The Mid-1970s Demersal Resources in the Indonesian Side of the Malacca Strait[a]

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Abstract

The results of demersal surveys in the Indonesian half of the Malacca Strait area by the research trawlers *Mutiara 1, 2* and *4* conducted in 1973 and 1975 gave an estimate of the standing stock of 73,000 t. Comparing with other areas, and considering the state of exploitation of the resources in the mid-1970s, the unexploited stock was estimated to have been around 150,000 or 2.66 $t \cdot km^{-2}$. Catch rates and catch composition by depth are given.

The commercial trawl fishery in the Indonesian Malacca Strait prevailing in the 1970s was analyzed on the basis of the statistics in provincial reports and of field interviews. Sustainable yields for two distinct fisheries, Aceh and North Sumatra-Riau, were estimated to be 8,000 $t \cdot year^{-1}$ and 77,000 $t \cdot year^{-1}$, respectively. The stocks were, at the time, beginning to be overfished.

Abstrak

Hasil survei sumberdaya demersal di Selat Malaka dengan kapal trawl Mutiara 1, 2, *dan* 4 *yang dilaksanakan pada tahun 1974 hingga 1975 memberikan estimasi kelimpahan ikan sebesar 73.000 t. Dibandingkan dengan daerah lain, dan mengingat tingkat eksploitasi pada pertengahan tahun 1970-an, stok ikan pada tingkat awal diperkirakan 150.000 t atau 2,66 t. per* km^2. *Hasil tangkapan rata-rata dan komposisi hasil tangkapan disajikan dalam tulisan ini.*

Keadaan perikanan trawl di Selat Malaka di sekitar tahun 1970-an dianalisis berdasarkan data statistik propinsi dan kabupaten serta wawancara di lapangan. Potensi lestari perikanan di sekitar dua daerah, Aceh dan Sumatra Utara-Riau, diperkirakan masing-masing sebesar 8.000 t. dan 77.000 t. per tahun. Saat itu sudah terlihat adanya gejala lebih tangkap.

Introduction

The Malacca Strait (Fig. 1), being one of the world's main shipping routes, is rather well documented in the geological and maritime literature (see Emery 1971; Valencia 1979 and Box 1).

The fisheries of the Malacca Strait are also well documented (SCSP 1976a, 1976b, 1978), although the small pelagics (especially mackerels and scads) have received far more attention than the demersal fishes (c.f. Sujastani 1975, 1976; Anon. 1976a, 1976c, 1976d, 1987 for pelagics; Mansor Mat Isa 1987; Sivasubramaniam 1987; Tampubolon and Sedana Merta 1987; Tampubolon 1988; Soriano et al. 1988 *vs* Menasveta 1970; Anon. 1976b, 1976e; and Mahyam Binti Mohd. Isa 1988.

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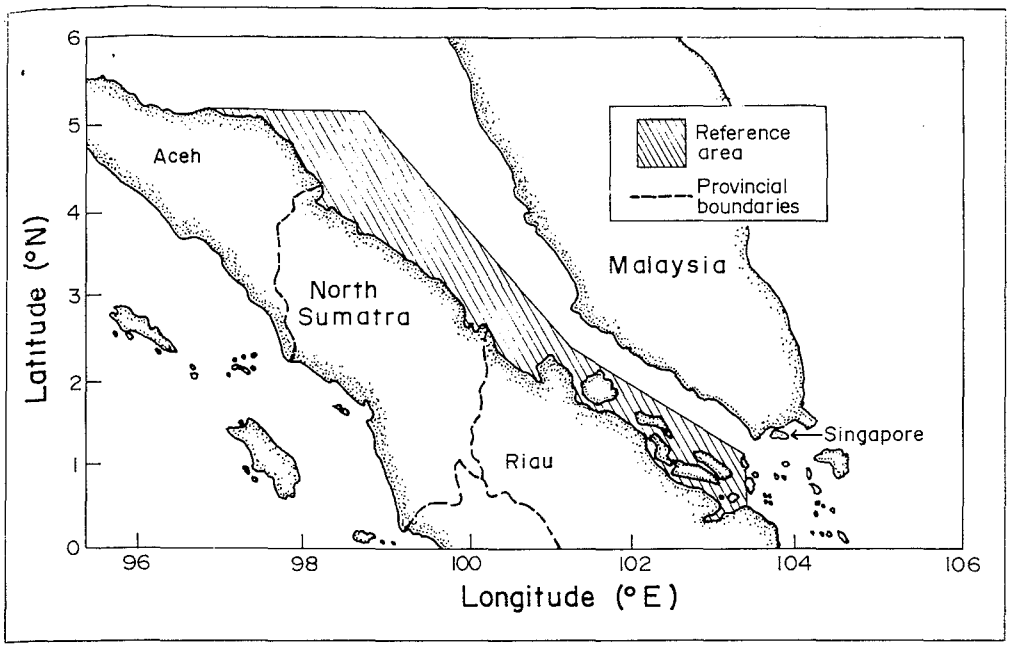

