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MAIN RESULTS OF THE PREVIOUS STUDIES OF THE SMALL PELAGIC FISHERY IN THE JAVA SEA

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MAIN RESULTS OF THE PREVIOUS STUDIES ON THE JAVANESE PURSE SEINE FISHERY

INTRODUCTION.

In the Java Sea, a large range of fishing gears is used to catch the pelagic species: traps, lift nets, anchored gill nets, drifting or circling gill nets, lines, seines and purse seines. Most of them are used near the coast by small scale boats as canoes and open boats with sculls, sails or outboard engines.

Since 1970, the purse seine spreads out from the harbours of the north coast of the Java Island. Now that kind of fishing covers the whole Java Sea. There are two types of vessels using purse seines. The big purse seiners and the mini purse seiners.

The present article covers the big purse seiners fishery which is the only artisanal fishery existing in the Java Sea since the trawl ban in 1980. This fishery is exploited mostly by 500 purse seiners.

The activity of the big purse seiners is focused on the Central Java Province where are situated the landing places.That is one of the main type of fishing for small pelagic fish as scads, sardines and mackerels. Three steps characterise the evolution of the fishery.
1973-1979. The growth of the fishery is limited to the traditional fishing areas of the javanese fishermen.
1980-1982. It is a transitional step. The traditional fishing areas are heavily exploited and many trawlers are transformed in seiners when the trawl ban in the Java Sea becomes effective.
1983-..... The fishing extends eastwards and northwards in the The Java Sea and in the southern part of the South China Sea (figure 1). However, the fishing vessels seem not to be able to extend the exploitation over the 200 metres isobath. Now they are fishing more and more north in the strait of makassar.

The extension of the fishery seems to reach a critical stade in the actual state of the fishing method. The pelagic stocks are very unstable and an estimation of the level of exploitation reached so far has become urgent.

I. THE MAIN SPECIES.

Amongst the dozen of pelagic fish families living in the Java Sea (Sunda shelf), four families are commercialy very important and comprise numerous fish species. There are the Clupeidae, the Engraulidae, the Carangidae and the Scombridae. The first two families comprise only species with small size fish, the last two include also some species whose adults widely overeach fifty centimetres.

For all those families, most of species are linked to the continental shelf or to its immediate vicinity. Many are littoral or even estuarin species and in that case are as often as not small size (Clupeidae and Engraulidae). Some species inhabit the whole available space on the continental shelf and can accomplish large and seasonal movements, juveniles and young fish staying near the littoral.

About twenty pelagic or semi-pelagic species are caught by the big purse seiners. Amongst those, eleven species provide 90% of the total catch (table 1).

The scads (Decapterus macrosoma, Decapterus russelli) are the predominant species with sardines (Sardinella sirm, Sardinella gibbosa, Sardinella fimbriata), mackerels (Rastrelliger kanagurta, Rastrelliger brachysoma) and the big eyes (Selar spp.).

II. BIOLOGICAL CHARACTERISTICS.

II. 1 Life parameters.

Some studies on the main biological parameters (growth, length-weight relationship, mortality, fecundity and feedingg habits) were already conducted by many authors and institutions (BPPL, LON, Universities). Tables 2 and 3 summarise the main results.

In general, these species are characterised by a short life (2 to 3 years) with a more or less fast growth . All of them are multispawners (two peaks of reproduction per year) with a fecundity comprise between 20 000 and 60 000 eggs.

II. 2. behaviour.

These fish live near the surface and in the upper part of the water column, often in shoals more or less dense. In general, they also show a nycthemeral behaviour, staying nigthly near the sea surface and daily more deeper. They have a tendancy to aggregate under drifting objects. their feeding behaviour is not well known. Some results are available for a few observations. They are planktinovorous.

III. THE EXPLOITATION.

III. 1. The fishing grounds.

The different fishing zones, delimited by the fishermen, are characterised by the name of the groups of the islands scattered, throughout the Java Sea (figure 1). Some of the zones however are closer to other groups of islands than those of which they bear the name. This is the case with the islands of Bawean and Masalembu. The fishermen often possess only a compass and these islands serve as landmarks for positioning.

Since the first purse seiner operated in 1970, the major fishing ground has been mainly on the coastal shelf platforms of the islands in the eastern half of the Java Sea, i.e. from Karimun java islands and adjacent waters in the west to Bawean and Masalembu islands in the east.

Since 1983, the fishing areas have been expanded eastwards to Matasiri and recently to Lari-larian in the Makassar strait and northwards in the south of the South China Sea.

For example, from 1976 to 1986 the fishing surface extend from::

fishing surface 1976-1982	26 000 mille2
fishing surface 1983-1984	52 000 "
fishing surface 1985-1986	59 000 "

III. 2. The fishing tactics.

The fishing is conducted around anchored rafts called "rumpons" where the fish is aggregated with or without lamps.

Once the ship has reached its destination the boat launches its rafts at a distance of some hundred metres or nautical miles one from the other. The number of rafts launched by each boat varies from 5 to 30. They are left on the fishing grounds until they disappear. There is a notable difference in the number of raft those of old boats (6 to 12) and those of new ones (20 to 30). the number also varies with the seasons. During the period observed (october 86 - april 87), the lowest number was recorded in october when the greatest catches are taken, and the highest number in april when the catches are decreasing (figure 2). Obviously the fishermen increase the number of rafts when the resource is not easily accessible, in order to multiply the aggregative sources.

During the day the boat remains near the rafts. At dusk the different rafts are then inspected and the boat returns to the one with the maximum concentration of fish. At night, five to ten lamps are lit and some of them are placed on the raft. These are usually petrol lamp of 200 to 300 watts (petromax). Some vessels nowadays are equipped with electricity.

When the skipper considers that the fish is sufficiently concentrated around the raft the lamps on board ship are

extinguished and the net is set. This is when the skiff serves as fixed point.

The fishing tactics vary according to the ships, but all skippers make at least two sets each night, often early on, but above all before dawn (figure 3). Investigations carried out at Tegal show that 30% of the net settings take place between 20h and 0h and 56% from 3h to 7h, with a maximum just before dawn (between 4h and 5h according to the fishing ground).

It is exceptional to set nets visually in daytime, without the help of rafts, and in fact none of the fishermen questioned operated "visually". This method is used though for catching the mackerels Rastrelliger brachysoma and Rastrelliger kanagurta at certain seasons of the year.

III. 3. The Catch.

Since 1976, the catch increase fivefold (figure 4) going from 20 000 tons to 100 000 tons.

