

# EXPLOITATION OF THE LARGE AND MEDIUM SEINERS FISHERIES

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REPAIRING THE NET

MENJURAI DAN MEMPERBAIKI JARING



## ABSTRACT

Since the trawl ban in 1980 pelagic species are the main resources exploited in the Java Sea by numerous fisheries. Among those the purse-seine fisheries are the main ones. The large and medium seiners located in the province of Central Java are heavily involved in this exploitation. The fleets consisting of wooden vessels prospect the Java Sea, the Makassar Strait and the southern part of the South China Sea.

Pekalongan and Juwana are the main centers where 70% of the vessels gather and 90% of the catch is landed. If the activity in Pekalongan is

**Exploitation of the Large and Medium Seiners Fisheries**



high since 1976 it is new in Juwana and related to the displacement of the main fishing grounds to the eastern part of the Java Sea.

Since 1979, the landing of the seiners has increased four times reaching 155 000 tons in 1992. Among the thirty species caught by the seiners seven species form 90% of the landings. Two species of scads are the main targets of the exploitation and represent up to 60% of the catch. Mackerels, sardines and big eyes scads are the other species caught in great number by the seiners. Their importance in the landings varies according to the years. These species are part of different populations with different ecological needs. According to the environment and the geographic location of the catch, they are more or less exploited by the seiners. The fishing pressure is high on the coastal and neritic populations and lower on the oceanic populations. Modelization of these resources is difficult as some parameters are still lacking.

*Sejak larangan trawl pada tahun 1980, ikan-ikan pelagis adalah sumber daya utama yang diusahakan di Laut Jawa, dimana sumber daya tersebut diusahakan oleh bermacam-macam alat tangkap. Diantara alat tangkap yang ada, purse seine merupakan alat tangkap utama. Purse seine besar dan sedang yang berada di Propinsi Jawa Tengah mempunyai peranan yang paling penting didalam perusahaan sumber daya tersebut. Armada purse seine terdiri dari kapal kayu yang beroperasi di seluruh Laut Jawa, Selat Makassar dan bagian Selatan Laut Cina Selatan. Pekalongan dan Juwana merupakan pusat dari penangkapan purse seine, 90% dari hasil tangkapan didaratkan disana dan 70% dari kapal-kapal purse seine berasal dari Pekalongan dan Juwana. Kegiatan di Pekalongan sangat tinggi sejak tahun 1976, sedangkan di Juwana berkembang belum lama setelah daerah penangkapan bergeser lebih ke Timur Laut Jawa.*

*Sejak tahun 1979 ikan yang didaratkan oleh purse seine mencapai 155.000 ton pada tahun 1992. Diantara tiga puluh species yang tertangkap, 7 species diantaranya merupakan 90% dari hasil tangkapan yang didaratkan. Dua species ikan layang merupakan tujuan penangkapan dan mencapai 60% dari hasil tangkapan. Banyar, Siro dan Bentong merupakan species lain yang tertangkap cukup banyak oleh purse seine. Berdasarkan tahun, jumlah masing-masing species yang tertangkap sangat bervariasi.*

*Species-species tersebut merupakan bagian dari populasi yang berbeda yang mempunyai kebutuhan ekologi yang berbeda. Berdasarkan keadaan lingkungan dan lokasi geografi dari pada hasil tangkapan, mereka lebih banyak tertangkap oleh purse seine. Tekanan penangkapan lebih besar di daerah pantai dan populasi neritik dari pada populasi yang bersifat oseanik. Modelisasi dari sumber daya tersebut adalah tidak mudah, sepanjang beberapa parameter belum diketahui.*

## INTRODUCTION

Since the trawl ban in 1980, pelagic species are the main resources exploited in the Java Sea. Their exploitation by artisan fisheries is very old and has an important socio-economic impact on the islands bordering that sea. First limited to onshore resources of the North coast of the Java Island, the exploitation extended offshore since the implementation of the purse seine.

The purse seine was introduced in the Java Sea in order to have a longer fishing period and a higher catch than with the traditional nets. It spreads out quickly and the seiners were able

to extend their exploitation area outside the Java Sea in order to free themselves from the high seasonal fluctuations of the catch occurring there. The exploitation of the resource by the large purse seiners is now twenty years old and during this period many changes occurred.

The fishery is not a static but a dynamic system which quickly reacts to internal and external changes. In 1987 smaller seiners coming from the Pekalongan harbor entered the fishery. The geographic distribution of pelagic is such that the mini, medium and large seiners are now exploiting same or overlapping populations. This is why in the statistics analysis on large and medium seiners the data collected on other fisheries has also to be taken into account.

## 1. MATERIAL AND METHODS

Accurate data has been available since 1979. Before that year a lack of accuracy in the national system or the implementation lag of the sampling scheme proposed by FAO in 1976 did not allow to have reliable data. Since 1985 with the beginning of the cooperation between ORSTOM (French Institute for Research and Development in Cooperation) and BPPL (Indonesian Research Institute for Marine Fisheries) a sampling scheme for the collect of data coming from the large seiners fishery has been set in the different landing places. The catch and effort are now known by fishing ground and by commercial category.

Since the Java Sea Pelagic Fishery Assessment Project started in May 1991 the sampling scheme has been improved. Catch is known by species and by fishing ground. Effort data is collected from the fishing port administration of Pekalongan where entries and exits of the seiners are registered. At other landing places the effort estimation is derived from enquiries on board of the seiners during every landing. Such data has been available since mid-1984.

**Table 1**

DEFINITIONS OF THE DIFFERENT CATEGORIES REFERRING TO DIVERSE SOURCES

PENJELASAN DARI BEBERAPA KATEGORI YANG BERBEDA BERDASARKAN BEBERAPA SUMBER

STATISTICAL	LANDING PLACES	SIZE CATEGORIES	SPECIES
Layang	Layang	Unyir = very small Bloco = small Layang = standard Korok = big	<i>Decapterus russelli</i> <i>macrosoma</i>
Lemuru	Siro		<i>Amblygaster sirm</i>
Kembung	Kembung	Kemari = small Kembung = standard	<i>Rastrelliger brachysoma</i>
	Banyar	Kemari = small Banyar = standard	<i>Rastrelliger kanagurta</i>
Tembang	Tanjan - Juwi		<i>Sardinella gibbosa</i> <i>lemuru</i> <i>fimbriata</i>
Selar	Bentong	Mandring = small Bentong = standard	<i>Selar crumenophthalmus</i>
	Selar	Selar = standard Como = big	<i>Selaroides leptolepis</i> <i>Atule mata</i> <i>Aleppes djeddaba</i>
Lain-lain	Campuran		Mixed species

## 2. EXPLOITED SPECIES

The Javanese seiners catch around thirty pelagic and semi-pelagic species. Eleven of these species form 90% of the landings. According to official statistics, these eleven species are gathered in five statistical categories. In the different landing places the names of these categories are replaced by local names related to species and size (tab. I).

## 3. FLEETS

The large seiners fleet is the oldest to use the seine net in the Java Sea. The number of fishing vessels increased from 1979 until 1985 when the fleet reached 520 units. In 1987 and 1988, the number of large seiners drastically decreased. Despite the construction of many new vessels in the last years the number of seiners, with 357 units in activity in 1992 (fig. 1), is still far from the 1985 figure. This fleet represents 61% of the whole seiners in activity in the province of Central Java .

Medium seiners appeared in 1987 and their number slightly increased until 1991. In 1992, with new investors, the fleet quickly expanded and reached 232 units (fig. 1).