Fig. 1. The Indonesian part of the Malacca Strait (shaded), covering an area of about 55,000 km^2.
[Gambar 1. Selat Malaka bagian Indonesia (diarsir), meliputi luas sekitar 55.000 km^2.]

Table 1. Specifications of the research vessels and gear used for trawl surveys on the Indonesian side of the Malacca Strait, 1973 and 1975.
[Tabel 1. Spesifikasi kapal dan alat yang digunakan dalam survei di Selat Malaka, 1973-1975.]

Name of boat	Gross tonnage	h.p.	Length (m)	Gear	Length of head rope (m)	Mesh size of codend (mm)
Mutiara 1	124	365	23.6	double rig[a]	23.4 (each)	30
Mutiara 2	53.4	165	18.9	double rig[a]	19.0 (each)	30
Mutiara 4	110	316	24.0	Thailand trawl	36.0	40

[a]Shrimp trawl.

Menasveta (1970) reviewed the bottom trawl surveys conducted in the Malacca Strait, notably the results of trawling by the *R/V Tongkol* (Birtwistle 1928), the *R/V Manihine* (Ommanney 1961), and the *Selayang* (Pathansali et al. 1966). Later surveys were conducted with *K.M. Jenahak* (Latiff 1973). Most of these surveys were conducted in what are now Malaysian territorial waters: less information is available on the Indonesian side of the Malacca Strait.

A first report on catch/effort and catch composition data obtained by two Indonesian fisheries research vessels, *R/V Mutiara 1* and *R/V Mutiara 2*, on the Indonesian stocks of the Malacca Strait, was published in Indonesian by Martosubroto (1973). The station grid of *R/V Mutiara 1* and *2* was not truly random, i.e., fishing was directed. Nevertheless, their catch rates are incorporated in the present paper, itself an updated version of Sujastani et al. (1976).

Anon. (1976e) reported on the composition of 12 trawl hauls taken on the Indonesian side of the Malacca Strait in January 1975 by *R/V Lemuru* (see Venema, this vol., for details on *R/V Lemuru*).

Further data for the present contribution originate from the survey conducted by *R/V Mutiara 4* in the Malacca Strait, in early 1975 (see Pauly et al., this vol. for the context of this survey and the sampling methods used, and Torres et al. (this vol.) for a description of a database with details on these and *R/V Lemuru*'s stations).

The fourth source of material used here is the landing and effort statistics of the Provincial Fisheries Offices of the Provinces of Aceh, North Sumatra and Riau. Additionally, interviews with skippers of commercial trawlers operating in the area were conducted towards the end of 1975 by the second author. Fig. 1 shows the area covered here.

Box. 1. Sediments and benthos of the Malacca Strait.
[Boks 1. Sedimen dan benthos di Selat Malaka.]

Emery (1971), based on Keller and Richards (1967) and other sources, describes the sediments of the Malacca Strait as consisting mainly of "*sand* (detrital or calcareous grains 0.05 to 2 mm in diameter and having a hard smooth to rippled surface), *sand-and-mud* (fine sand and silt having a firm to soft smooth surface), *mud* (silt and clay having a soft surface), *gravel* (pebbles and cobbles of broken rock, locally containing many calcareous shells), *rock* (outcrops of bedrock and boulders near outcrops), and *coral* (large areas or reefs of massive calcareous algae and coral)".