III. 3. 1. Evolution according to the species.

90% to 95% of the catch consist of seven commercial categories including eleven main species. Between 1979 and 1981, all the categories were found in more or less equal quantities, none of them dominating. Since 1983, the layang category (Decapterus macrosoma, Decapterus russelli) becomes the most prevalent, accounting for over 60% (figure 5). The banyar catches (Rastrelliger kanagurta) have increased regularly since 1979 and in 1985 they were the second largest contingent of the seiner catches. The lemuru (Sardinella sirm), the tanjan (Sardinella gibbosa and Sardinella fimbriata) and the bentong (Selar crumenophthalmus) all have a similar profile, some years with a greatly increased yield and others with a notable drop. These are accessory species which represent between 8 and 12% of the whole of the catches. The selar (Selar spp. and Selaroides leptolepis) and the kembung (Rastrelliger brachysoma) represent only a small part of the total (1-3%).

This evolution and the changes in the distribution of the catches may be due to the transfer from the traditional coastal fishing zones to others farther out at sea, to economic causes, the layang and banyar categories reaching the highest prices at the fish auctions and also to environmental factors. The seiners now catch species with a behaviour more "oceanic" (layang, banyar and lemuru) than "coastal" (tanjan, selar, kembung). Two factors appear to reinforce this hypothesis. The maximum production of "coastal" species occurs in june and july, with fishing operations near the coasts of North Tegal and Karimunjava, whereas that off the oceanic species takes place farther east at Masalembu and Matasiri in october and november.

The catch shows a clear seasonal trend with a maximum from september to november during the "musim ikan" (figure 6).

III. 3. 2. Evolution according to the harbour.

The landing of the javanese seiners in the five ports can be grouped into three sectors: Tegal, Pekalongan-Batang, Juwana-Rembang.

At Tegal, catches increase from 1979 to 1981 and then stagnate from 1982 until 1983, when it is the port with the second largest quantity of landings, 1984 see a sharp drop due to economic factors (delays in payment for the catches) and to the seiners moving eastwards to operate. It is not compensate in 1985.

The Pekalongan-Batang sector represents, for historical reasons, the main landing centre for the javanese seiners, these vessels first appearing there in the 1970's, and also for economic ones, Pekalongan being the most up-to-date port in the Central Java Province. In 1979, the distribution of catches was almost equal between the two harbours, but since then the landings at Pekalongan have constantly increased. At Batang, landing continue to drop until 1984. Then, in 1985, a substantial increase in the volume of catches is noted (increase for 1984-1985: 118%, owing to many Pekalongan vessels unloading there during the "musim ikan".

The Rembang-Juwana sector derives full benefit from the ex tension eastwards of the fishing zones. After stagnating until 1982 (9% of the total catch), landings then increase considerably. In july 1984 the port of Juwana opens up, where it was far easier for the seiners to unload their fish, so that this tendancy to increase rises. By 1985 Juwana becomes the second centre of landings for the fleet (increase for 1984-1985: 146%). While this development was underway, landings at Rembang decrease from 1983.

III. 4. The fishing effort.

In the current state of knowledge, the most convenient expression of the fishing effort of "big" purse seiners is in days at sea.

The monthly evolution presents two maxima,, in march-april and in october-november, and two minima in june-july and in december-january. The moving average method (for three months) reveals this phenomenon clearly, whereby the minimal periods correspond to the monsoon and the maximal ones to the intermonsoon, the one in october-november being particularly marked (figure 7).

The number of trips has decreased regularly since 1979 (50% of the volume from 1979 to 1985). This is due to the fact that the ships go farther and farther away in search of new fishings grounds, for this is now possible with the larger-sized vessels.

When analysing the investigations carried out at Tegal and Pekalongan, the effort is seen too have moved away from the traditional fishing grounds of north Tegal and Karimunjava towards sectors situated farther east (Masalembu and Matasiri).

Expressed in days at sea the effort increased from 1979 to 1983 and then decreased from this date onwards (figure 8). In opposite the effective effort expressed in days at sea corrected by the relative power of the fleet increases from 1976 to 1986 (figure 8)

The effort exerted by the Pekalongan fleet followed a pattern identical to the general curve, whereas that of Tegal has decreased regularly since 1982. In Juwana the effort shows a big increase since the port opened up to the "big" purse seiners. The effort of Batang after decreasing steadily until 1982, stabilised with the arrival, during the "musim ikan" (september to october) of ships from Pekalongan, no longer able to absorb the traffic of all its own ships. The effort of Rembang fleet has remained stable at a very low level.

Though the number of days at sea per trip has increased regularly, the number of days at sea per ship has decreased.

III. 5. The catch rates.

The nominal catch rate expressed in tons per day at sea increase from 1976 to 1986 going from 0.6 ton/day to 1.2 tons/day. The evolution of the effective catch rate is more different with a decline from 1976 to 1981 and a stabilisation since that date at around 1.2 tons/day (figure 9). For this type of exploitation the catch rate seems poor.

They show the same seasonal trend as for fishing effort and catch. The highest values are found in september-november and the lowest from february to june.

These poor values and the seasonal trend observed seem due to environmental factors (winds and rainfall), to the ships used (their design does not permit to quit the harbours when bad weather conditions), and to the economic factors (in may and june the species with high prices are absent of the catch).

III. 6. The current state of exploitation.

In the state of the actual knowledge on the fishery it is very difficult to use other models than synthetic models (Schaefer and Fox). Garcia and Caddy transform the models mentioned above to take in part the extension of the fishing areas. Used in Cyprus for demersal species (no migration of the biomass) we apply this model to the purse seine fishery.

The results show that the stocks are fully exploited (figure 10) The maximum sustainable yield (MSY)is estimate at around 100 000 tons for an effort of 70 000 days at sea.

IV. CONCLUSION.

Since 1970, the purse seine fishing in the Java Sea knows a real increase from the javanese north littoral. Over the last ten years, the big purse seiners knows a fast and important

development; increasing fourfold of the landings that excedeed 110 000 tons in 1985 in the Central Java Province, number of fishing vessels multiplied by five, fast growth of their size and power, extension of their activity to the whole Java Sea, to the southern part of the South China sea and to the strait of Makassar.

The biology of the different species is rather well known but some points stay to study specially feeding habits, reproduction, fecundity and the identification of the different populations existing in the Java Sea.

Even if the fishing method usually employed stays very archaic, it is nevertheless relatively efficient. Thanks to its drop the seine net is capable of collecting the entire concentration of fish around it attracted by the light. The lack of navigational equipment makes the search for the rafts rather problematic the only way to find the position is to take the island for landmarks and this wastes time. As the fishing operation are manual they are naturally very lengthy.

The catch is composed at around 50% by scads and presents a seasonal trend well marked with a maximum during the "musim ikan" from september to october. The fishing effort and the catch rate follow the same scheme. The fishing effort is stabilised at a high level and the values of the catch rate are rather poor.

The exploitation seems to have reached a critical stage with the stocks of pelagic fish in the Java Sea almost or fully exploited.