These two well distinct fleets with different vessels and fishing strategies tend to overlap each other. Since 1979, size, horse power (fig. 2) and fish hold capacity have increased. This evolution linked with a better fishing efficiency (fig. 3) allowed the exploitation located in the traditional Javanese fishing grounds to extend to the eastern part of the Java Sea, to the Makassar Strait and to the South China Sea. In 1992, we can assess three segments (fig. 3) exploiting different fishing grounds in the fishery :

**Table II**

SEINERS LANDINGS IN THE DIFFERENT LANDING PLACES OF THE FISHERY FROM 1979 TO 1992

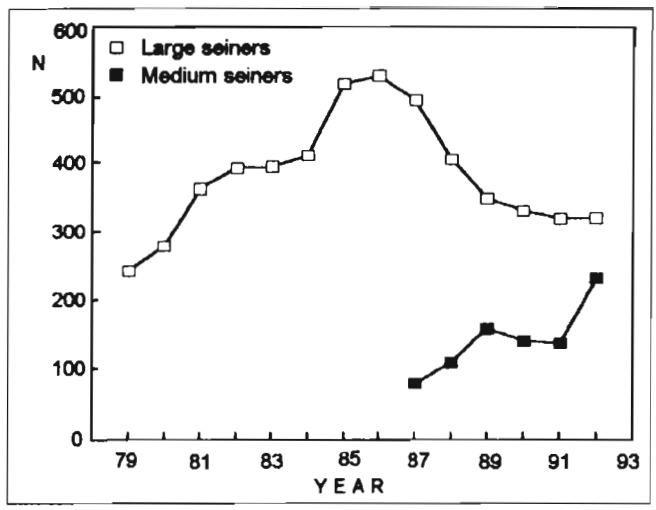
PENDARATAN PURSE SEINE PADA TEMPAT PENDARATAN IKAN YANG BERBEDA DARI TAHUN 1979 SAMPAI DENGAN TAHUN 1992

YEAR	TEGAL	PEKALONGAN	BATANG	JUWANA	REMBANG
1979	8 100	21 200	12 100		3 200
1980	9 100	24 300	8 400		4 400
1981	8 600	21 700	4 900		3 200
1982	12 500	28 300	4 400		4 700
1983	16 100	45 100	4 700		9 100
1984	11 500	49 800	5 500	6 400	7 100
1985	13 500	67 600	11 900	15 700	8 600
1986	11 700	63 300	8 800	20 600	3 800
1987	10 100	45 100	2 400	18 500	1 200
1988	9 200	41 400	1 400	13 300	
1989	12 600	56 800	600	22 200	
1990	13 000	57 500	1 000	27 000	
1991	13 700	74 300	600	33 400	1 700
1992	16 000	86 000	400	47 300	5 100

**Figure 1 (top)**

EVOLUTION OF THE NUMBER OF LARGE AND MEDIUM SEINERS UNITS BETWEEN 1979 AND 1992

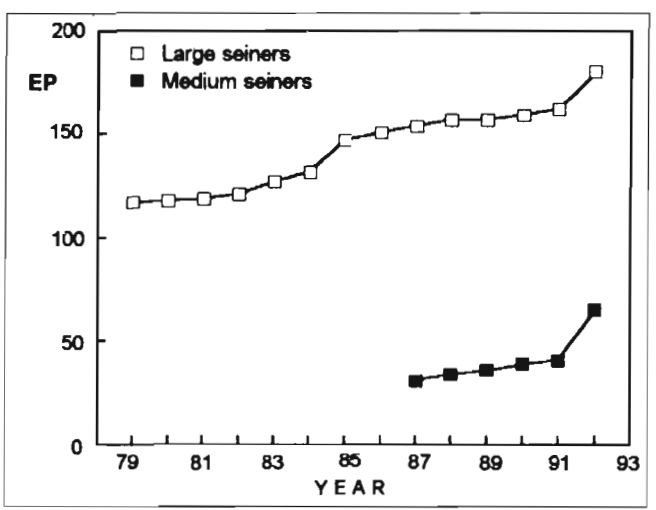
EVOLUSI NOMOR PURSE SEINE BESAR DAN SEDANG DARI TAHUN 1979 SAMPAI DENGAN TAHUN 1992



**Figure 2 (middle)**

EVOLUTION OF THE LARGE AND MEDIUM AVERAGE ENGINE POWER (EP, HORSE POWER) BETWEEN 1979 AND 1992

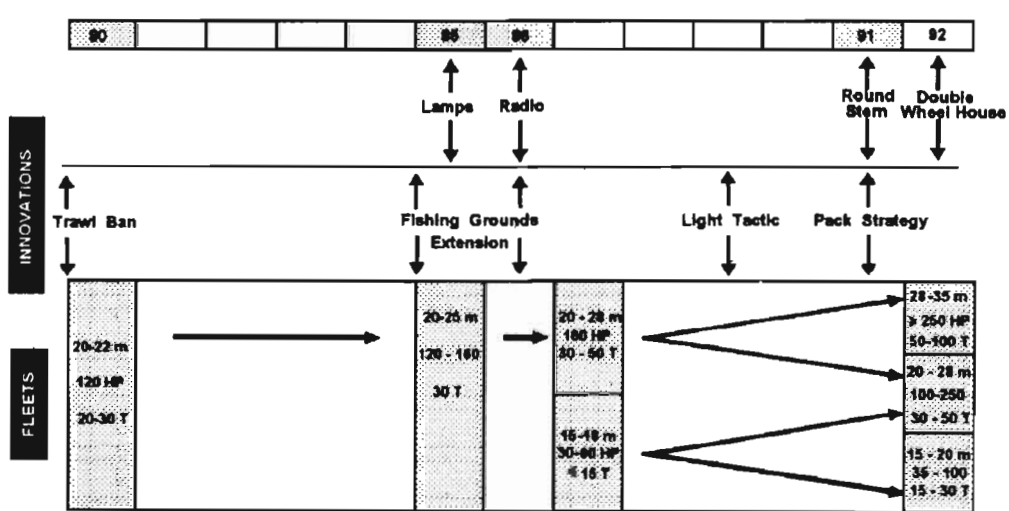
EVOLUSI PURSE SEINE BESAR DAN SEDANG, RATA-RATA "HP" DARI TAHUN 1974 SAMPAI DENGAN TAHUN 1992



**Figure 3 (bottom)**

TECHNICAL INNOVATIONS AND FLEET EVOLUTION WHICH OCCURRED IN THE SEINERS FISHERIES BETWEEN 1980 AND 1992

EVOLUSI INOVASI TEKNIK DAN ARMADA PURSE SEINE DARI TAHUN 1980 SAMPAI DENGAN TAHUN 1992

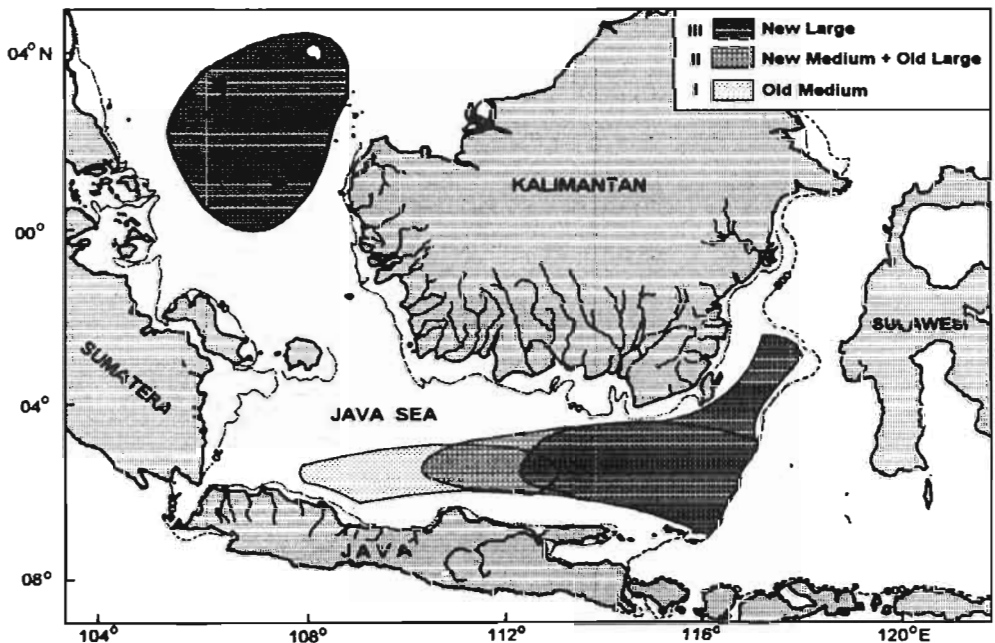


- The first one which exploits the traditional fishing grounds of the Javanese fishermen consists of the old medium seiners (15-18 meters).
- The second one whose fishing grounds extend from the Karimunjawa Islands (fig. 4) to Matasiri is made of old large seiners built before 85 and a new generation of medium seiners.
- The last one which mainly exploits the eastern part of the Java Sea, the Makassar Strait and the South China Sea consists of the newest large seiners built since 1985.

