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An important shrimp fishery has blossomed in Indonesia since 1965.

A Review of the Indonesian Shrimp Fishery and Its Present Developments

M. UNAR

Location of Indonesia in white.

INTRODUCTION

Although there has been a shrimp fishery for a long time in Indonesia, it attracted special attention only after 1960 and grew rapidly some time after 1965 when modern shrimp fishing technology was introduced in Indonesian waters. Some of the methods of catching shrimp which have been applied locally for many years include the use of bottom gill nets, beach seines, the "chantrang" Danish seine, push nets, and tidal traps. The last mentioned method, which is conducted on a large scale along the east coast of Sumatra and particularly in the waters of the southern part of Malacca Strait, seems to be the most efficient. (See maps, pages 23, 24, and 25, for place names mentioned in the text.)

Although it was introduced earlier for experimental purposes, shrimp trawling started commercially only in 1966 in the waters of Malacca Strait, particularly in the area surrounding the estuary of the Rokan river, with Bagansiapi-api as its base. This fishery is characterized by the operation of wooden sampan-like motorized vessels of 5-20 GT employing a single Gulf-type shrimp trawl of 40 feet head-rope. This fishery developed rapidly and at the end of 1971 not less than 800 vessels, including some (less than 50) modern ones were operating in these waters. In the beginning of the development of this fishery, shrimp was the main objective. However, owing to the great demand for fish in the surrounding regions, such as Java which traditionally has become a market for salted fish processed from the catches of tidal traps in this region, the new shrimp fishery has finally developed into a conventional trawl fishery in which shrimp constitute the most valuable component of the catch. In the meantime there were increasing activities in the local shrimp fisheries along the north coast of Java and south Sumatra from which the landings were collected and taken to Jakarta. From there they were exported along with catches from other areas.

The great demand for shrimp in overseas markets has attracted the attention of not only domestic capital, but in particular of foreign capital as well. In 1968 joint ventures involving foreign capital were established in shrimp fisheries in several parts of Indonesia, particularly in the Sumatra, Kalimantan, and West Irian regions. This has given rise to the establishment of new small shrimp centers such as those in Kotabaru, on the island of Pulau Laut in southeast Kalimantan, Ambon and Sorong. At least 10 new cold storage plants for shrimp were installed throughout Indonesia in 1971. In these joint ventures some highly experienced companies, belonging to the four biggest Japanese fishing companies, are involved. Experience has shown that within a relatively short time they were able to adapt themselves to the local conditions, especially as regards the shrimp fishing grounds in the waters for which they are licensed to operate.

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However, these developments and the steadily increasing demand for shrimp have given rise to concern as regards the possibility of biological overfishing, as well as the possible overcapitalization in this fishery. It is unfortunate that, particularly in those regions with important concentrations of the shrimp fishery such as the east coast of Sumatra, catch and effort data on these industries are scarce. The catch and effort data available relating to new fishing grounds, although still incomplete, constitute basic material for the evaluation of the developments of this industry and for the planning of its further growth.

SOURCE OF DATA

Data on shrimp landings are compiled by the Directorate General of Fisheries from the data collected by Regional Fisheries Services. Since the compilation of these data has been carried out for a long time without being directly used in stock assessment studies, the data have not been collected in desirable detail. This is the case, for example, for the east coast of Sumatra and Java, while for some other areas only recently have shrimp been considered an important resource. Therefore exact figures on the total landings, the number and kinds of fishing gear employed, and, in particular, data on landings, specified according to species or groups of species and fishing gear, are lacking. Despite the difficulties encountered at the beginning, it is presently possible to compile data from new shrimp fishery centers, and more detailed information is expected after the establishment of the cold storage plants. In the meantime, efforts are being taken to improve the whole fishery statistical system.

In general the establishment of shrimp joint ventures is preceded by trial fishing or surveys which last for about one year. Such commercial surveys are supervised by the government and conducted by the Marine Fishery Research Institute in cooperation with the shrimp companies involved. The data obtained from these exploratory surveys are used in this report to analyze the shrimp fisheries in such areas as Kalimantan and the Arafura Sea.

THE SHRIMP FISHERY

Shrimp production from marine and estuarine fisheries in recent years is estimated at roughly 30,000-35,000 metric tons annually. Butler (1959) estimated these landings at around 26,000 metric tons, for the year 1955. Penaeid shrimps are fished in practically all the coastal areas of Indonesia. The most important species are: *Penaeus merguiensis, P. indicus, P. monodon, P. semisulcatus, P. latisulcatus, Metapenaeus monoceros* and *Parapenaeopsis* spp. Trade names, possibly originating from Australia and recently introduced by the joint ventures, include: banana prawn for *Penaeus merguiensis* and *P. indicus*, tiger prawn for *P. monodon* and *P. semisulcatus*. In some cases *Parapenaeopsis* spp. are also known as tiger prawn. *Metapenaeus monoceros* and *Penaeus latisulcatus* are called endeavour and king prawn, respectively. The greater part of the landings consist of *P. merguiensis*.