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SCIENTIFIC NAME		COMMON NAME		SUCCINCT DESCRIPTION	Do not Confuse
SPECIES	SYNONYM	ENGLISH	INDONESIAN		
Amblygaster sirm WALBAUM, 1792	Sardinella sirm	Spotted sardinella	Siro - Lemuru	Round and oblong body. 8 ventral fin rays (i, 7) 10/20 small black spots along upper flanks.	A. leiogaster A. clupeoides S. lemuru
Sardinella lemuru BLEEKER, 1853	Sardinella longiceps		Lemuru	Round and oblong body. 9 ventral fin rays (i, 8) long head	A. sirm
Sardinella gibbosa BLEEKER, 1849		Goldstripe sardinella	Tanjan - juwi Tembang	Body deep, moderatly compressed. 8 ventral fin rays (i, 7). Black spot at basis of anterior dorsal rays. Narrow horizontal gold line along flanks.	S. fimbriata S. brachysoma
Sardinella fimbriata VALENCIEN-NES, 1847		Fringoscale sardinella	Tembang - juwi Tanjan	Body deep, moderatly compressed. 8 ventral fin rays (I, 7). Flanks silvery. Plain blue-green back. Anterior scales perforated and fimbriated.	S. gibbosa S. brachysoma
Sardinella brachysoma BLEEKER, 1852		Deep body sardinella	Tanjan Tembang	Body deep and compressed. 8 ventral fin rays (i, 7). Flanks silvery. Black spot at dorsal fin origin.	S. gibbosa S. fimbriata
Decapterus russelli RUPPELL, 1828	Decapterus maruadsi	Round scad	Layang	Body elongate and slightly compressed. Pectoral fin falcate, reaching to below origin of the second dorsal fin. Small black spot on margin of operculum. Finlets.	D. macrosoma S. crumenoph-thalmus
Decapterus macrosoma BLEEKER, 1851		Layang scad	Layang	Body very elongate and round. Pectoral fin no falcate reaching to below posterior spines of first dorsal fin. Straight part of the lateral line short. Small black blotch on margin of operculum. Finlets.	D. russelli D. macarellus
Selar crumenoph-thalmus		Bigeye scad	Selar Bentong	Oblong and moderatly compressed body. Large eye. Deep furrow on lower margin of gill opening.	D. macrosoma S. boops
Selar boops VALENCIEN-NES, 1833		Oxeye scad	Selar Bentong	A deep furrow on lower margin of gill opening. Lateral line becoming straight before origin of second dorsal fin. Broad golden band along the flanks.	S. crumenoph-thalmus S. leptolepis
Selaroides leptolepis VALENCIEN-NES, 1833		Yellowstripe trevally	Selar	Oblong and compressed body. Dorsal and ventral profiles equally convex. Black spot on operculum. Bright golden yellow band from snout to caudal fin.	S. boops
Rastrelliger brachysoma		Short-bodied mackerel	Kembung perempuan	Body very deep. A row of dark spots along back. Intestine very large.	R. kanagurta
Rastrelliger kanagurta CUVIER, 1816		Indian mackerel	Banyar Kembung laki.	Body moderatly deep. Two rows of small dark spots below dorsal fin bases. Dark or golden longitudinal streachs on back. A black spot below pectoral fin.	R. brachysoma

Table 1. The eleven main species caught by the javanese purse seiners (SUBHAT et al., 1987).

	D.r	D.m	S.s	R.b	R.k	S.c	S.l
Lø (cm)	26.5	23.8	25.8	22.9	23.9	25.9	22.0
K (th^{-1})	0.98	0.80	1.15	2.26	2.27	1.25	1.20
Z (th^{-1})	1.56	3.88	5.80	0.82	1.20	5.56	5.75
M (th^{-1})	0.92	1.18	2.06	0.38	0.37	2.17	2.21
F(th^{-1})	0.64	2.70	3.74	0.44	0.83	3.39	3.54
E	0.41	0.69	0.65	0.54	0.69	0.61	0.62
Lc (cm)	14.8	16.3	18.8	14.0	16.9	17.8	9.90
L (cm)	17.1	17.0	19.2	16.1	17.7	18.6	10.3
Lm (cm)	13.6	14.6	17.0	18.0	17.0	14.4	--
W (gm)	49.2	42.8	61.5	40.0	48.3	55.4	9.9
a	0.0106	0.0104	0.0086	--	--	0.0104	0.014
b	2.962	2.938	3.088	2.88	3.19	3.111	3.043

D.r : Decapterus russelli
D.m : Decapterus macrosoma
S.s : Sardinella sirm
R.b : Rastrelliger brachysoma
R.k : Rastrelliger kanagurta
S.c : Selar crumenophthalmus
S.l : Selaroides leptolepis

Lø, K : Parameters of the Von Bertalanffy growth curve.
Z, M, F : Mortality coefficients (Z : total, M : natural, F : fishing).
E : Exploitation rate
Lc : Length at the first capture, L : Mean length of fish caught,
Lm : Mean length at the first maturity.
W : Mean weight of the fish.
a,b : Coefficients of the length-weight relationship.

Table 2. Main biological parameters of the main species caught by the purse seiners (SUHERMAN et al., 1987).

Species	Spawning season	Spawning area
D. russelli	march-april juli-august	Bawean, Masalembu Matasiri islands.
D. macrosoma	august-september	Bawean, Masalembu Matasiri islands.
R. kanagurta	october-february	Indian ocean, South China Sea
	june-september	Eastern part of the Java Sea
R. brachysoma	may-october	Java Sea

Table 3. Spawning seasons and areas for four species caught by the big purse seiners.