The benthos of the Malacca Strait appears to be sparse, at least offshore, far from the mouth of rivers. Neiman (1973) reports of three benthos stations (see Fig. 2 for their locations) from west to east which yielded densities of 4.4 g^{-2} (shallow water) 1.0 g^{-2} in (deep water) and 2.4 g^{-2} (shallow water). He also mentions that far from the mouths of rivers, otter trawls often catch sponges and soft corals, and sea urchins.

Materials and Methods

Trawl Survey Data

The specifications of *R/V Mutiara 1, 2,* and *4* and the gears used for their surveys are summarized in Table 1.

The survey by *Mutiara 1* and *2* in the Malacca Strait lasted from July to September 1973. A total of 148 hauls were made, 61 by *Mutiara 1* and 87 by *Mutiara 2*. The survey of *Mutiara 4* lasted from 27 January to 14 March 1975 and yielded 40 valid hauls (Fig. 2, Table 2). The surface area of each depth horizon is also given in Table 2. These data were used to estimate standing stock size using the swept area method as described in Pauly et al. (this vol.) and using the same assumptions as to the catchability of the gear. Particularly, the same escapement factor was assumed to apply to *Mutiara 1, 2* and *4*.

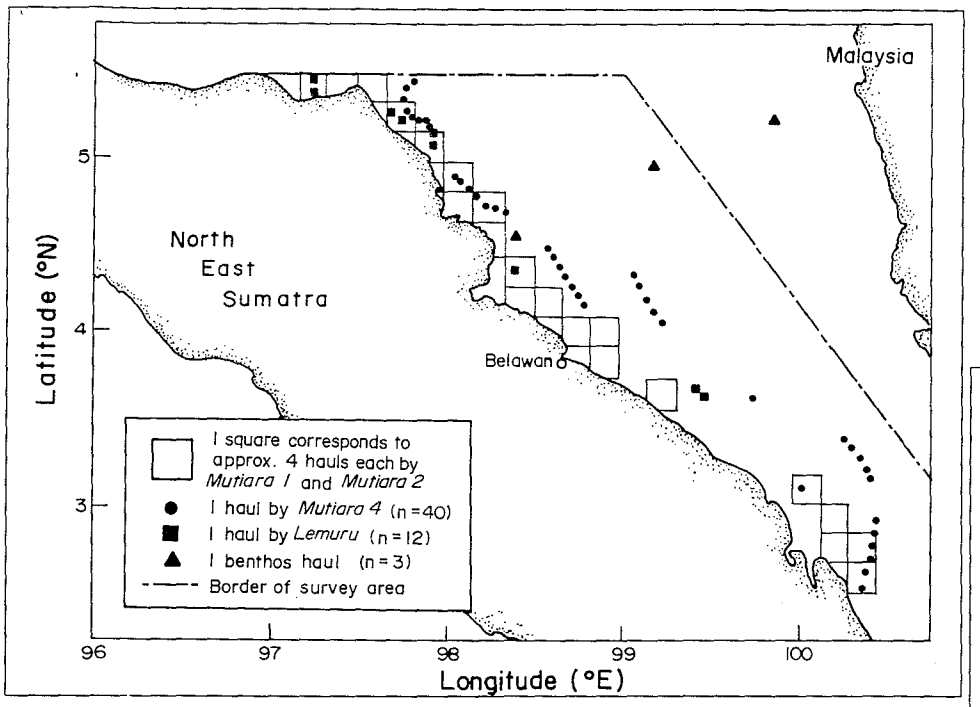

Fig. 2. Location in the Malacca Strait of trawl hauls performed by *FRV Mutiara 1* and *2* in 1973, by *FRV Mutiara 4* in January/February 1975, by *FRV Lemuru* in January 1975. [Also included are three benthos grab hauls made by *R/V Akademik Knipovich* in 1966].
[Gambar 2. Lokasi stasiun trawl di Selat Malaka oleh kapal penelitian Mutiara 1 dan 2 pada tahun 1973, kapal Mutiara 4 pada Januari/Februari 1975, kapal Lemuru pada Januari 1975. (Termasuk juga tiga stasiun pengambilan contoh benthos oleh kapal penelitian Akademik Knipovich pada tahun 1966).]