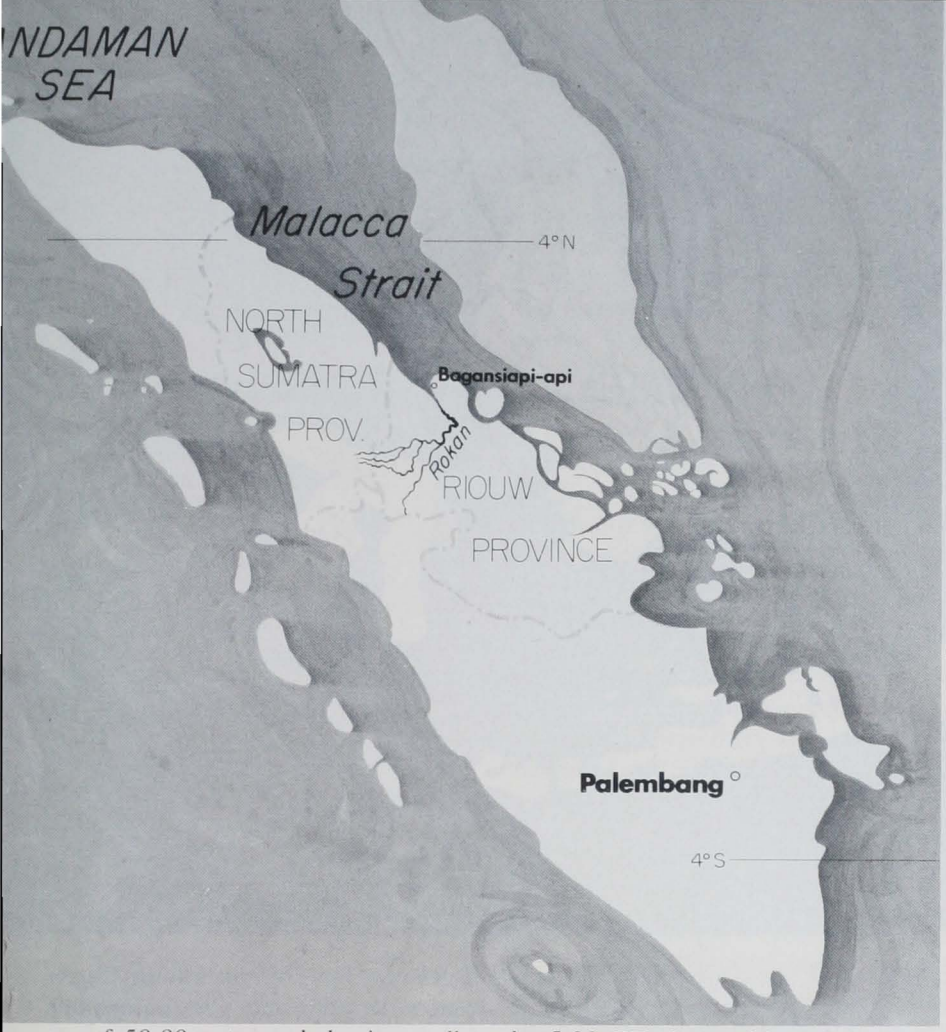
Another group of shrimp which occupies an important place in the production and diet on a national scale is the so-called rebon, jambret, or blachan, a mixture of the specimens of the order Myscidacae, *Sergestes* of the order of Decapoda, and juveniles of penaeid shrimp. From this mixture, which is normally caught along the coast near estuaries, shrimp paste is manufactured and is widely used in the daily diet. Its production must be fairly high in view of the wide use of shrimp paste, but this report does not deal with this group of shrimp.

The major part of the above-mentioned penaeid landings comes from the waters of the Indonesian Sunda Shelf, in particular the east coast of Sumatra, Kalimantan, and Java. Sumatra is the leading producer with a total landing estimated around 20,000-25,000 metric tons per year, followed by Kalimantan and Java in that order. In the eastern part of Indonesia, the new fishing grounds in the Arafura Sea on the West Irian coast are considered to be the best. The coastal areas facing the Indian Ocean do not produce shrimp in abundance. It is estimated that only around 300-500 metric tons are landed annually on the west coast of Sumatra and the south coast of central Java. In view of the differing conditions of the fishing ground and the differential development of the shrimp fishery, it seems appropriate to discuss the fisheries on a regional basis.

The East Coast of Sumatra

There is shrimp fishing along this entire coast (see map, page 23) but intense fishing is carried out only in the coastal areas between lat. 4°N-4°S and the heaviest fishing is concentrated in the southern part of the Malacca Strait. In this area the primary productivity is reported to be rather high. There is a weak northward drift current throughout the whole year, while a tidal current from the Andaman Sea becomes stronger with an increasing amplitude as it approaches the relatively narrow passage. Owing to the effluent of the rivers of Sumatra, the Strait is gradually becoming shallower and recent observations indicate an average depth of 6-53 m. In the southern part where the fishery is most intense the depth is 6-27 m.

In this area the coastal shrimp fishery is characterized by the use of tidal traps, mostly consisting of a conical net made of synthetic twines, with the mouth of the net placed between two poles inserted in the bottom of the sea in such a way that their plane is perpendicular to the direction of the tidal flow. Thus, the nets fish on both directions of the tidal current. Such nets are placed in rows, forming batteries in places with depths varying from 2-6 m. A unit consisting of a



Sumatra, showing locations mentioned in the text.

row of 50-80 nets, each having a diameter ranging between 5-8 m, is common. Around Bagansiapi-api, in the estuary of Rokan river, there are at least 500 such units. These conditions are almost identical to those prevailing in the coastal areas south of Malacca Strait reaching as far as lat. 4°S, although the number of traps in the south is less than those in the Strait. Since this gear is primarily employed for filtering "rebon," the mesh size of the codend is very small, ranging between 0.5-1.0 cm. Estuarine and other coastal fishes are the main catch, but "rebon" and penaeid shrimp are caught together in amounts between 5-80 percent of the total catch. The penaeids are dominated by *Parapenaeopsis* spp. followed by *P. merguiensis* and, in lesser quantity, by *Metapenaeus brevicornis* and *M. mastersii*.