#### 4. LANDING PLACES

At the beginning of the seiners exploitation the fishing vessels landed in five harbors of the province of Central Java : Tegal, Pemalang, Pekalongan, Batang and Rembang. Quickly Pemalang was abandoned and the landings concentrated in the three areas of Tegal, Pekalongan-Batang and Rembang-Juwana. Since 1979 Pekalongan is the main landing place (tab. II, fig. 5). Most part of the fleet is registered there.

As the fishing grounds moved eastward their distance from Tegal increased which led landings to decrease there. Batang and Rembang are secondary landing places dependent on the Pekalongan and Juwana activity. The activity of Batang is hampered by a fast silting up which prevents the large seiners to enter the river. At Rembang the auction is made along the beach and the seiners cannot land directly.

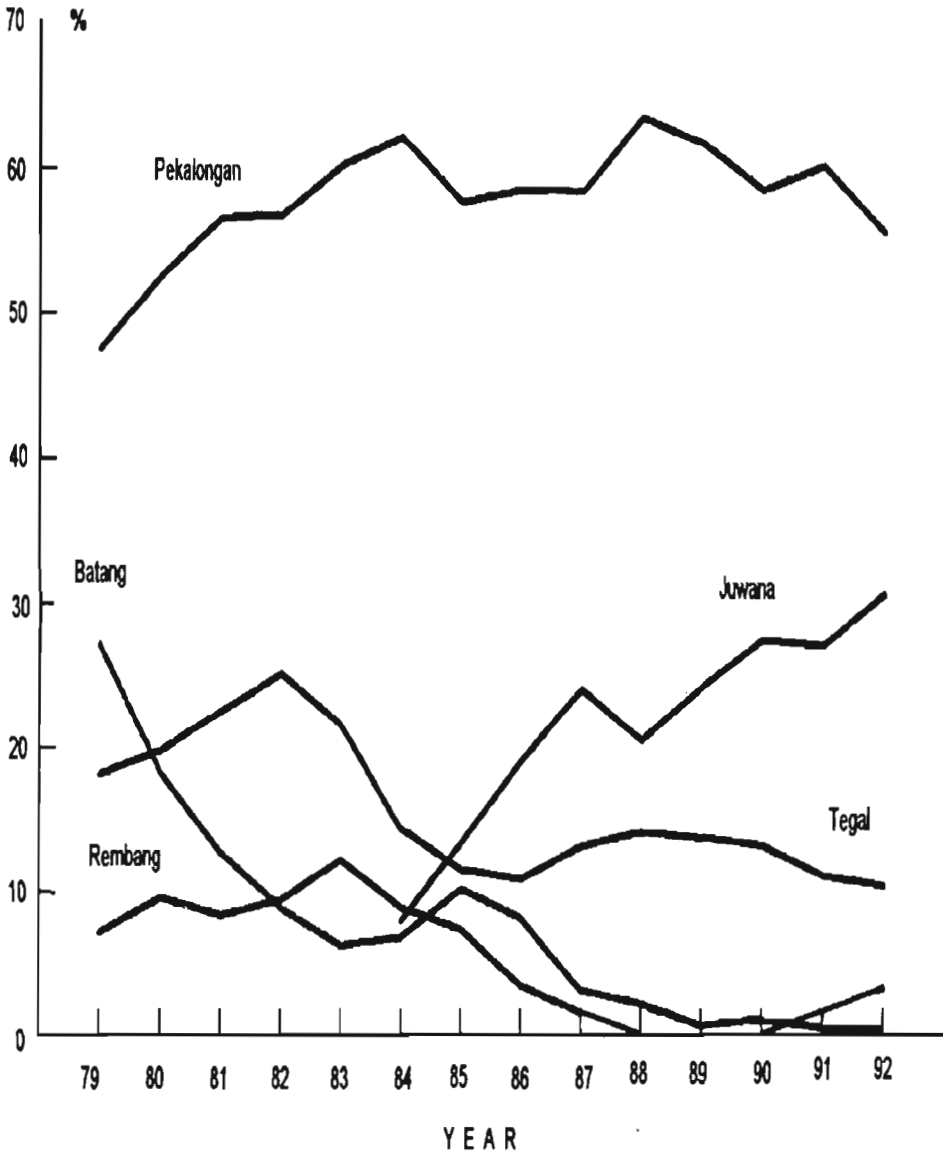


**Figure 4**

FISHING AREAS OF THE DIFFERENT SEINERS FLEETS IN 1992

DAERAH PENANGKAPAN DARI ARMADA PURSE SEINE YANG BERBEDA PADA TAHUN 1992.

In 1992, 90% of the seiners catch was landed at Pekalongan and Juwana but the situation of the two harbors is rather different. The fishing vessels landing at Pekalongan are registered there, while the activity of Juwana mainly depends on vessels registered in other places (fig. 6). Opened in 1984 to the large seiners the landings made at Juwana, quickly grew. The harbor is well located, near the main fishing grounds.



**Figure 5**

EVOLUTION IN PERCENTAGE OF THE LANDINGS IN THE LANDING PLACES OF THE SEINERS FLEET BETWEEN 1979 AND 1992

EVOLUSI PERSENTASE PENDARATAN PADA DAERAH PENDARATAN PURSE SEINE DARI TAHUN 1979 SAMPAI DENGAN TAHUN 1992



**Table III**

LANDINGS EVOLUTION OF THE MAIN COMMERCIAL CATEGORIES CAUGHT BY PURSE SEINERS FROM 1979 TO 1992  
 EVOLUSI HASIL TANGKAPAN YANG DIDARITAKAN OLEH PURSE SENE DARI TAHUN 1979 SAMPAI DENGAN TAHUN 1992

<b>Layang :</b>	<i>Decapterus russelli</i>	<b>Banyar :</b>	<i>Rastrelliger kanagurta</i>
	<i>Decapterus macrosoma</i>	<b>Lemuru :</b>	<i>Amblygaster sirm</i>
<b>Tanja :</b>	<i>Sardinella gibbosa</i>	<b>Bentong :</b>	<i>Selar crumenophthalmus</i>
	<i>Sardinella lemuru</i>		
	<i>Sardinella fimbriata</i>		

YEAR	TOTAL	LAYANG	BANYAR	LEMURU	TANJAN	BENTONG	SELAR
1979	44 700	14 800	5 900	2 400	5 900	11 100	700
1980	46 100	10 300	4 900	7 700	8 000	10 000	700
1981	38 400	8 200	6 700	7 900	5 800	6 100	700
1982	50 000	15 400	7 300	8 300	6 900	8 100	1 800
1983	75 300	34 500	8 300	14 200	7 200	6 400	1 400
1984	80 400	49 800	10 800	7 000	3 900	5 400	600
1985	117 300	67 900	17 100	9 000	8 900	8 900	2 000
1986	108 100	50 100	23 000	7 800	7 300	11 500	700
1987	77 200	35 000	13 200	6 500	7 400	7 800	300
1988	66 800	25 200	10 900	9 400	7 000	7 800	900
1989	92 200	53 300	12 100	6 000	5 900	8 200	1 000
1990	98 600	58 200	11 300	7 900	6 600	7 900	1 000
1991	126 900	67 200	18 600	17 500	7 600	8 700	900
1992	155 000	70 300	26 800	22 800	9 300	17 200	900

## 5. CATCHES

Landings of large and medium seiners show great variations. But since 1979 the catch increases four times reaching 155 000 tons in 1992 (tab. III).