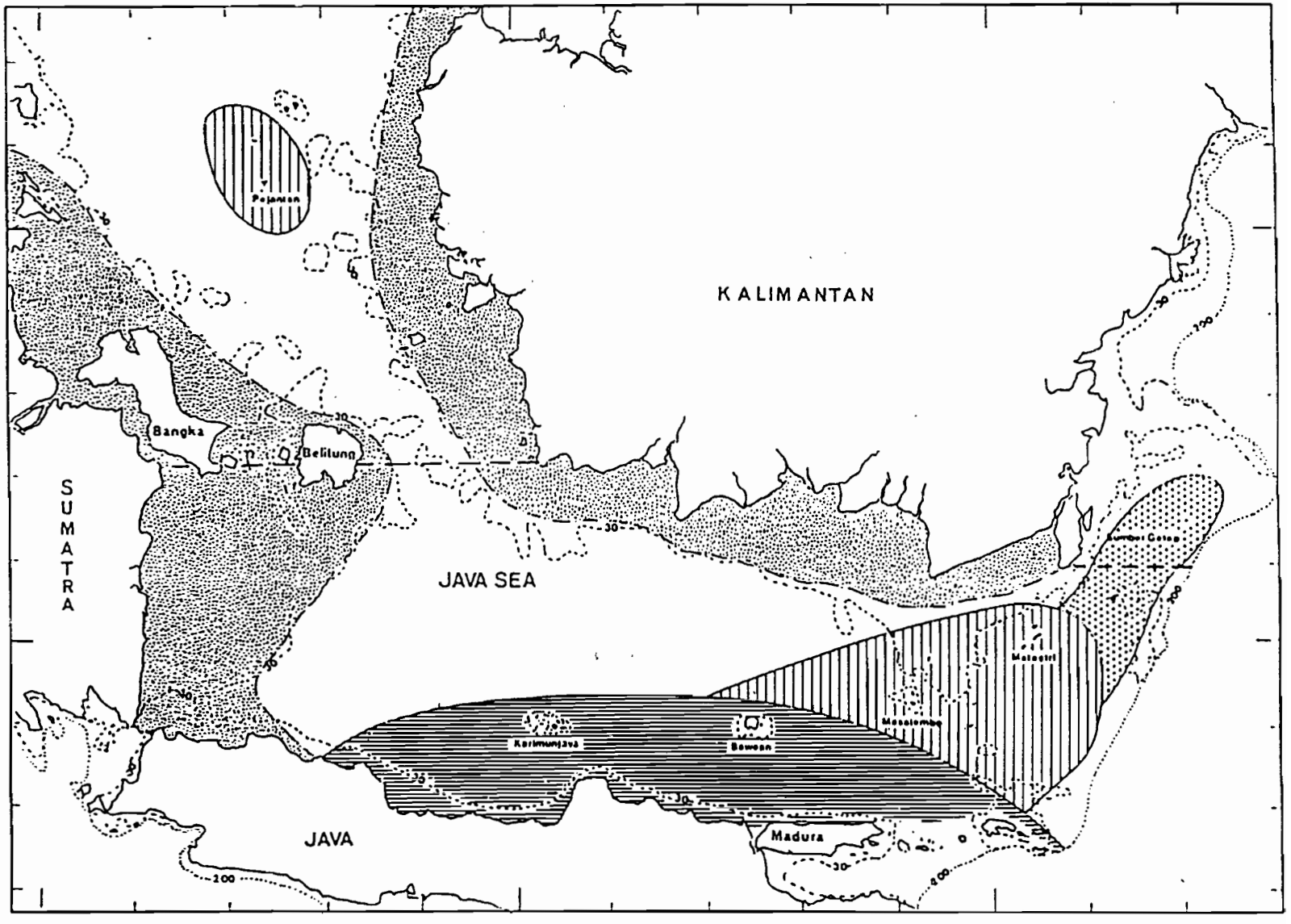


Figure 1. Main fishing grounds of the javanese purse seiners since 1976 (traditional areas), (extension 83-84), (extension 85-86).

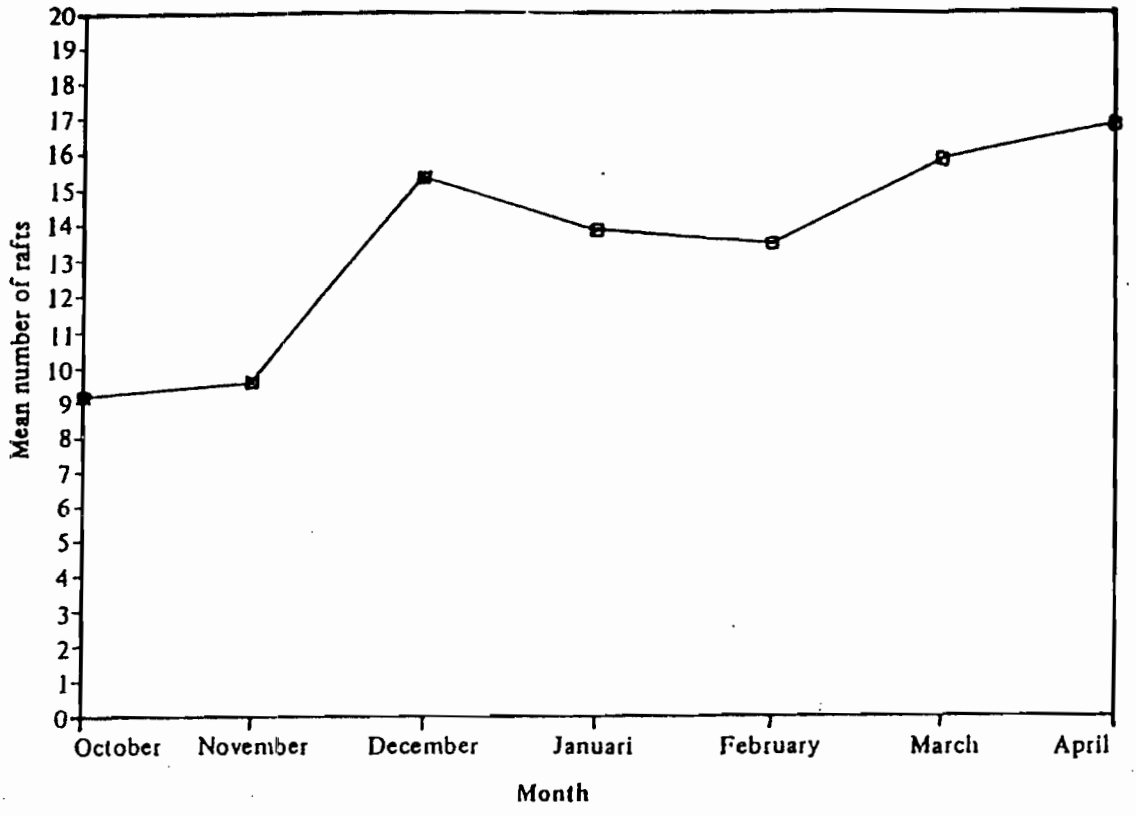


Figure 2. Monthly average of the rafts anchored by the purse seiners from october 1986 to april 1987.