Table 2. Haul numbers of *Mutiara 1, 2* and *4* in the Malacca Strait, 1973 and 1975.
[Tabel 2. Jumlah hauls/tarikan Mutiara 1, 2, *dan* 4 *di Selat Malaka, 1973-1975.]*

Depth (m)	Surface area (km^2)	No. of hauls by Mutiara:		
		1	2	4
0-9	7,354	2	5	-
10-19	6,860	31	44	-
20-29	4,710	16	38	1
30-39	5,378	12	-	7
40-49	4,719	-	-	11
50-59	7,792	-	-	14
60-69	8,561	-	-	4
70+	10,097	-	-	3
Total	54,931	61	87	40

Box 2. Standardization of trawling effort.
[Boks 2. Pembakuan upaya penangkapan trawl.]

Standardizing the effort of trawlers can be done by relating their catch per effort to their tonnage (as index of "power", since large boats require large engines). The table below documents how the large, medium, and small trawlers were standardized such as to obtain a measure of fishing effort (days fished per year) comparable between provinces.

Vessel characteristic	Large trawlers	Medium trawlers	Small trawlers
Boat class (GT)	> 20	10-20	10
Mean gross tonnage	30	20	10
Average catch ($kg \cdot day^{-1}$)	276	218	160[a]
Power factor	1.27	1	0.74
Nominal effort[b] (by province)			
Aceh	264	-	-
North Sumatra	288	264	240
Riau	280	-	-
Effective effort[c] (by province)			
Aceh	335	(264)	-
North Sumatra	336	264	178
Riau	356	(280)	-

[a]As obtained by linear extrapolation, down to 10 GT, of ratio of catch:tonnage.
[b]Trawler days at sea.
[c]Days at sea of a standard trawler.

The *FRV Lemuru* data were not used for standing stock estimates owing to the small number of hauls (Fig. 2).

Commercial Catch Data

The fisheries catch data originate from the Provincial Fisheries Offices of the Provinces of Aceh, North Sumatra, and Riau and go back as far as reports were available (to 1969). The second author also conducted field interviews in the three abovementioned provinces from November to December 1975. In Aceh Province, four large landing places were visited with about three interviews of trawler skippers at each landing site. In North Sumatra Province, landing sites were visited with the same rate of interviews. In Riau Province, only three landing places were visited with four interviews each. Catch per unit of effort data and effort data (actual fishing days) for large and medium trawlers in the three provinces were derived from these interviews.

The provincial reports did not assign the landed fish and shellfish to the gear that caught them. It was thus necessary to identify, from the catch data, those groups of fish and shellfish which could be assumed to originate from trawl catches. This was done on the basis of Table 3 by assuming that fish contributing more than 2% to the survey catches of *Mutiara 1, 2* or *4* were mainly demersal. Those fishes were then selected from the reports' lists and their catches combined to represent the trawler's catches.

When presenting the data, care was taken to avoid double accounting, as occurred between the Province of North Sumatra, where many trawlers from Riau landed their catch, and the latter province. As no figure was available on the amount of this double accounting, a figure of 50% was assumed; accordingly, the catches reported from Riau Province were cut by half.

Annual catch was plotted against the corresponding levels of effort for the Malacca Strait as a whole and for Aceh Province and North Sumatra-Riau Provinces.

Table 3. Demersal fish catch composition (% of weight) in the Malacca Strait by research vessel and depth range.
[Tabel 3. Komposisi hasil tangkapan sumber daya demersal (berat dalam %) di Selat Malaka berdasarkan kapal dan kedalaman.]