### 5.1 Composition of the commercial categories

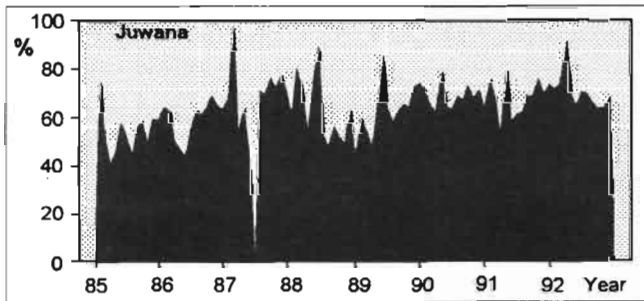
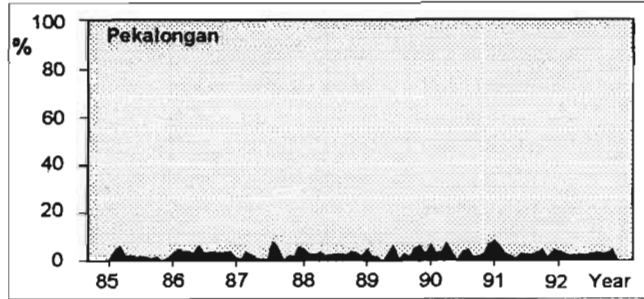
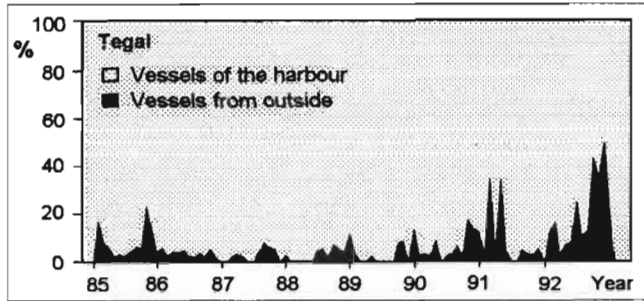
Ninety to ninety-five per cent of the catches consist of six commercial categories including seven species (tab. I). Two species of scads (*Decapterus russelli* and *Decapterus macrosoma*) are caught by the seiners. The catch shows high fluctuations with two peak productions in 1985 and 1992 (fig. 7a). Since 1993, every year, they account at least for 50% of the total catch and form the bulk of the catch in each fishing ground (fig. 8). The total landings of the seiners fishery is highly related to the fluctuations of the scads landings (fig. 9). As the fishing grounds move eastward, the catch of the two species shows different trends. The landings of *Decapterus russelli* decrease while those of *Decapterus macrosoma* increase. In 1992 *Decapterus macrosoma* is dominant in the landings (fig. 10). Due to different fishing areas, the exploitation of the two fleets do not focus on the same species. Medium seiners mainly catch *Decapterus russelli*.



**Figure 6**

DISTRIBUTION OF THE LANDINGS AMONG VESSELS (%) REGISTERED IN THE HARBOR AND OTHERS BETWEEN 1985 AND 1992

PENYEBARAN PENDARATAN ANTARA KAPAL PURSE SEINE (%) YANG TERDAFTAR SETEMPAT DAN KAPAL PENDATANG PADA PELABUHAN PERIKANAN YANG BERBEDA DARI TAHUN 1985 SAMPAI DENGAN TAHUN 1992

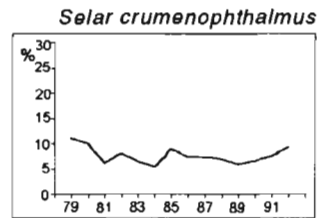
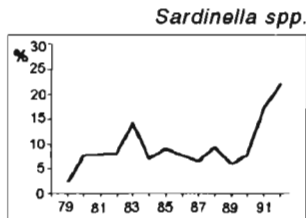
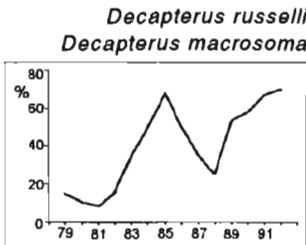
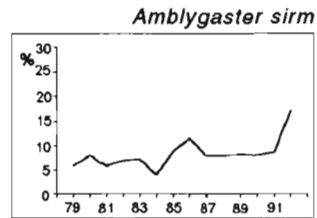
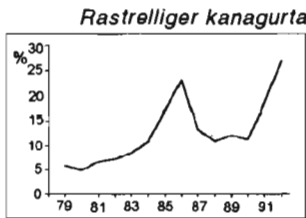


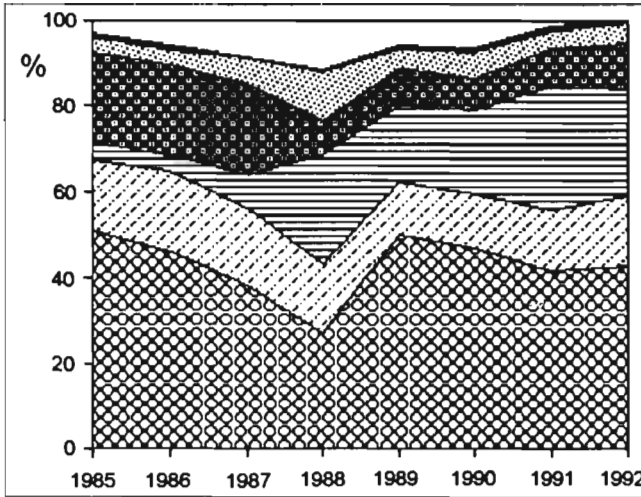
**Figure 7**

YEARLY EVOLUTION OF THE CATCH FOR THE MAIN COMMERCIAL SPECIES BETWEEN 1979 AND 1992

EVOLUSI TAHUNAN UNTUK SETIAP KATEGORI HASIL TANGKAPAN DARI TAHUN 1979 SAMPAI DENGAN TAHUN 1992

C : \* 000 tons

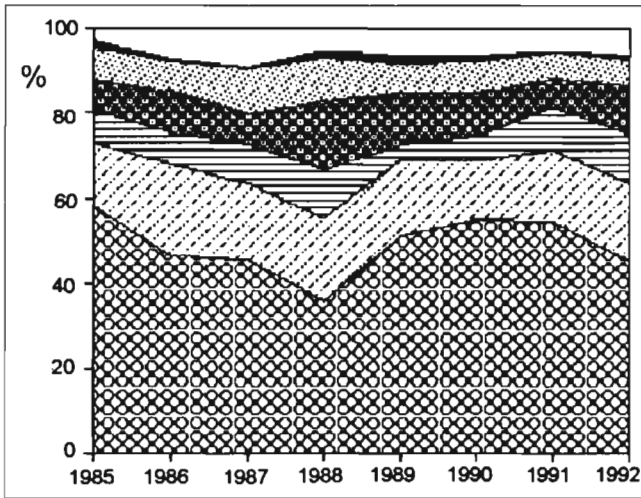
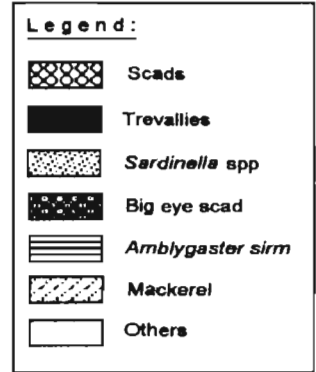




**Figure 8**

YEARLY CATCH EVOLUTION FOR THE MAIN COMMERCIAL CATEGORIES BETWEEN 1985 AND 1992

EVOLUSI HASIL TANGKAPAN TAHUNAN DARI KATAGORI KOMERSIAL UTAMA DARI TAHUN 1985 SAMPAI 1992

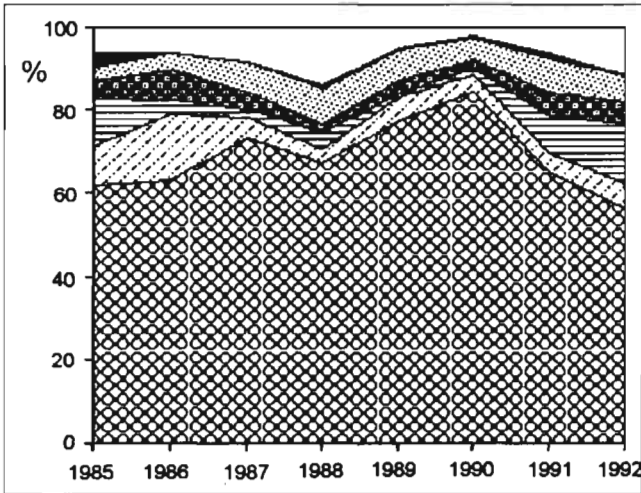


**Right page**

**Figure 9 (top)**

YEARLY EVOLUTION OF THE TOTAL CATCH (SCADS AND OTHER SPECIES) LANDED BY THE SEINERS BETWEEN 1979 AND 1992

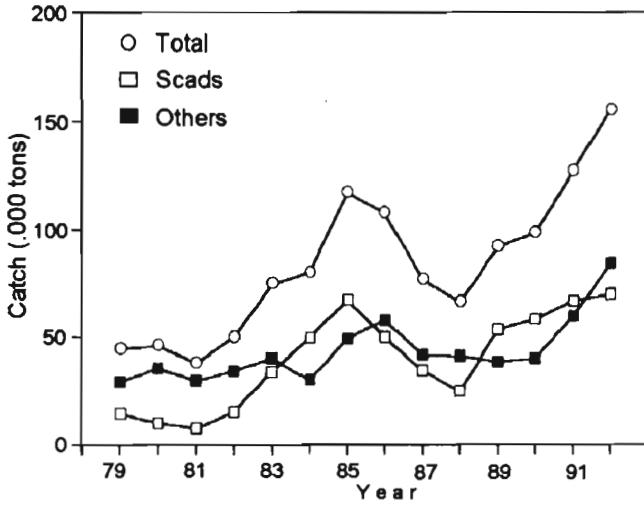
EVOLUSI TAHUNAN DARI TOTAL HASIL TANGKAPAN, LAYANG DAN GABUNGAN SPECIES LAIN YANG TERTANGKAP OLEH PURSE SEINE DARI TAHUN 1979 SAMPAI DENGAN TAHUN 1992