The offshore southern part of Malacca Strait is the area in which the trawlers operate. These are generally flat wooden sampan-like trawlers of the 5-20 GT class. Although many of them are provided with winches, there are still those which use manually operated wooden rollers. Lately some modern double-rigged trawlers, with sizes ranging between 40-100 GT, were introduced in this area. Bases are scattered over the entire coast. In two provinces on the southern part of Malacca Strait, the Riouw and the north Sumatra provinces, the number of trawlers increased from 8 in 1966 to 830 at the end of 1971 (Table 1). As was mentioned earlier, this fishery is becoming a conventional trawl fishery although shrimp is still the highest prized catch. Unfortunately, except for information on the number of licensed vessels, no data are obtainable on the catch and effort and it is impossible to analyze the condition of the stock on the basis of this information alone. However, about 50 vessels have recently transferred their operation from this area to the north coast of Java, because, according to the operators, the catch rates in the Malacca Strait have been dwindling rapidly. This may be an indication of overcapitalization at the producers' level. Starting in 1968, a company with Japanese capital and technicians, based in Palembang, south Sumatra, operated a fleet of 26 relatively small shrimp trawlers in that coastal area. They have recently transferred their operations to east Kalimantan owing to low catches, which were estimated at around 5 metric tons (heads-on) per vessel annually. No detailed data were obtained during the course of their operations.

Table 1.—Number of trawlers licensed from the two provinces bordering the Malacca Strait, the Riouw and north Sumatra provinces, 1966-1971.

Year	Number of trawlers
1966	8
1967	59
1968	113
1969	363
1970	590
1971	830

It is worth noting that other fishing methods, such as bottom gill nets, Danish seines, and other kinds of traps, can be found all along the Sumatran coast and contribute substantially to the shrimp landings.

The North Coast of Java

The central part of the northern coast of Java, which in a way constitutes a bay, and the Madura Strait in east Java are the main fishing grounds for the coastal shrimp fishery. There are no large rivers flowing into the Java Sea in comparison with the south coast of Kalimantan which faces north Java across the Java Sea. The Java Sea, like other waters in Indonesia, is subject to the influence of the two monsoons; the East or Dry Monsoon from May to October and the West or Wet Monsoon from November to March. During the East Monsoon, winds come from the ESE and reach maximum force in June-August. During the West Monsoon,

Indonesia, showing areas of importance to the shrimp industry mentioned in text.

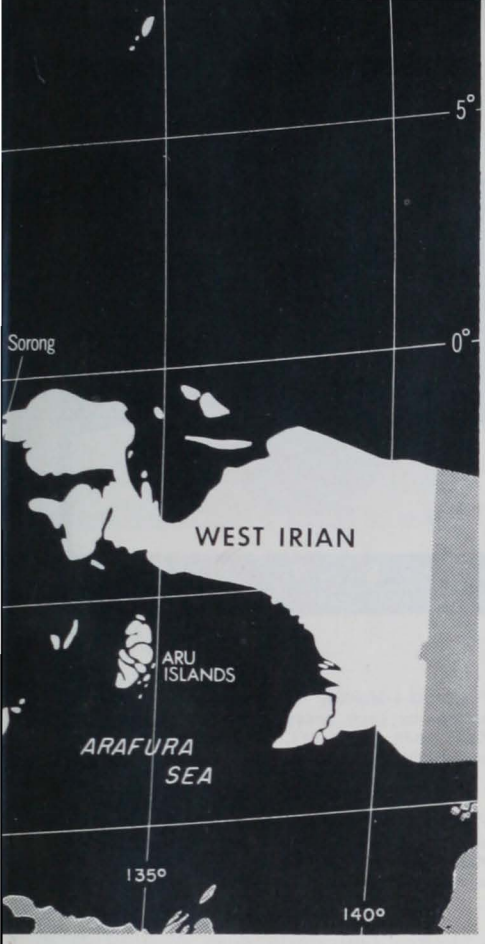
winds come from the opposite direction and reach a maximum in January-February. April and November are transitional periods with winds of less strength and unpredictable directions. The westbound surface current lasts from May to October, with strongest flow culmination in June. The eastbound surface current lasts from November to March, with a peak in February. The latter, although of shorter duration, is stronger and is associated with winds and generally heavy rains. As a consequence of these physical conditions of the sea, the shrimp are concentrated in the shallow coastal waters and trial fishing with a trawl failed to produce satisfactory results. Local fishing with bottom gill nets is more successful. At present this fishery is developing at a very rapid rate, but the recent annual landings of 2,500 metric tons should not be attributed to this fishery only, since shrimp catches are also made by varied other fishing gears of individual minor importance. In the last two years, new cold-storage plants have been installed in Jakarta, Semarang, and Surabaya.

The West and South Coasts of Kalimantan

Along the west coast of Kalimantan, particularly in the vicinity of estuaries, the coastal shrimp fishery presents the same characteristics, although in a smaller scale, as those prevailing on the east coast of Sumatra where tidal traps play an important role. In addition, some other gears, although much less efficient than tidal traps, are distributed throughout the Kalimantan coastal areas. Because there are large rivers flowing into the Java Sea, shrimp grounds are extended farther offshore as compared with the north coast of Java where the rivers are smaller. Local Fisheries Services estimate the present coastal shrimp landings at around 3,500 metric tons annually.

In 1968 a company with Japanese capital, the Kyokuyo Hogei, obtained a licence for shrimp fishing in the waters of south and west Kalimantan from a base in Jakarta. In order to determine whether the establishment of the investment could be commercially justified, it was preceded by trial fishing or surveys for one year. Two vessels of about 99 GT each were used as survey vessels. The survey commenced in May 1968 and concluded in April 1969. The area covered by the survey is shown in Figure 1. In 1969 it was decided to proceed with the enterprise and another vessel of 377 GT was added. In 1970 six vessels, five of which were of the 100 GT class, continued the fishing operations in this area and in 1971 thirteen vessels of the same size class constituted the total number of vessels employed by the company. However, in that same year the company expanded its area of operation to West Irian. Only two vessels operated the entire year in Kalimantan and the whole fleet of thirteen vessels had only 50 boat-months in this area.