Depth range (m)	0-9		10-19		20-29			30	-39	40-49	50-59	60-69	70+
Group or species/*Mutiara*	*1*	*2*	*1*	*2*	*1*	*2*	*4*	*1*	*4*	*4*	*4*	*4*	*4*
Sharks and rays	0.2	0.4	0.7	1.7	3.1	0.3	3.3	1.1	0.5	15.7	1.4	1.0	0.9
Engraulidae	0.2	0.1	1.4	2.6	1.4	1.4	-	0.8	1.7	1.2	0.1	8.0	-
Clupeidae	1.7	4.9	1.1	4.1	0.8	2.5	41.9	0.1	3.9	4.1	3.9	12.8	0.7
Chirocentrus dorab	0.6	1.0	4.1	1.6	2.9	1.6	-	1.8	0.1	0.4	0.1	0.1	0.8
Anadontostoma chacunda	-	-	0.3	0.1	0.1	-	-	0.1	-	-	-	-	-
Synodontidae	0.4	1.5	2.3	5.3	1.8	3.9	-	9.8	2.0	0.5	2.6	2.4	2.8
Ariidae	-	0.7	0.9	0.4	2.6	0.5	-	2.9	0.7	4.3	1.8	7.0	0.2
Sphyraena spp.	0.3	0.3	0.6	0.5	1.2	0.6	-	0.7	6.9	1.5	0.2	-	-
Serranidae	-	0.1	0.5	0.7	1.5	0.1	-	1.9	0.4	0.1	2.1	-	0.6
Terapontidae	0.9	6.4	2.2	3.8	10.4	1.9	0.9	9.0	0.9	0.3	1.1	2.6	0.3
Priacanthidae	-	-	0.1	0.1	1.4	0.1	-	0.9	0.5	1.3	2.0	0.3	0.3
Rachycentron canadus	-	-	0.1	0.5	-	-	-	-	-	0.4	0.1	-	-
Carangidae[a]	1.9	8.3	4.3	6.6	3.5	4.6	4.4	3.2	16.5	11.5	6.2	7.3	15.5
Formio niger	-	0.2	0.3	0.3	0.4	0.1	-	0.1	0.5	0.2	0.1	0.1	0.9
Lutjanidae (incl. *Caesio* spp.)	-	-	1.0	0.5	0.9	0.8	-	2.4	1.3	5.4	14.4	8.4	.9
Nemipteridae[b]	-	-	2.1	2.8	1.8	3.5	-	2.8	7.5	5.6	6.4	6.8	3.5
Leiognathidae	0.5	7.5	26.8	5.1	20.7	12.6	17.7	8.8	2.9	8.4	7.8	0.3	0.3
Gerreidae	0.9	1.6	1.3	0.6	0.8	0.6	-	1.1	-	2.4	9.5	0.6	17.6
Pomadasyidae[c]	10.9	6.9	5.8	1.7	5.9	1.6	-	4.6	3.9	7.5	4.3	19.4	4.9
Sciaenidae	15.7	11.2	4.4	10.0	3.8	8.8	0.9	4.5	-	4.2	0.9	7.7	-
Mullidae	-	0.9	3.3	2.4	4.5	5.1	-	8.9	6.4	10.7	10.0	1.3	22.9
Siganus spp.	3.4	-	3.9	-	1.9	-	-	1.0	2.1	1.1	0.1	-	0.1
Trichiuridae	1.4	0.9	4.0	5.4	2.5	3.0	8.8	6.1	2.2	3.3	8.8	6.5	1.4
Rastrelliger spp.	1.4	-	0.2	0.6	0.1	-	-	-	-	0.2	1.3	-	-
Scomberomorus spp.	0.3	0.8	0.9	0.4	1.0	0.7	-	1.3	-	-	-	-	-
Pampus argenteus	-	3.1	0.5	0.9	0.2	0.8	9.9	0.1	2.0	0.2	-	0.2	-
Platycephalidae	0.5	2.3	0.5	0.4	1.5	-	-	2.7	0.1	0.1	0.1	-	-
Psettodes erumei	-	0.3	2.1	0.9	0.8	0.8	-	1.3	0.3	0.1	0.9	0.6	0.3
Other flatfishes	13.2	8.9	1.7	4.1	2.5	1.9	0.4	1.9	-	0.1	0.1	0.2	-
Other fishes	45.4	21.9	19.7	26.3	17.3	28.9	4.4	18.4	24.5	7.4	6.5	4.1	3.7
Loligoidae	-	1.3	-	1.8	1.3	2.5	0.4	0.3	10.1	3.6	5.3	2.1	3.7
Sepiolidae	-	1.3	0.9	2.2	1.3	0.9	-	0.1	0.8	0.5	0.8	0.3	0.2
Penaeidae	1.0	1.0	0.2	5.0	0.4	7.8	4.0	0.2	0.1	0.1	-	0.6	-
Thenus orientalis	-	-	0.3	0.1	0.7	-	-	1.1	0.1	0.1	0.2	0.1	-
Other crustaceans	-	1.7	1.0	1.0	0.3	0.6	2.6	-	0.1	0.1	-	0.1	-

[a]Excluding *Decapterus* spp.
[b]Including *Scolopsis* spp.
[c]Including *Plectorhynchus* spp.