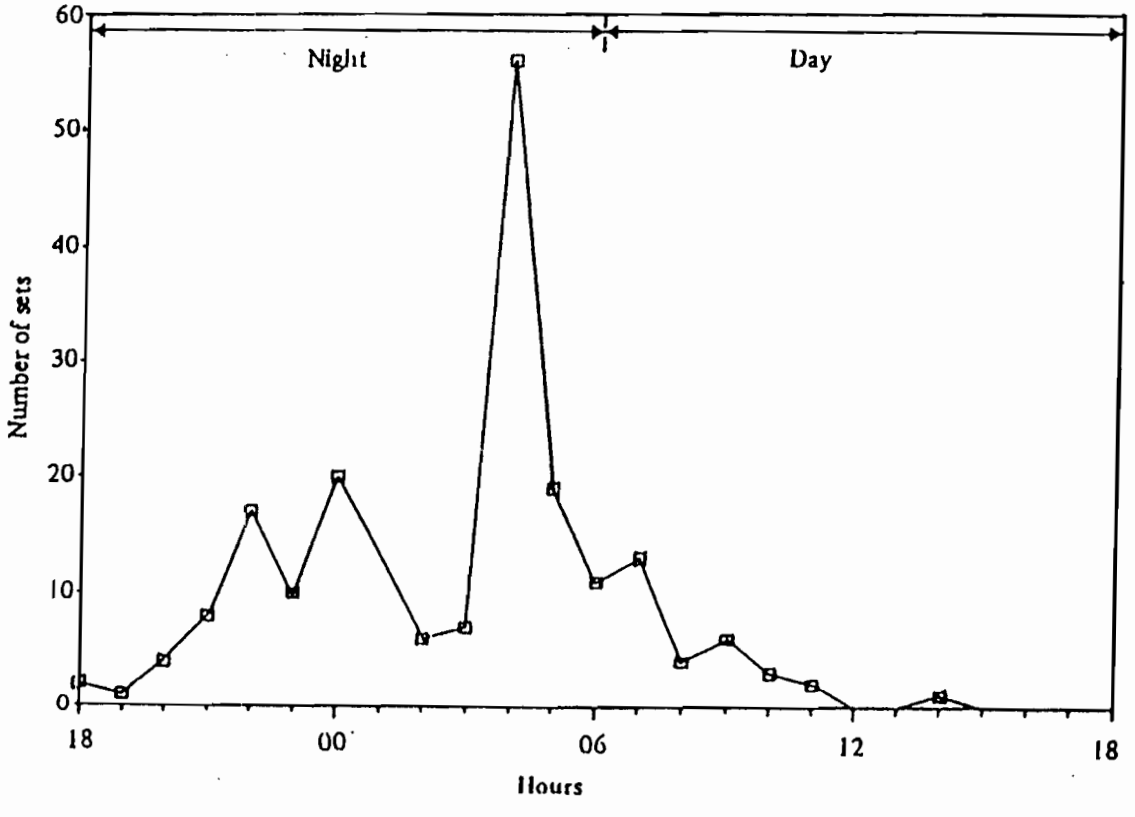


Figure 3. Number of sets according to the time from october 1986 to april 1987.

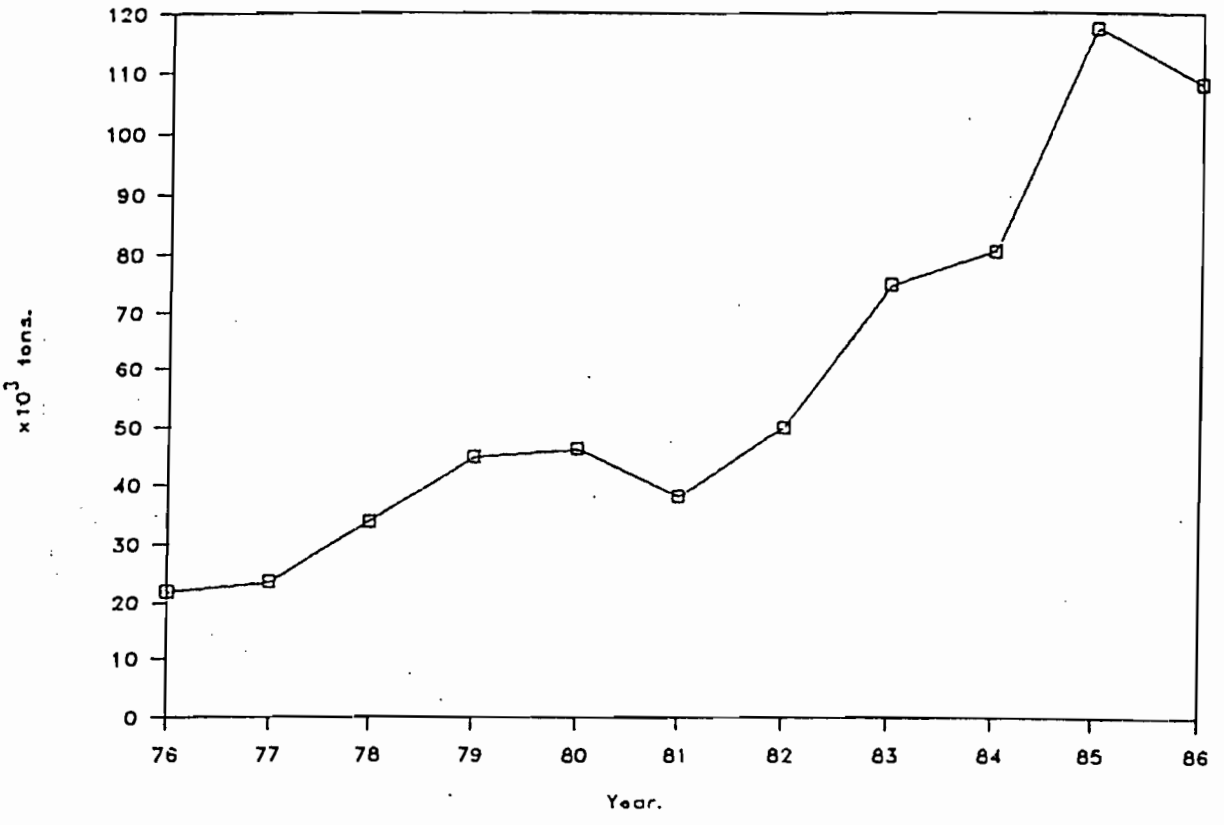


Figure 4. Evolution of the total catch of the javanese purse seiners (tons) from 1976 to 1986.