The total landings showed an increase each year. Including the catches



of the survey period, the total landings (heads-off) were as follows:

1968	38,016 kg
1969	50,000 kg
1970	132,397 kg
1971	231,771 kg

Two vessels which were in full operations in this area in 1971 landed 61,582 kg and 61,127 kg respectively. The average catch-per-vessel in 1968 was 19 metric tons; in 1969 this decreased slightly to 16.7 metric tons; in 1970 it increased considerably to 22 metric tons; and in 1971 catch-per-vessel declined again to 17.8 metric tons. Figure 2 illustrates the course of the developments as described above. The drop in the landings of 1969 was due to the absence of the vessels after finishing the surveys, while the third bigger vessel, which started its operation in that year, failed to demonstrate its ability to operate effectively in shallow waters. The drop in 1971 must be attributed to the fact that a bigger part of the time of the fleet was spent in the waters of West Irian. The present operations are concentrated in relatively limited areas, i.e., in the vicinity of Nuri Gulf on the west Kalimantan coast and around the Kumai Gulf on its south coast, both in depths between 10-20 m, where the density of shrimp is highest.

In Figure 3 are shown the average monthly landings per vessel. In four of the months the landing per vessel (heads-off) was less than 3 metric tons. This catch rate could possibly be marked as a minimum target to be reached by vessels of about 100 GT.

The East Coast of Kalimantan

This coastal region faces the Makassar Strait, where there is a rather limited shelf and a continuous southward surface current. Several fairly large rivers discharge their waters into this Strait. During limited periods, trial fishing has already been performed by several companies, both national and foreign. Despite indications of the presence of favorable shrimp grounds in this area, it was not until 1970 that a company, formerly operating in south Sumatra, decided to start fishing in the southern part of this region, from a base at Kotabaru on the island of Pulau Laut, southeast Kalimantan. In 1970 only nine vessels were transferred from Sumatra and operated in east Kalimantan. In the following year the whole fleet of 26 vessels had transferred their operation. Most of these vessels are small 10-20 GT wooden vessels, some of which were built in Java. The above-mentioned fleet consists of 1 vessel of 80 GT, 3 of 60 GT and 22 of 10-20 GT. A mothership of 400 GT carries out the collection and processing of the catch. At the end of 1971 a cold-storage plant was installed at Kotabaru.

The total catch (heads-on) in 1970 was 75,214 kg and this increased in 1971 to 345,270 kg. The annual

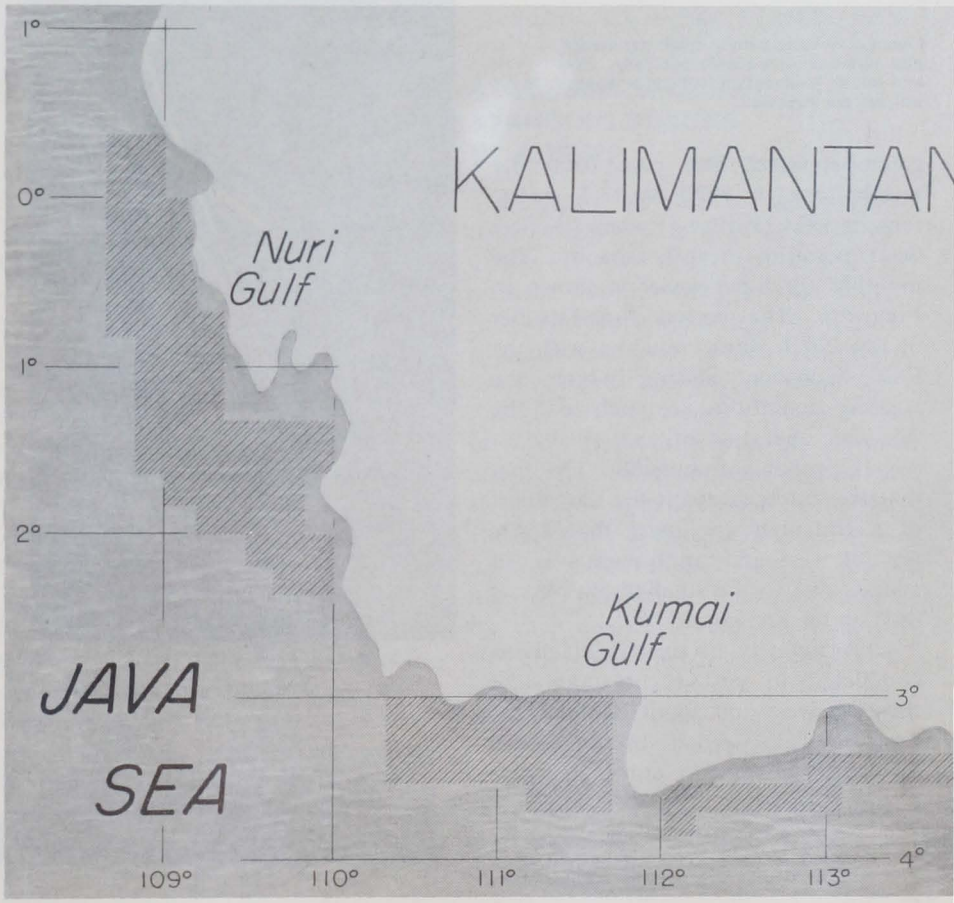


Figure 1.—Map showing the area surveyed in west and south Kalimantan 1968-1969.