Commercial Effort Data

The official reports on the number of boats did not state whether these were trawlers or seiners. It was assumed that the large, medium and small motorized boats were trawlers, and that none of the sailing boats were engaged in trawling. The small motorized boats in Riau Province were mainly gillnetters, and were thus not included; neither were some unregistered motorized boats in North Sumatra operating as purse seiners.

On the basis of the field data, it appears that the large trawlers had an average gross tonnage of 30 t, the medium trawlers of 20 t, and the small trawlers of 10 t (Box 2). The medium-sized trawlers were selected as standard, and the other types converted to this by means of their catch per unit effort (Box 2).

Nominal fishing days for each type of trawler in each province were then multiplied by the appropriate power factor, which led to a measure of effective effort ("corrected fishing days").

Combined with the abovementioned catch data, these estimates of effort allowed the parametrization, via plots of catch/effort *vs* effort, of surplus production models, subject to the caveats in Martosubroto (this vol.).

Results and Discussion

The area covered the surveys of *Mutiara 1* and *2*, and the trawl haul stations of *Mutiara 4* and *Lemuru* are shown in Fig. 2. The composition of the catch of *Mutiara 1* and *2* is given in Table 3 together with that of *Mutiara 4*. To facilitate comparison, all figures were converted into percentages of total catch. For the same reason, those groups of fishes recorded on only one or two of the boats have been added to "other fishes".

Table 4. Mean fish stock densities by depth in the Indonesian sector of the Malacca Strait.
[Tabel 4. Rata-rata densitas stok ikan pada berbagai daerah di paparan Sunda.]

Depth (m)	Mean catch/effort (kg·hour^{-1}) of *Mutiara*			Biomass (t·km^{-2}) based on *Mutiara*:			
	1	*2*	4[a]	*1*	*2*	4[a]	Mean
0-9	36.7	65.3	-	0.5	1.4	-	0.9
10-19	77.8	45.4	-	1.1	1.0	-	1.0
20-29	77.7	41.0	45.3	1.1	0.9	0.7	0.9
30-39	68.4	-	63.9	1.0	-	1.0	1.0
40-49	-	-	158.2	-	-	2.5	2.5
50-59	-	-	100.1	-	-	1.6	1.6
60-69	-	-	84.1	-	-	1.3	1.3
70+	-	-	94.4	-	-	1.5	1.5

[a]Mean values for the surveys documented in Pauly et al. (this vol.).

A feature discussed by Menasveta (1970), the increase with depth of the percentage of more valuable fish groups was confirmed for the Lutjanidae, Serranidae, Carangidae, Pomadasyidae, and others. Less valuable groups such as the Leiognathidae, Siganidae, Sciaenidae, Platycephalidae, and "other fishes" decreased with increasing depth.

Table 4 summarizes the estimates of standing stock, by depth range. Overall, a standing stock of about 80,000 t was estimated for the Indonesian waters of the Malacca Strait, as delimited in Fig. 1., but excluding the depth range 0-9 m, i.e., for a reference area of 47,600 km^2. This corresponds to a mean stock density of 1.67 t·km^{-2}. Here, however, the value for the depth range 10-19 m, where the *Mutiara 4* had not been fishing, was assumed to correspond to the relatively high average value of the same depth range from other, mostly unexploited areas covered by *Mutiara 4* (see Pauly et al., this vol.).