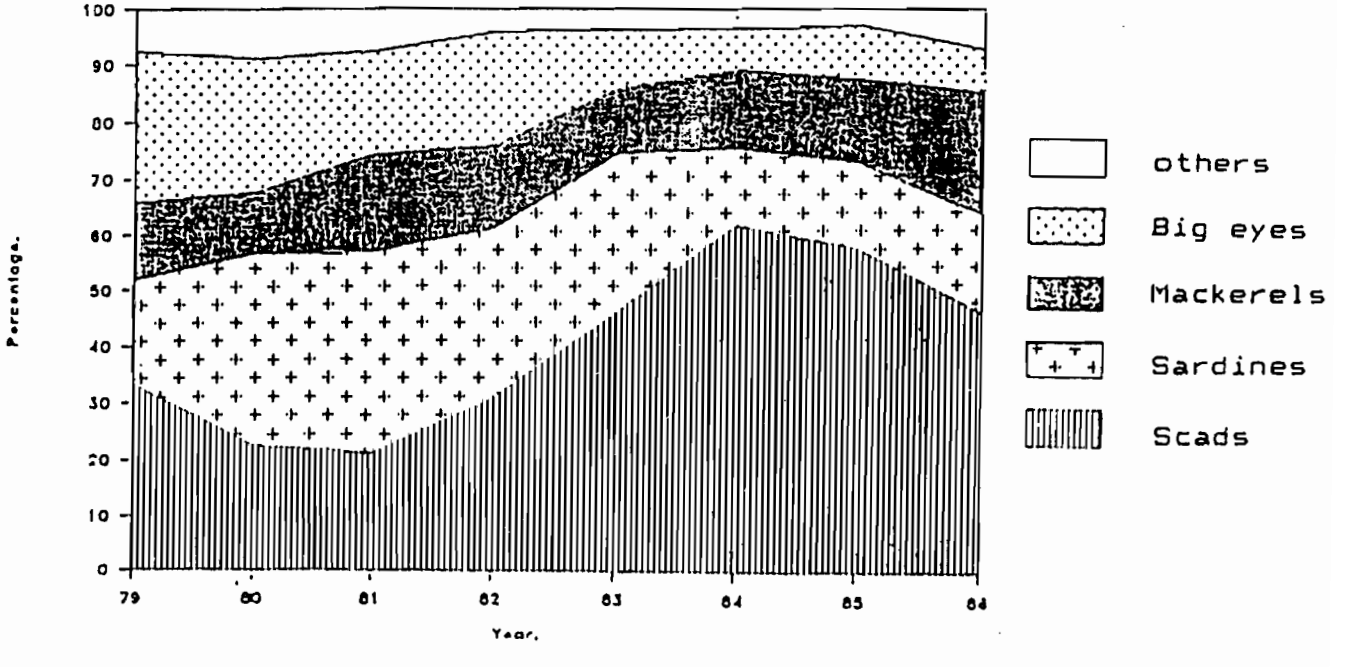
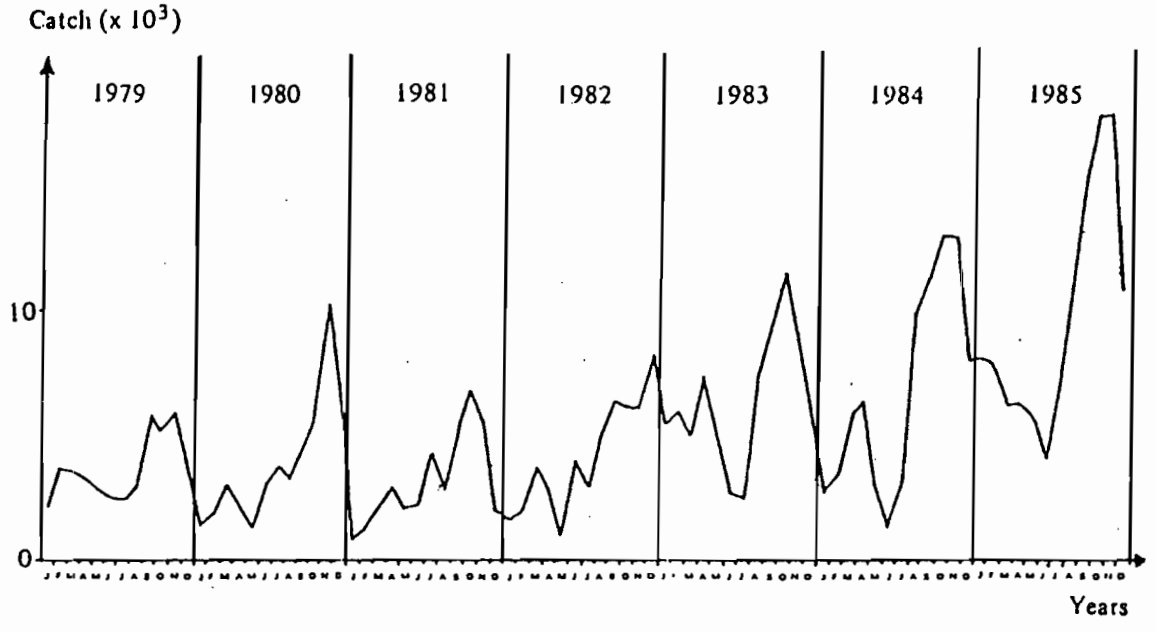


Figure 5. Catch repartition of the javanese purse seiners according to commercial groups from 1979 to 1986.



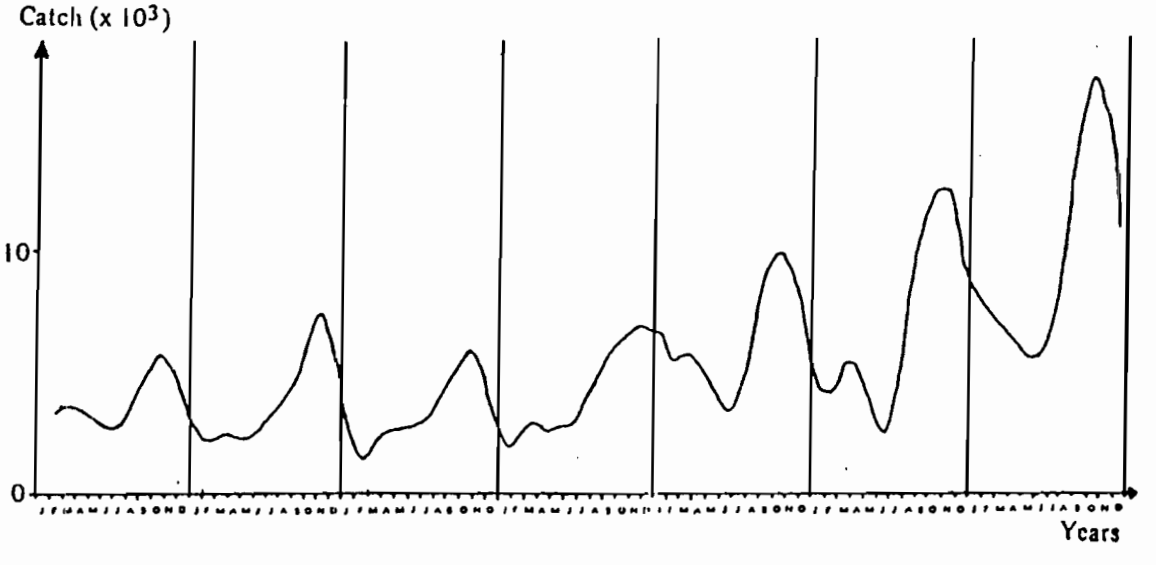


Figure 6. Monthly evolution of the purse seiners catch in the Java Sea from 1979 to 1985 (tons).
(a) raw data (b) moving average over three months.

