHINA	JAVA SEA	MAKASSAR STRAIT	SOUTH CHINA .
QUARTERS						
Dec.91-Feb.92	18.00	19.25	-	17.75	18.75	-
Mar.92-May 92	18.75	19.75	16.75	17.75	17.75	-
Jun.92-Aug.92	15.40	20.00	18.70	12.50	-	14.75
Sep.92-Nov.92	17.75	17.75	-	16.50	-	-
Dec.92-Feb.93	18.50	18.75	18.60	17.75	17.75	20.25
Mar.93-May 93	18.85	19.70	18.00	18.20	19.00	18.00
Jun.93-Aug.93	14.25	-	16.30	14.00	-	16.00
Sep.93-Nov.93	16.00	-	14.50	15.50	-	14.50

SEINERS TYPE	LARGE			MEDIUM		
ZONES	JAVA SEA	MAKASSAR STRAIT	SOUTH CHINA	JAVA SEA	MAKASSAR STRAIT	SOUTH CHINA .
QUARTERS						
Dec.91-Feb.92	17.00	17.60	-	17.20	16.75	-
Mar.92-May 92	17.60	17.80	17.00	16.50	17.50	-
Jun.92-Aug.92	15.20	17.20	15.60	11.75	-	14.50
Sep.92-Nov.92	16.00	16.20	-	15.50	-	-
Dec.92-Feb.93	16.75	17.00	16.50	16.25	16.10	16.25
Mar.93-May 93	17.00	17.20	16.50	16.85	16.70	16.60
Jun.93-Aug.93	12.75	-	16.00	12.50	-	15.50
Sep.93-Nov.93	15.50	-	15.00	15.00	-	14.90

SEINERS TYPE	LARGE			MEDIUM		
ZONES	JAVA SEA	MAKASSAR STRAIT	SOUTH CHINA	JAVA SEA	MAKASSAR STRAIT	SOUTH CHINA .
QUARTERS						
Dec.91-Feb.92	15.90	17.00	-	16.00	14.25	-
Mar.92-May92	16.50	16.00	11.80	14.30	14.90	-
Jun.92-Aug.92	13.75	17.75	13.00	9.75	-	8.75
Sep.92-Nov.92	15.00	15.50	-	13.50	-	-
Dec.92-Feb.93	15.50	16.40	15.60	14.50	15.60	16.50
Mar.93-May93	16.10	16.10	15.90	15.80	16.10	16.10
Jun.93-Aug.93	11.35	-	12.40	11.20	-	11.30
Sep.93-Nov.93	14.30	-	12.25	14.25	-	13.20

SEINERS TYPE	LARGE			MEDIUM		
ZONES	JAVA SEA	MAKASSAR STRAIT	SOUTH CHINA	JAVA SEA	MAKASSAR STRAIT	SOUTH CHINA .
QUARTERS						
Dec.91-Feb.92	14.25	14.75	-	14.20	14.25	-
Mar.92-May 92	14.20	14.75	14.65	12.25	14.50	-
Jun.92-Aug.92	14.20	13.30	14.75	12.50	13.75	-
Sep.92-Nov.92	14.70	14.15	-	13.10	-	-
Dec.92-Feb.93	14.20	14.20	15.00	13.75	13.70	12.50
Mar.93-May93	12.60	14.75	11.80	12.15	14.00	11.60
Jun.93-Aug.93	13.20	-	14.20	13.00	-	-
Sep.93-Nov.93	13.70	-	13.75	13.70	-	13.75

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