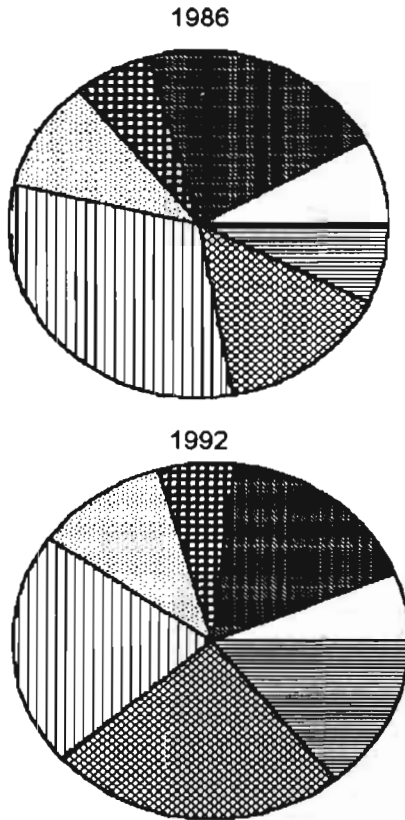
**Figure 10 (bottom)**

DISTRIBUTION OF THE SEINERS CATCH BY SPECIES IN 1986 (TOP) AND 1992 (BOTTOM)

PENYEBARAN HASIL TANGKAPAN BERDASARKAN SPECIES PADA TAHUN 1986 (ATAS) DAN TAHUN 1992 (BAWAH)



Most mackerels represented in the large and medium seiners catch are *Rastrelliger kanagurta*, *Rastrelliger brachysoma* being accidentally present in the landings. The evolution of the *Rastrelliger kanagurta* catch shows the same trend as for the scads with high fluctuations and a peak production in 1986 (fig. 7b) when 23 000 tons were landed. Most part of the catch comes from the eastern part of the Java Sea and the Makassar Strait.



The landing of *Amblygaster sirm* was important between 1979 and 1983. It could represent up to 20% of the seiners catch. From 1983 and until 1988 the landing decreased a lot before increasing again sharply in 1991 and 1992 (fig. 7c). The bulk of the catch is made in the Makassar Strait. It is mainly caught by the large seiners and accounts for a small part in the medium seiners landing.

Landing of "tanjan" (*Sardinella gibbosa*, *Sardinella fimbriata*, *Sardinella lemuru*) shows regular fluctuations. These fishes are not the target species of the seiners fleets. They are caught by the large as well as the medium seiners. In 1992 the landing sharply increased (fig. 7d). The major part of the catch is made in the Java Sea in May-June.



*crumenophthalmus*) is caught in small quantity by the large and medium seiners. Since 1979, the landing tends to decrease slightly (fig. 7e). The bulk of the catch is made in the Java Sea. Certain years, some important catch occurs in the South China Sea.

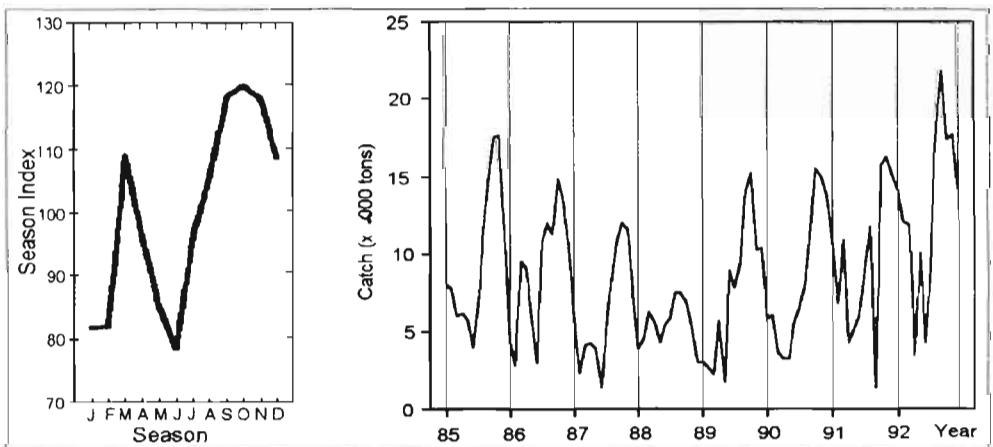
The other species account for 6 to 8 % of the total catch. They are accidentally caught and, among others, consist of "japuh" (*Dussumieria acuta*), "Bawal hitam" (*Formio niger*) and small tunas as *Auxis spp.*

### 5.2 Seasonal and geographic composition

Landings show a high seasonal trend which is more or less related to the monsoons (Potier et Boely, 1990). A monthly seasonal index based on average ratio to the moving average shows two peaks, a minor one in March-April, a maximum one in September-November (fig. 11).

The decrease of the landings in December-January is highly related to the North-West winds which blow at that season and prevent the fishing vessels to go at sea. The environmental conditions of this part of the year are extremely important for the seiners exploitation. As the rainfalls are positively correlated to the winds strength during this period, they condition the extension of the area covered by low salinity waters, the length of the stagnation of these waters and the entry of oceanic waters in the Java Sea. Thus, they influence the length of the low fishing season, the movements of the fish and the displacements of the fishing vessels among the fishing grounds.

During the peak fishing season (September-December) most of the catch is made in the Java Sea, while from January to March-April it is made in the Makassar Strait. As the waters of low salinity extend eastward and reach their maximum of extension in May-June, the bulk of the catch is made in the South China Sea.



**Figure 11**

ESTIMATED SEASONAL COMPONENT AND MONTHLY EVOLUTION OF THE SEINERS TOTAL CATCH BETWEEN 1985 AND 1992

DUGAAN KOMPONEN MUSIMAN DAN EVOLUSI BULANAN DARI HASIL TANGKAPAN TOTAL PURSE SEINE DARI TAHUN 1985 SAMPAI DENGAN TAHUN 1992

According to these moves the catch of the different species change. Because of their different ecological needs, the species are not equally distributed in the fishing grounds.

A sun ray plot analysis performed on the distribution of the catch in various fishing grounds for each species (fig. 12) shows that the geographical distribution of the species varies. *Decapterus macrosoma* and *Amblygaster sirm* are found in the eastern part of the Java Sea and the Makassar Strait, the mackerel *Rastrelliger kanagurta* in the eastern part of the Java Sea, *Decapterus russelli* and *Selar crumenophthalmus* in the Central Java Sea and the South China Sea while the "tanjan" (mainly *Sardinella gibbosa*) is found in the Java Sea waters.