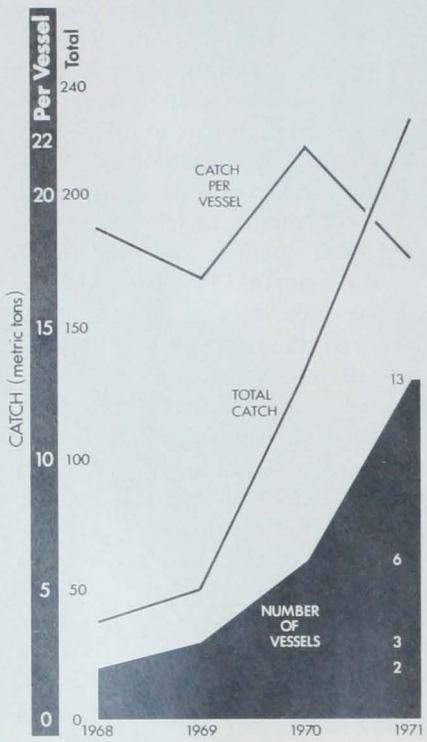


Figure 2.—Total catch, catch-per-vessel, and number of vessels-per-year, west and south Kalimantan 1968-1971. Shrimp weights are heads-off.

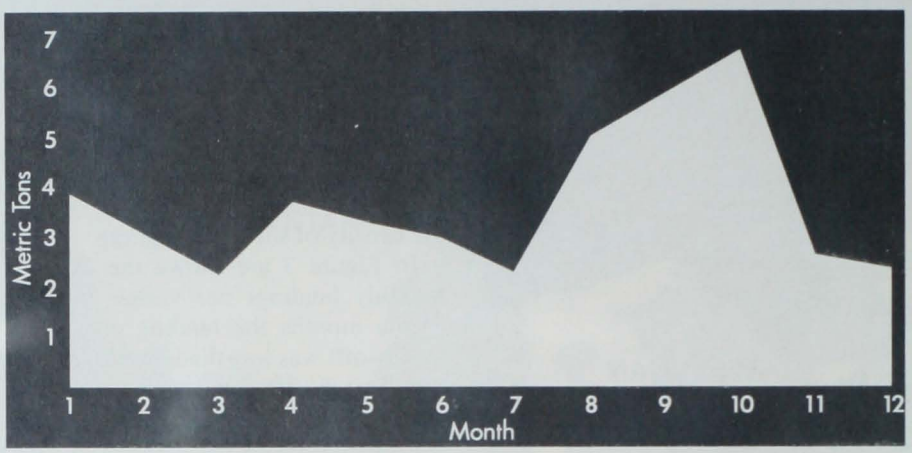


Figure 3.—Monthly average landings of shrimp by each vessel, west and south Kalimantan 1968-1971. Shrimp weights are heads-off.

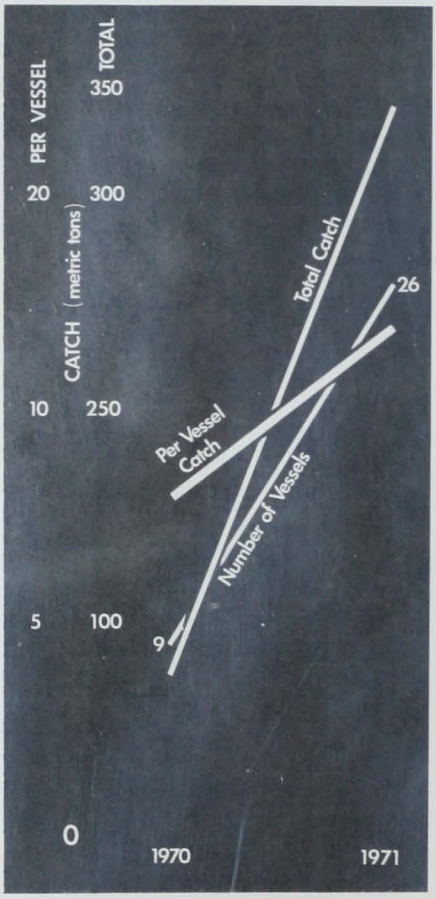


Figure 4.—Total catch, catch-per-vessel, and number of vessels-per-year, east Kalimantan 1970-1971. Shrimp weights are heads-on.

catch-per-vessel also rose from 8.4 metric tons in 1970 to 13.3 metric tons in 1971 (Figure 4) when the fleet was operating in full capacity. The monthly catch-per-vessel is shown in Figure 5. The period June-October of low catch rates coincides with the East Monsoon, during which the weather conditions are such that the full-scale operation of such small vessels is probably impossible. The fact that the catch rates on the east coast of Kalimantan are lower than those on the west and south coasts is, of course, due to the smaller size vessels used on the east coast.

Unfortunately, no surveys have been conducted in east Kalimantan like those in west and south Kalimantan. Essential data needed for the assessment of the shrimp stock in these waters are consequently lacking. Likewise, no detailed information on species or group of species of shrimp caught are available, except that banana prawn constitutes the main catch. The industry has expanded in 1972 with the addition of eight new ships.

The Arafura Sea

The local shrimp fishery practiced along the coastal areas of West Irian is limited to simple gears operating in the vicinity of towns only. The Arafura Sea of the West Irian area constitutes a large shelf situated between lat. 4°S and lat. 8°S along the southwest coast of West Irian and extends westward reaching the Aru Islands. It represents a favorable area

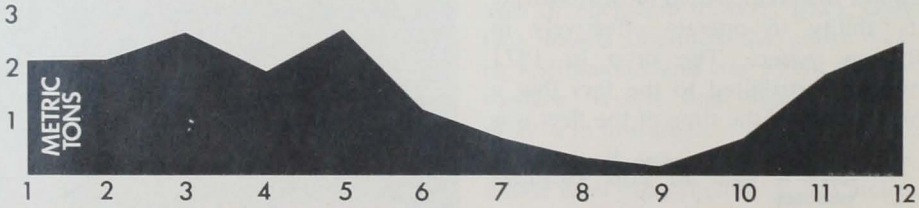


Figure 5.—Monthly average landings of shrimp by each vessel, east Kalimantan 1970-1971. Shrimp weights are heads-on.