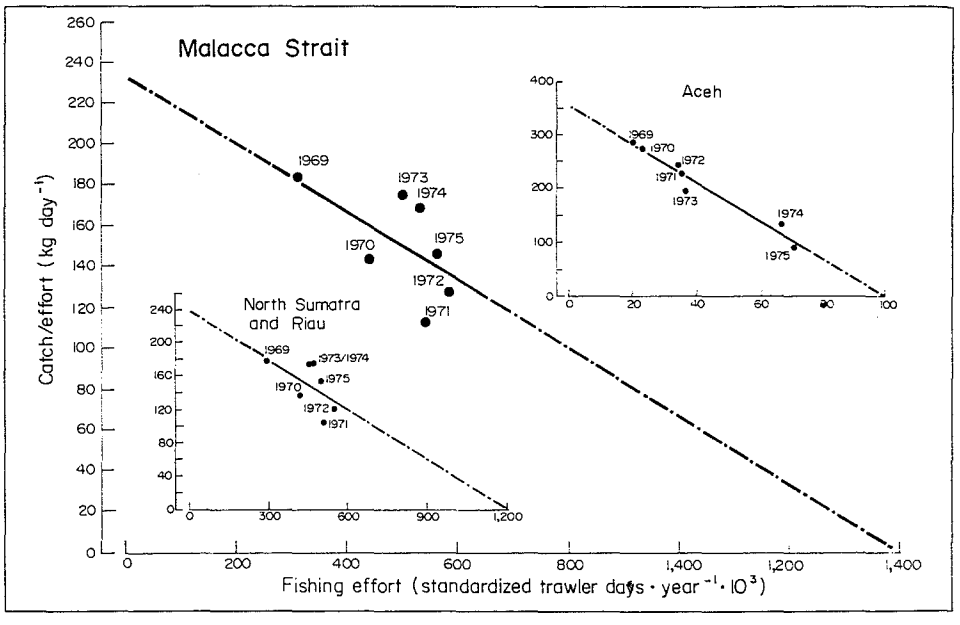

Fig. 3. Trawler catch/effort *vs* effort on the Indonesian side of the Malacca Strait, 1969-1975; note decline, for both subareas considered here (Aceh and North Sumatra-Riau), and consequently, for the area as a whole (see also Table 5).
[Gambar 3. Hubungan antara hasil tangkapan per upaya penangkapan dan upaya penangkapan di Selat Malaka bagian Indonesia, 1969-1975; perhatikan grafik penurunan untuk kedua daerah (Aceh dan Sumatra Utara-Riau) dan selanjutnya untuk seluruh daerah (lihat juga Tabel 5).]

In the specific case of the Malacca Strait, this assumption was probably too optimistic, as heavy trawling was already taking place in the shallow waters. Thus, to correct this figure, the stock densities obtained from the catch rates of *Mutiara 1* and *2* were also calculated (Table 4). These estimates were then used for the depth ranges missing in the *Mutiara 4* survey, while overlapping data of the three boats were averaged. The results are also presented in Table 4, from which an average weighted mean stock density of 1.33 t·km^{-2} was derived (including the depth range 0-9 m). The corrected stock estimate, thus, amounts to 73,000 t, over a surface area of 55,000 km^2.

The value of 1.33 t·km^{-2} and the corresponding standing stock are very low when compared with the data from other areas of the Sunda Shelf (see Pauly et al., this vol.), where the average stock density was 2.66 t·km^{-2}, exactly double the Malacca Strait figure. The low density in the Malacca Strait is most probably the result of the existing trawl fishery, which is backed by the fact that it is mainly the shallow waters (down to 39 m) of the Malacca Strait (where almost all, if not all of the trawling takes place) that the stock densities differ from those of other areas. It seems, therefore legitimate to assume, as a first approach, that the unexploited standing stock, before the onset of the trawl fishery, was also double the stock observed in the mid-1970s, or about 150,000 t.

Based on the plots of catch/effort *vs* effort (Fig. 3), maximum sustainable yield (MSY) was estimated at about 8,000 t·year^{-1} for Aceh Province, and 77,000 t·year^{-1} for North Sumatra and Riau combined. Overall, an MSY yield of 85,000 t·year^{-1} was estimated for the Indonesian waters of the Malacca Strait (Fig. 4).