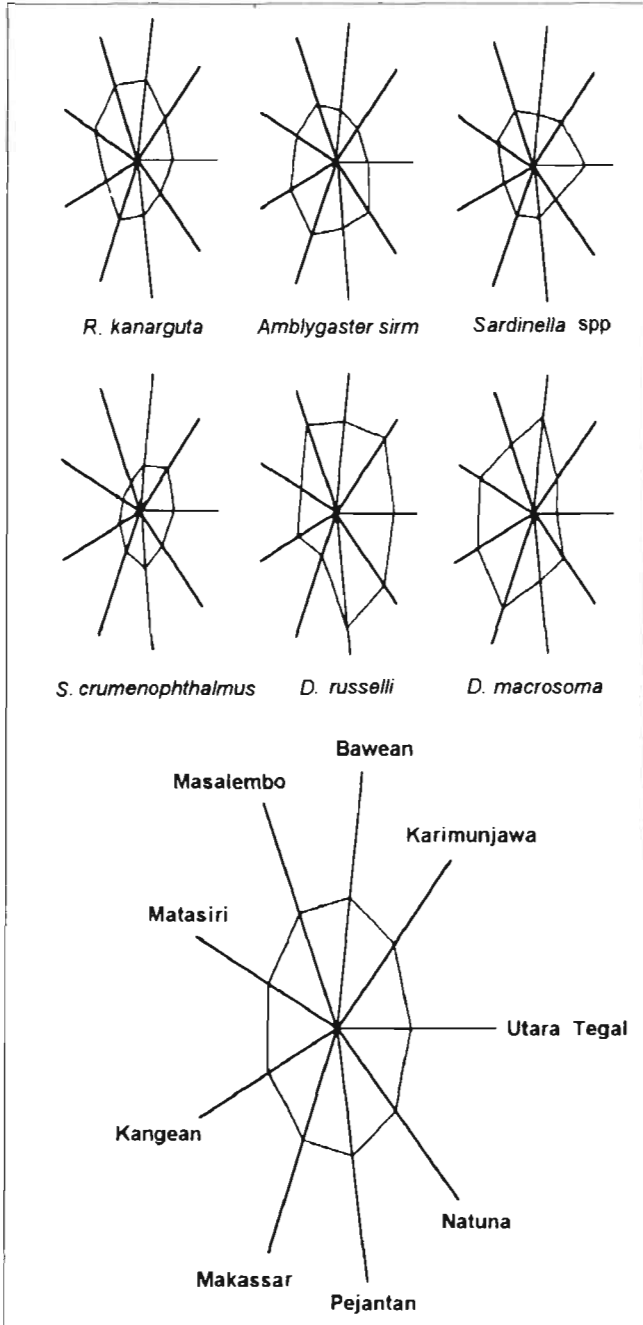
A cluster analysis carried out with the average distance method allows us to group the different species into clusters of "similar" points (fig. 13). Taking into account the sun ray plot results, the yearly catch and the CPUE trends, three groups are found. They correspond to three different types of populations among the seiners catch.

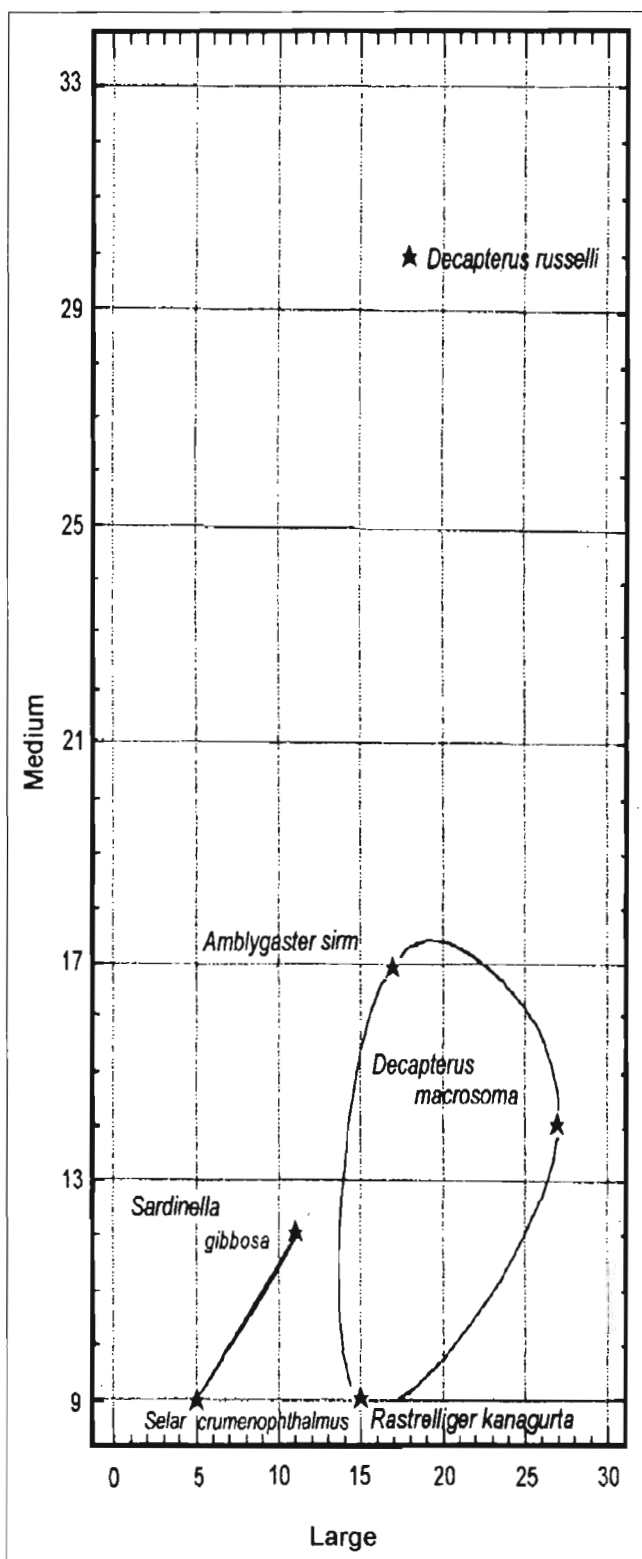
■ OCEANIC POPULATIONS  
*Decapterus macrosoma*,  
*Amblygaster sirm*, *Rastrelliger kanagurta*. They live

## Figure 12

RESULTS OF A SUN RAY PLOT ANALYSIS PERFORMED ON THE SPECIES CAUGHT BY THE SEINERS

HASIL ANALISIS "SUN RAY PLOT" PADA IKAN-IKAN YANG TERTANGKAP OLEH PURSE SEINE





**Figure 13**

RESULTS OF A CLUSTER ANALYSIS PERFORMED ON THE SPECIES CAUGHT ON THE SEINERS.