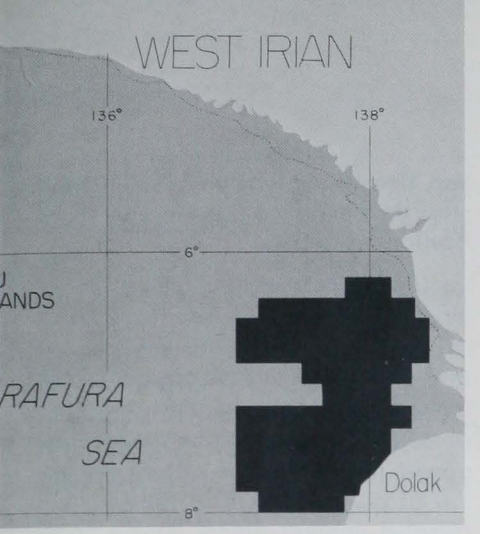


Figure 6.—Map showing the area surveyed in the Arafura Sea, West Irian 1969-1970 which is also the present main fishing ground.

for shrimp grounds in view of (1) the relatively wide area of shelf, (2) the number of rivers flowing from the hinterland of West Irian, and (3) the lack of strong currents.

Faunistic studies carried out by the research vessel *R. I. Jalanidi* in 1964 and 1967 revealed the presence of shrimp, in each of its hauls made by a 40-ft shrimp trawl and a 12-ft beam trawl, throughout the shelf at depths varying between 12-70 m. In 1969 two Japanese companies, the Taiyo and Nippon Suisan, started joint ventures from bases at Ambon in the Moluccas and Sorong in West Irian. As was the case with south Kalimantan, the actual operation was preceded by a survey or trial fishing which lasted for about one year. The area covered by these surveys is shown in Figure 6. Although the licenced fishing area covers almost all waters of West Irian, the actual operations thus far have been concentrated in the area where the surveys were carried out. Lately, several companies are trying to expand their operations to the east coast of the Aru Islands and the northern coast of West Irian, but so far the southern coast of West Irian (east of Dalak Islands) has thus not been touched yet.

In 1969 nine vessels were operating as commercial survey vessels; in 1970, 17 vessels; and in 1971 the number increased to 42 vessels, 70 percent of which are of the 100 GT

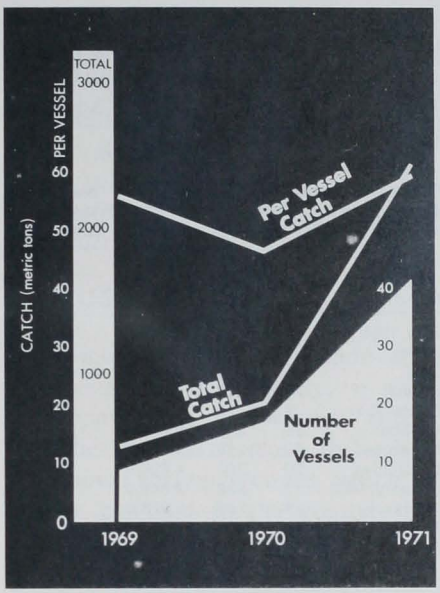


Figure 7.—Total catch, catch-per-vessel, and number of vessels-per-year, the Arafura Sea, West Irian 1969-1971. Shrimp weights are heads-off.

class and the remainder of the 300 GT class. The total landings (heads-off) included with the trial catches were:

1969	504,525 kg
1970	805,320 kg
1971	2,493,371 kg

The annual catch-per-boat was 56,056 kg in 1969, which in 1970 dropped to 47,247 kg and in 1971 rose again to 59,366 kg. The drop in 1970 was caused by the absence of the vessels after finishing the surveys, reducing thus the number of fishing days, while new vessels started their operations only toward the end of 1970 (Figure 7).

Penaeus merguiensis constitutes about 80-90 percent of the catch. Closer to the estuaries *Parapenaeopsis* spp. can be caught in big quantities, but the thick muddy bottom in such shallow waters prevents continuous operations. At the end of 1971 some new vessels arrived in these waters and surveyed the area east of the Aru Islands. From October until December 1971 six vessels of the 100 GT class have landed 201,216 kg of shrimp, of which 161,358 kg consisted of tiger prawn with *Penaeus semisulcatus* as the most abundant species. The monthly catch-per-vessel data are shown in Figure 8. There are three peaks in the course of the year which exceed 10 tons. An expansion of the fishery is expected in the coming years, following the installation of two cold-storage plants in Ambon and one in Sorong toward the end of 1971.

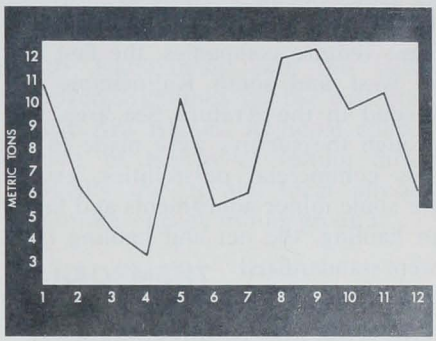


Figure 8.—Monthly average landings of shrimp by each vessel in the Arafura Sea, West Irian 1969-1971. Shrimp weights are heads-off.

ASSESSMENT OF THE STANDING STOCKS OF SHRIMP

Owing to the lack of appropriate data collections, it is possible to examine only the newly established Indonesian shrimp fisheries, for which there are appropriate data, in respect to catch and effort. Catch and effort data obtained from west, south and east Kalimantan and the Arafura Sea off West Irian show that the shrimp resources in these areas are still in the early stages of exploitation. To evaluate the future development and magnitude of these fisheries (say, to determine the maximum number of vessels for each area), the analyses of catch and effort data need to be continued and extended to provide information on the status of the stocks. An estimate of the total shrimp potential can be obtained from a resource survey carried out by a vessel. The catch rates-per-area covered by the gear, which provide minimum estimates of the

shrimp abundance in the track of the net, can be used to obtain a minimum estimate of the standing stock in the whole area covered by the survey. If the shrimp stock in the area is unexploited, it may be taken that the potential annual yield of this stock is at least equal to the standing stock estimate.