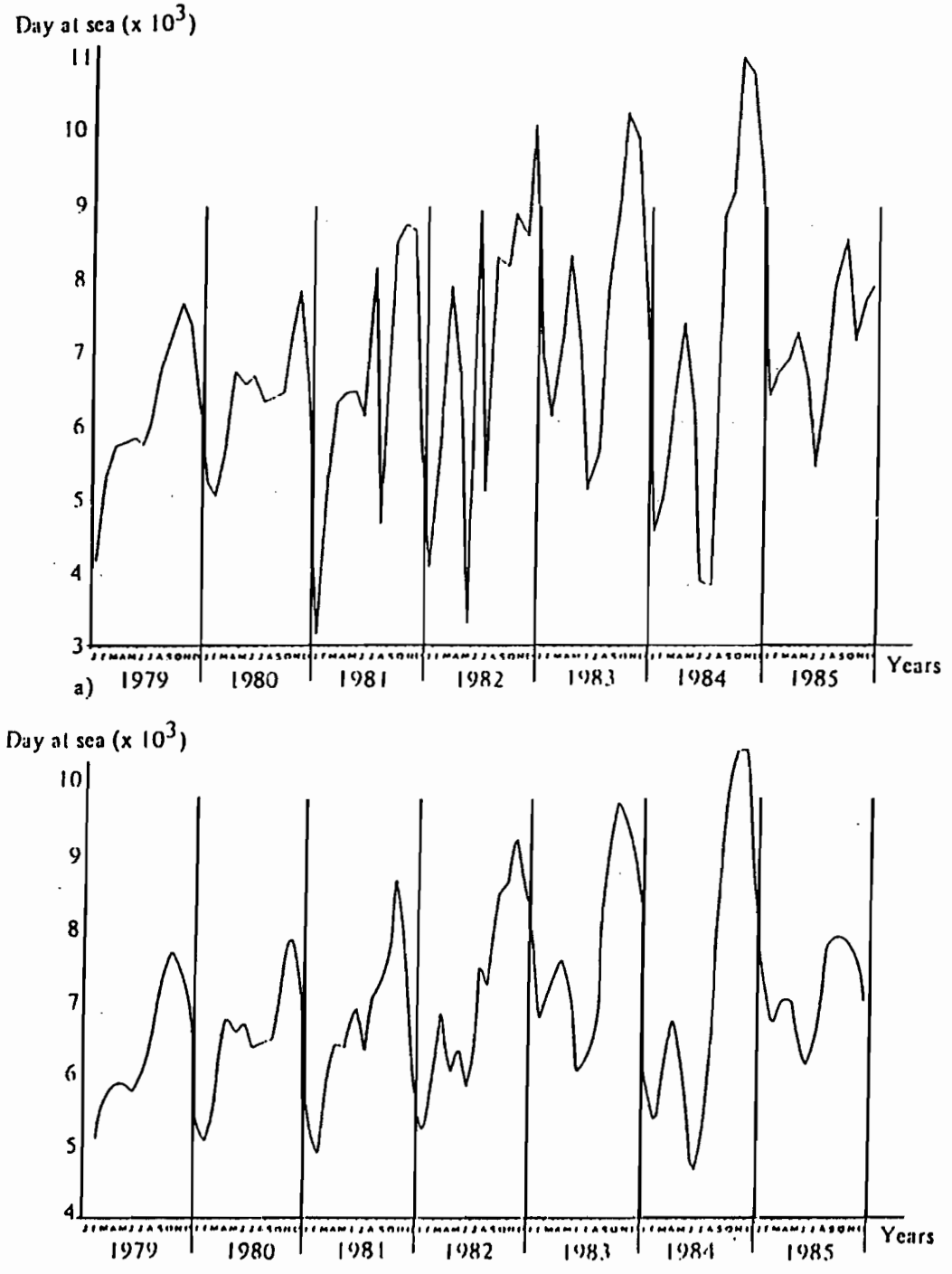


Figure 7. Monthly evolution of the purse seiners' effort in the Java Sea from 1979 to 1985 (Days at sea).
(a) raw data (b) moving average over three months.

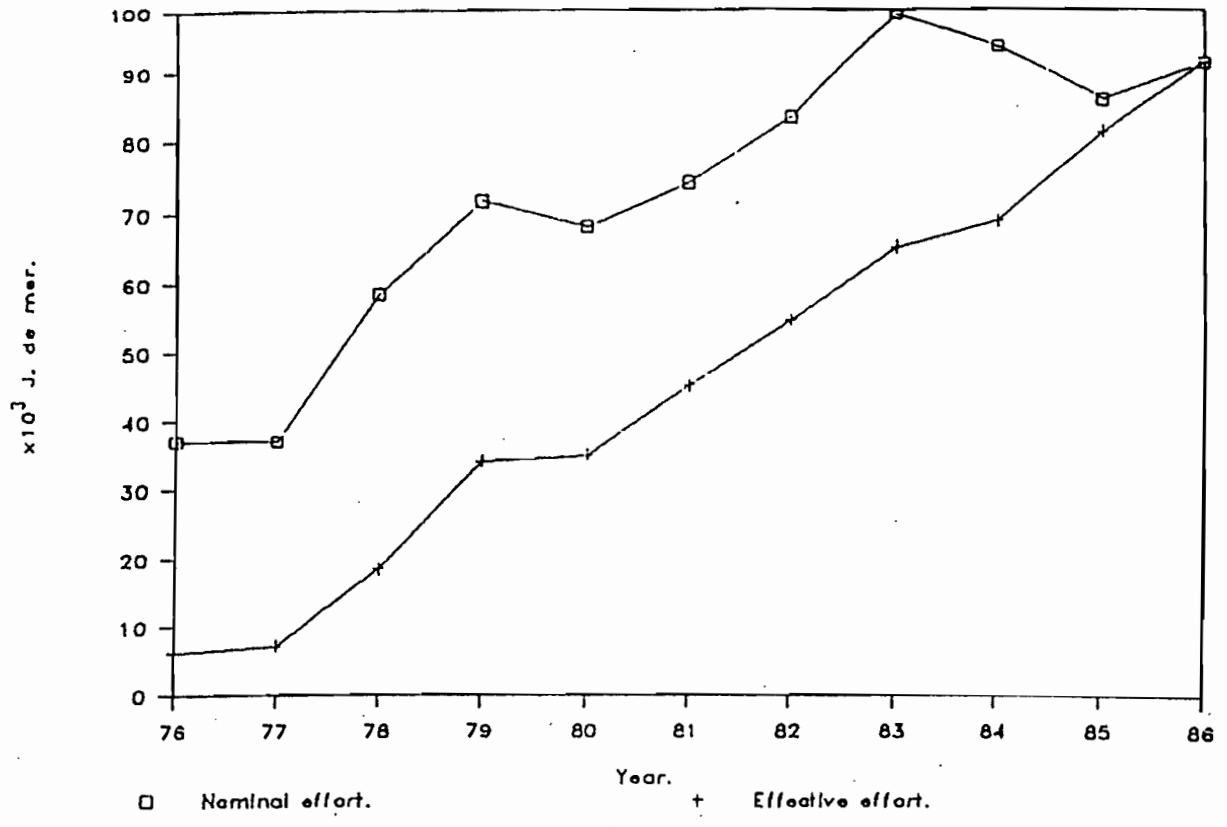


Figure 8. Evolution of the nominal effort (days at sea) and effective effort (standard days at sea) of the javanese purse seiners from 1976 to 1986.