HASIL ANALISIS CLUSTER PADA IKAN-IKAN YANG TERTANGKAP OLEH PURSE SEINE

**Right page**

**Figure 14 (top)**

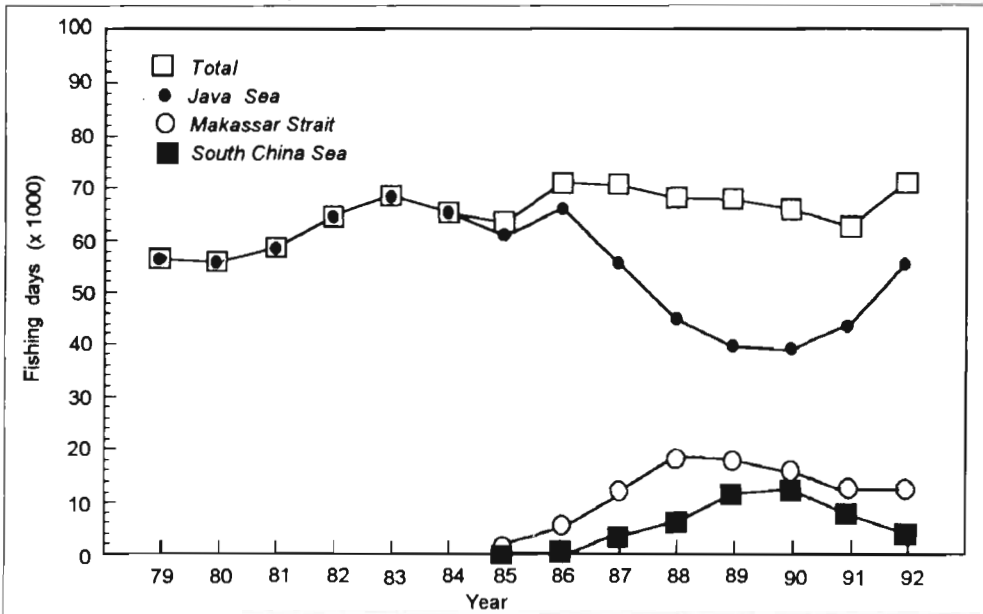
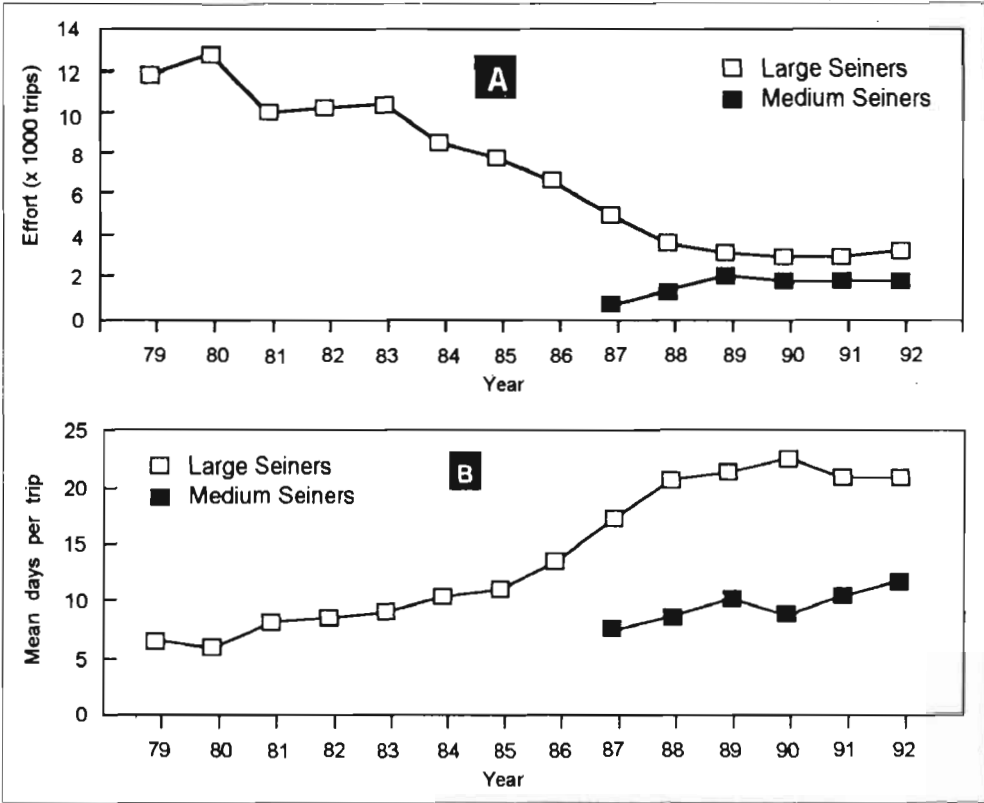
EVOLUTION OF THE NUMBER OF TRIPS (A) AND MEAN DAYS PER TRIP (B) IN THE LARGE AND MEDIUM SEINERS FISHERIES BETWEEN 1979 AND 1992

EVOLUSI JUMLAH TRIP DAN JUMLAH HARI RATA-RATA SETIAP TRIP PADA PURSESEINE BESAR ( ) DAN SEDANG (.) DARI TAHUN 1979 SAMPAI DENGAN TAHUN 1992

**Figure 15 (bottom)**

YEARLY EVOLUTION OF THE EFFORT IN FISHING DAYS IN DIFFERENT FISHING AREAS OF THE SEINERS BETWEEN 1979 AND 1992

EVOLUSI TAHUNAN DARI UPAYA PENANGKAPAN PURSE SEINE DALAM HARI LAUT PADA DAERAH PENANGKAPAN YANG BERBEDA DARI TAHUN 1979 SAMPAI DENGAN TAHUN 1992



Exploitation of the Large and Medium Seiners Fisheries



near the continental shelf edge. They are found in waters where salinity is more than 34‰. They are caught at the end of the year when the oceanic waters enter the Java Sea.

#### ■ NERITIC POPULATIONS

*Decapterus russelli*. They live on the continental shelf in waters with salinities between 32-34 ‰. They are caught along the year by the seiners.

#### ■ COASTAL GROUP

*Selar crumenophthalmus*, *Sardinella gibbosa*. They are found near the coasts and live in waters with high fluctuations of salinity. They are found along the year in small quantity in the seiners catch.

## 6. EFFORT

It is difficult to classify the seiners fishing power and define a standard fishing vessel. Length, width and gross tonnage are underestimated in the registration forms. The engine power is the only parameter which could allow to perform this task, as it is well reported and acts on the fishery at one level; the surface of the prospected area grows when the engine power grows.

The time spent to search actively the fish has been defined as the best index of effort for purse seine fisheries by Marchal (1967) and Fréon (1980). According to them the days not related to search actively for fish, *i.e.* route from harbor to fishing grounds, setting time and rest time, have to be deducted from the days spent at sea. Since the Javanese fishermen fish around rafts, the seiners cannot be considered as searching actively for the fish. Thus, that index might not be the best one for the study of this fishery.

The number of sets, the number of rafts or the light power could give a good estimation of the effort. Because the Pelfish Project has not yet enough data to use these estimations, the number of trips and fishing days have been taken to estimate the effort. The number of days at sea and the fishing grounds prospected are known from enquiries and from the exit-entries books. From the time spent to go from the harbor to the fishing ground, we estimate the number of fishing days.

Expressed in number of trips (fig. 14A) the effort has decreased continuously since 1979. As the trips decreased the average number of days at sea per trip increased from 8 in 1979 to 24 in 1992 (fig. 14B). It can be related to the extension of the fishery, the growing distance between harbors and fishing grounds and the use of larger vessels which stay longer at sea.

The number of fishing days (tab. IV) increased from 1985 to 1987. Since 1987, it slightly decreased until 1991 before increasing sharply again in 1992. Most part of the effort comes from the large seiners vessels and is spent in the Java Sea (50 to 70 %) the rest is spent in the Makassar Strait and in the South China Sea (fig. 15). The effort is highly seasonal and related to environmental and human factors (fig. 16). When winds are stronger than 20 knots the vessels are not able to stay at sea. This situation occurs mainly during the first months of the year when the North western monsoon is well established. During these months, floods on the North coast of Java Island can entirely stop the activity of the seiners because the landing places are flooded. The fishing vessels are also at port around the end of the fasting month and during two weeks the effort drastically decreases. The effort is high in the second part of the year from August to November. Medium seiners deploy their whole effort in the Java Sea, while large seiners share it among the whole fishery space.



**Table IV**

EVOLUTION OF THE EFFORT (FISHING DAYS) AND THE CPUE (KG/FISHING DAYS) OF THE LARGE AND MEDIUM SEINERS FLEET SINCE 1985

EVOLUSI UPAYA PENANGKAPAN (HARI LAUT) DAN HASIL TANGKAPAN PER UNIT UPAYA DARI PURSE SEINE BESAR DAN SEDANG SEJAK TAHUN 1985

EFFORT	1985	1986	1987	1988	1989	1990	1991	1992
<b>Large</b>	56 282	62 052	70 345	56 087	50 086	51 256	46 364	52 889
<b>Medium</b>			2 873	8 157	16 915	12 569	14 136	17 539
<b>Total</b>	<b>56 282</b>	<b>62 052</b>	<b>73 218</b>	<b>64 244</b>	<b>67 001</b>	<b>63 825</b>	<b>60 500</b>	<b>70 428</b>
<b>CPUE</b>								
<b>Large</b>	2 120	1 742	1 077	1 097	1 683	1 697	2 350	2 387
<b>Medium</b>			512	477	511	939	1 226	1 688

## 7. CPUE

Values of the CPUE (tons/fishing day) decreased twice from 1985 to 1987 (fig. 17A) when the catch rate of the large seiners was 1 ton per fishing day. Since 1988, it increases by step and in 1992 is slightly higher than in 1985 reaching 2.4 tons/fishing day. The catch rate of the medium seiners after three years of stagnation increases since 1989.

The fluctuations of CPUE in the large seiners fishery are seasonal with a maximum peak at the end of the year and a minimum one in May-June (fig. 17B). In the medium seiners fishery there is only one annual peak during September-November (fig. 17D). The evolution of CPUE differs among the fishing areas. The Makassar strait and the Java Sea have a similar evolution (fig. 17C) with higher values in the Makassar strait. In the South China Sea CPUE fluctuates a lot.

## CONCLUSION

The exploitation of the small pelagic in the Java Sea is highly related to the monsoons and the change they induce in the water masses in that sea. The rainfalls of the North-West monsoon play a major role. The abundance of pelagic fish in the Java Sea is linked to the discharge of islands rivers which have an important role in the productivity of the sea and the availability of the fish. The large seiners extending their fishing ground outside the Java Sea try to avoid fluctuations of fish abundance, but the seasonal trend of the landings is still strong.