There were two surveys performed by the Marine Fisheries Research Institute in cooperation with shrimp joint venture companies: the first one in west and south Kalimantan and second in the Arafura Sea area. Although the surveys were made to assess commercial possibilities, except for some minor adjustments and faults in hauling, the net and hauling time were standardized.

The West and South Coasts of Kalimantan

The survey was conducted by two vessels. Only one, the *Akatsuki Maru*, a 99 GT steel trawler, completed the activities which started in May 1968 and terminated in April 1969. The vessel, which was originally a tuna longliner, modified as a double-rigged shrimp trawler, had the following specifications:

Length	28 m
Beam	5.20 m
Draft	2.40 m
Main engine	430 HP
Maximum speed	12 knots
Fish hold capacity	120 m^3
Contact freezer capacity	2 tons/day

The nets used throughout the operation, with some minor adjustments, were double polyethylene shrimp trawls with 65-ft ground ropes. The area under survey was primarily along the coast of west and south Kalimantan, where trawling is possible in depths between 8-25 m with most trawling concentrated between 10-20 m. The survey area was divided in grids of 100 square miles and the total area covered by the survey was about 9,000 square miles. The total fishing days were 254 days with 2,302 hauls and a total catch of 33,985 kg (heads-off). Most hauls were of 2 hours duration with a total of 4,582 hours of hauling (Table 2).

Table 2.—Number of days, hauls and catch (heads-off) by *Akatsuki Maru* 99 GT during the survey in 1968-1969, west and south Kalimantan.

Month	days	hauls	catch (kg)	catch per haul
May 1968	19	151	1,089.5	7.22
June	20	165	998.0	6.05
July	23	171	1,067.5	6.24
August	29	262	1,576.0	6.07
September	6	35	216.0	6.18
October	29	278	6,450.0	23.20
November	22	213	4,450.0	20.89
December	30	287	4,890.0	17.04
January 1969	22	222	3,846.0	17.33
February	28	269	5,078.0	18.88
March	19	184	3,056.0	16.61
April	7	65	1,268.0	19.51
Total	254	2,302	33,985.0	

The catch-per-haul was around 14.8 kg and the catch-per-hour was 7.4 kg. The width of the double net was estimated to be 30-40 m and the speed of the vessel was 3 knots. The area covered by the net is thus 0.048-0.066 square miles per hour. Escapement in shrimp trawling may be conservatively estimated to be 25 percent. The standing stock of shrimp is thus estimated to be about 1,261,364-1,734,375 kg heads-off or 140-193 kg per square mile. The catch composition is dominated by *Penaeus merguiensis*, with the biggest part belonging to the 26-30 per lb size group or 15.5-16.4 cm total length. There were indications that differences in the tiger prawn composition occur locally. The west coast, which is directly facing the West Monsoon, has tiger prawn catches of only 6 percent while catches on the south coast are considerably higher, reaching 35 percent. In both areas *Penaeus semisulcatus* was the most common species of tiger prawn.

The Arafura Sea, West Irian

The survey was conducted from May 1969 to March 1970. The *Izumo Maru*, owned by Nippon Suisan company and which was the first shrimp vessel entering these waters, was used as the survey vessel. The vessel, which was also a tuna longliner, is a 300 GT steel double-rigged trawler with specifications as follows:

Length	41.69 m
Beam	7.40 m
Draft	4.00 m
Main engine	570 HP
Maximum speed	12.3 knots
Fish hold capacity	157.3 m^3
Contact freezer capacity	4.8 tons/day

The trawl nets used throughout the survey were double polyethylene shrimp trawls having 85-ft ground ropes. The area under survey was from lat. 6°20'S-lat. 8°S on the Arafura coast of West Irian and extended offshore to long. 137°E. Fishing was carried out in depths between 10-40 m, with a concentration of effort at 17-28 m. This survey area was also divided in grids of 100 square miles and the total area covered by the survey was 6,500 square miles. The total fishing days were 228 days with 1,564 hauls and a total catch of 173,489 kg, heads-off (Table 3). Most of the hauls were of 2½ hours duration with a total hauling time of 4,000 hours. The catch-per-haul was about 111 kg and the catch-per-hour was 43.5 kg (heads-off). The opening of both nets is estimated to be 40-50 m at a speed of 3 knots. The area covered by the nets was 0.066-0.084 square miles. Escapement is also estimated at 25 percent. The standing stock in this area is thus

Table 3.—Monthly number of days, hauls and catch (heads-off) by *Izumo Maru* 300 GT during the survey in the Arafura Sea, West Irian 1969-70.

Month	days	hauls	catch (kg)	catch per haul
May 1969	16	104	4,959	47.68
June	21	118	21,422	181.55
July	25	158	28,738	181.88
August	22	126	31,369	248.96
September	20	150	17,290	115.30
October	21	140	17,148	122.50
November	21	151	14,345	95.00
December	31	238	13,442	56.48
January 1970	20	149	14,392	96.60
February	28	211	9,329	44.21
March	3	24	1,054	43.90
Total	228	1,569	173,488	

estimated to be about 4,207,588-5,355,023 kg or 647-834 kg per square mile.