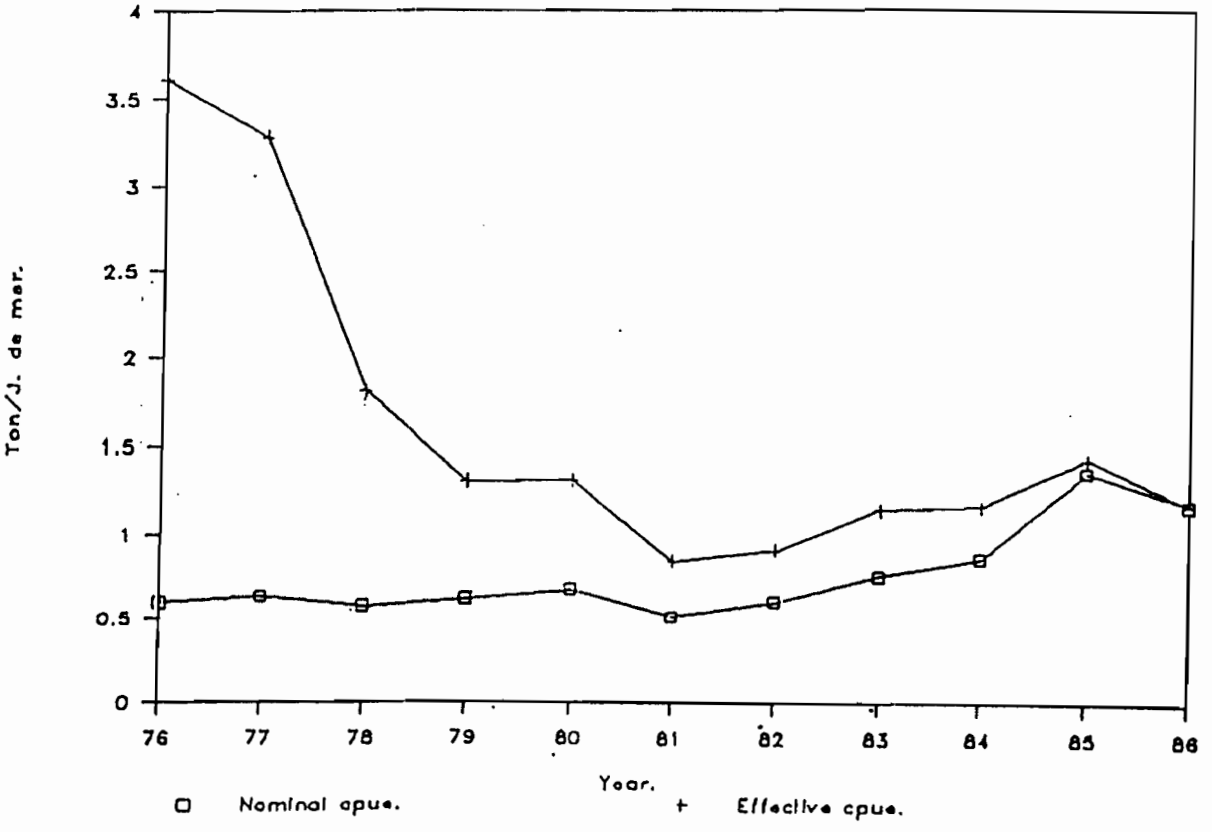


Figure 9. Evolution of the nominal catch rate (tons/days at sea) and effective catch rate (tons/standard days at sea) of the javanese purse seiners from 1976 to 1986.

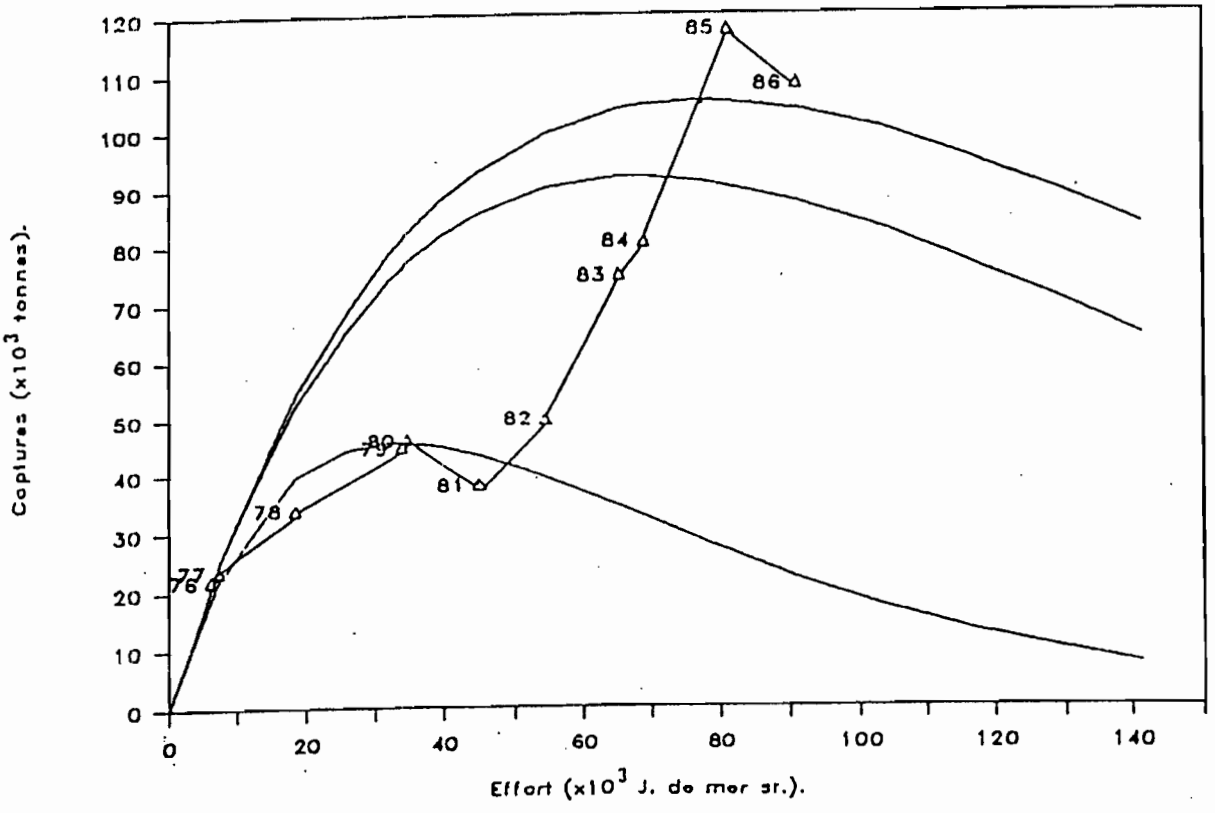


Figure 10. Relation catch-effort according to the fox model modified by Garcia and Caddy (1987).

Potier Michel, Suherman (1993)

Main results of the previous studies of the small pelagic fishery in the Java Sea

In : *Collected reprints on the big purse seiners fishery in the Java Sea : 4. Years 1991*

Djakarta : Agency for Agricultural Research and Development, 25 p. (Scientific and Technical Document ; 13). Seminar on the Pelagic Fishery Assessment in the Java Sea, Djakarta (IND), 91/03/21.