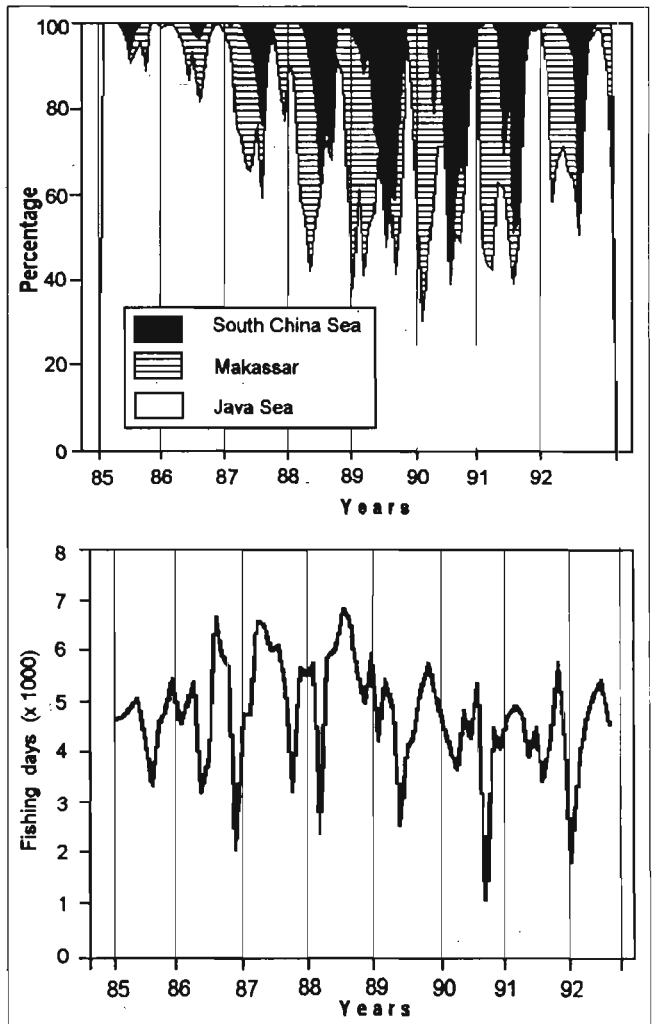
Until 1985 the effort exerted by these fisheries was exclusively concentrated on the stocks or part of the stocks living in the Java Sea. Now it also focuses on the stocks of the Makassar Strait and the South China Sea. According to this exploitation scheme, several stocks complexes are exploited by the seiners. Their structure is not yet well defined, but we can recognize three types of stocks; oceanic; neritic; and coastal. Nevertheless, fish move and mix among them and at least for the Java Sea and the Makassar Strait the resource has to be considered as common. Statistics and stock evaluations have to be examined together. On the other hand, South China Sea stocks could probably be managed alone.

Fishermen know very well the fish behavior and the environmental conditions affecting the fishing grounds. The pressure on the fishing area is high but according to the different stocks defined above, the level of exploitation is different.

The geographic boundaries of the neritic and coastal stocks overlap the fishing boundaries of the seiners and the coastal fisheries. Since many years these stocks have been heavily exploited.

Regarding oceanic stocks, the fishing pressure is lower as their geographic distribution exceeds the fishing boundaries of the seiners fishery and of any other fishery which catch them. With the present tactic and technological level reached by the fishery, the seiners cannot extend their prospecting beyond the 200 m isobath and part of these stocks are not vulnerable to fishing.

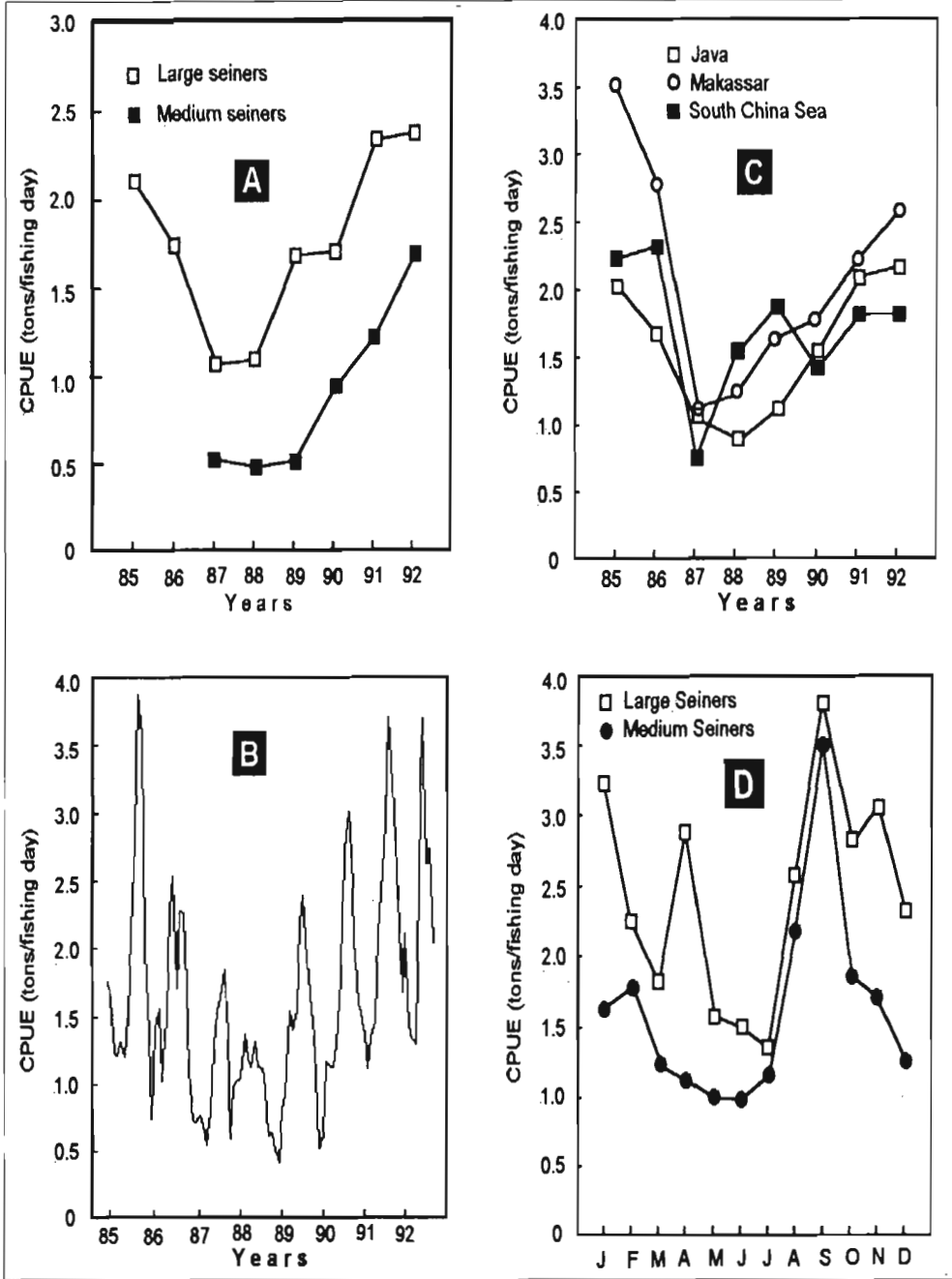
On same fishing grounds (Java Sea), the catch rate of the large seiners is always higher than those of small seiners (fig. 17D). The size of the net or the light power used to attract fish and to aggregate can explain such differences.



**Figure 16**

MONTHLY EVOLUTION OF THE EFFORT EXPRESSED IN FISHING DAYS AMONG VARIOUS FISHING AREAS AND TOTAL FOR THE SEINERS BETWEEN 1985 AND 1992

EVOLUSI BULANAN DARI UPAYA PENANGKAPAN PURSE SEINE DALAM HARI LAUT DI ANTARA DAERAH PENANGKAPAN YANG BERBEDA, DAN DAERAH PENANGKAPAN SECARA KESELURUHAN DARI TAHUN 1985 SAMPAI DENGAN TAHUN 1992



**Figure 17**

CPUE EVOLUTION (TONS/FISHING DAYS) OF THE SEINERS BETWEEN 1985 AND 1992

EVOLUSI HASIL TANGKAPAN PER UNIT UPAYA (TON/HARI LAUT) DARI TAHUN 1985 SAMPAI DENGAN TAHUN 1992



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