The catch composition was dominated by *Penaeus merguiensis* roughly representing 90 percent of the catch, while the tiger and other prawn catches were low. The percentage size composition by weight groups of *Penaeus merguiensis*, as is presented in Figure 9, shows the size group at 26-30 per lb or a total length ranging between 15.5-16.4 cm constituted the highest

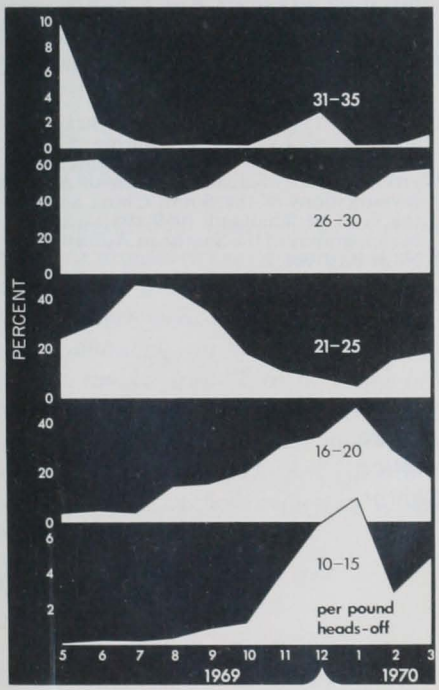


Figure 9.—Monthly size group by weight percentages of *P. merguiensis* landed by *Izumo Maru* during the survey in the Arafura Sea, West Irian 1969-1970.

percentage of the catches during the survey. Earlier observations in other shrimp areas indicated that this species spawns the year around with two peaks, one around March-April and the second around October-November, i.e., in the monsoon transitional periods. The absence of sharp drops in the monthly average catches by each vessel also clearly means that spawning occurs the year around. It is possible that the two peaks of the 31-35 per lb or a total length of 14.5-15.4 group were originally recruits from previous peak spawnings, reaching the age at about 8-9 months at the fishing ground. There is no clear explanation concerning the subsequent bigger shrimp except that the availability of the biggest size group may be attributed to the West Monsoon drift current.

DISCUSSION

Reviewing the general trends of the Indonesian shrimp fishery, a rapid development of commercial shrimp activities has taken place throughout the known shrimp grounds, which are mostly confined to the coastal shelf areas of the bigger islands where river outflow is relatively large. Regionally, the Arafura Sea on the west coast of West Irian is the best fishing ground, followed possibly by the southern part of Malacca Strait, Kalimantan, and Java in that order. However, no detailed data are available on most established local fisheries including the heaviest fishing areas such as the Malacca Strait and the north coast of Java.

In the new fishing areas, the early developments of the shrimp fishery includes increases in catch-per-vessel and in the total catches, except in the case of the west and south Kalimantan areas where the companies involved are still adjusting their operations taking into account the location and nature of the fishing grounds and the size of their vessels. As the present level of exploitation (1971) is about 50-60 percent of the maximum potential estimated for the Arafura Sea and about 13-18 percent of the potential estimated for West Irian, both Kalimantan and West Irian still provide room for expansion of the fleet, especially in the latter area where fishing is presently still centered in a certain limited area.

It is evident that *Penaeus merguiensis* is the most common species in the catch. During the early development of the new fishing areas, catches have been dominated by size group of 26-30 per lb or the equivalent of total lengths varying between 15.5-16.5 cm. It is most probable that spawning occurs the year around, while the strong West Monsoon drift current may play an important role in the availability of the biggest sizes in the shallow shrimp grounds. The tiger prawn, *Penaeus monodon* and *P. semisulcatus*, represent a smaller percentage in the catches, but in areas not directly facing the West Monsoon their importance is greater, as was shown in the catches of south Kalimantan and the newly discovered grounds on the east coast of the Aru Islands. Regional concentration of depths of fishing differs markedly due to the local physical conditions of each fishing ground.

MANAGEMENT

Various management measures can be introduced, toward the end of maintaining the sustainable yield or other management objectives, but serious consideration has to be given to the existing traditional fisheries and the economy of the shrimp industry. The effect of the various possible management measures depends to some extent on the growth and mortality rates of the smaller sizes of shrimp. Values obtained from estimates of shrimp mortality show a very wide range and some estimates are extraordinarily high. Because growth in young shrimp is very rapid, it would be beneficial if the young shrimp is protected, particularly in heavily fished areas. In an overexploited stock the protection of small shrimp will reduce the risk of depleting the adult stock to a level at which recruitment of the offspring might be seriously affected. Closed areas and mesh regulations for protecting small shrimp would not seem to be very effective and would be particularly difficult in existing traditional fisheries where, in most cases, the fisheries are concentrated in and around the estuaries with tidal traps and other gear using very small codends. However, considering the effect that this exploitation should have on the marine stock size and

catch, the enforcement of closed areas, closed seasons, or mesh regulations may appear to be profitable for the shrimp fishery as a whole. The establishment of closed areas for protecting the nursery grounds of juveniles of penaeid shrimp, generally around the estuaries, should be encouraged in the new fishing grounds. Aside from such protection of young shrimp, control of the amount of effort or fishing is very important and can be done through a catch quota, closed season, or direct regulation of fleet size. The difficulties in estimating recruitment variations for the short-lived shrimp could mean that catch quotas, which can be eventually coupled with closed seasons, are of little effect. It appears that the limitation of effort, such as the number of vessels or total tonnage of the fleet, is the most effective method of regulating the amount of fishing, not only from the standpoint of maintaining the productivity of the resource, but also from the standpoint of avoiding overcapitalization. In the future development of new fishing grounds, where there is still room for additional vessels and taking into account the fact that demand for shrimp will continue to increase (and price will continue to rise), the process of the increasing number of vessels must be controlled in such a way that the destruction of the stock and the economy of the industry can be avoided.

In order to facilitate management of the Indonesian shrimp fishery, it is necessary to collect data on catch and effort and on species and size composition of the catch. Prior to the establishment of this data base, management decisions will have to be based on less definitive information.

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