The above figure of 85,000 t·year^{-1} is compatible with an unexploited stock estimate (B_0) of 150,000 t (see above), i.e., implying that MSY $\approx$ M·½ B_0 (Gulland 1971), with M set at 1

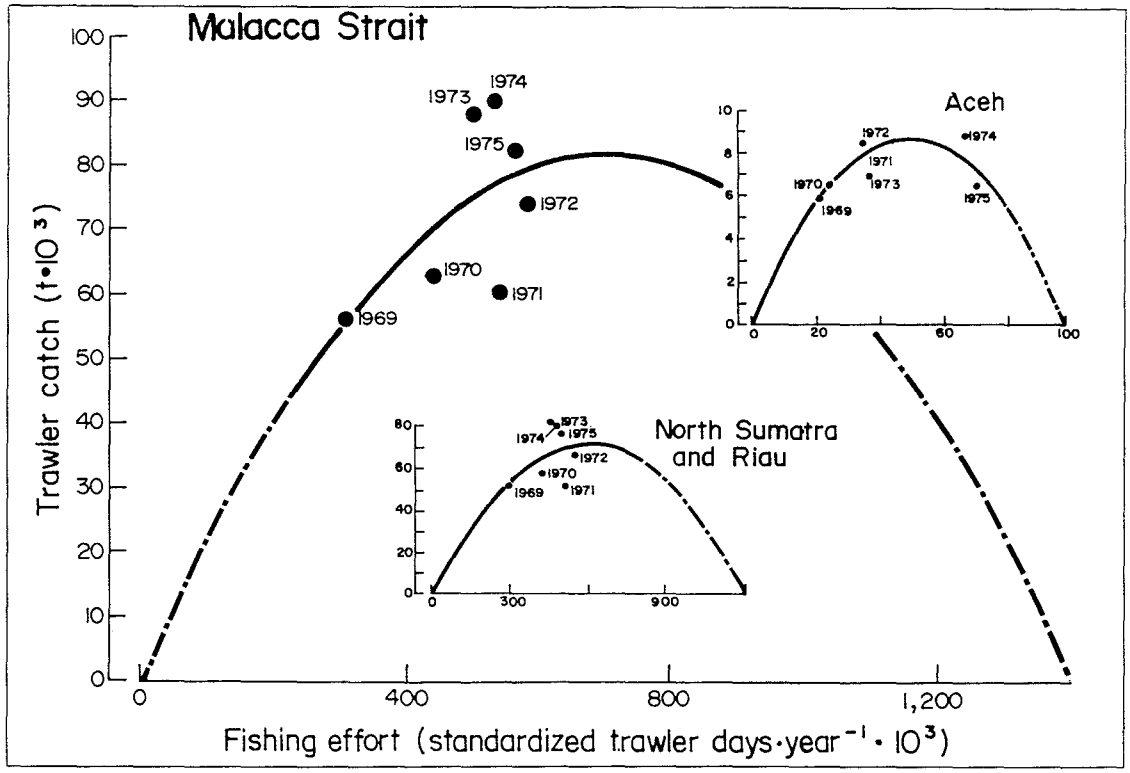

Fig. 4. Trawler catch *vs* effort on the Indonesian side of the Malacca Strait, 1969-1975. Note that effort was near optimal in the mid-1970s for the area as a whole, and for North Sumatra-Riau, but not for Aceh province, where effort was then already excessive.

[Gambar 4. Hubungan antara hasil tangkapan dan upaya penangkapan di Selat Malaka bagian Indonesia, 1969-1975. Perhatikan upaya yang mendekati optimal pada pertengahan tahun 1970an untuk seluruh daerah, dan juga untuk Sumatra Utara-Riau, tetapi tidak untuk propinsi Aceh, karena upaya penangkapan sudah melebihi optimal.]

year^{-1}, a value commonly used for the multispecies demersal stocks of Southeast Asia (see Pauly, this vol.). Further, the standing stock estimate of 73,000 t ≈ ½ B_o, as should occur when fishing effort is at the level generating MSY (Gulland 1971; Ricker 1975; Pauly 1984). Thus, it can be concluded that, overall, the level of trawling effort applied in the mid-1970s to the demersal stocks of the Indonesian side of the Malacca Strait was about right - except in very shallow waters, where the small shrimps attracted an excessive amount of effort. Sujastani et al. (1976), based on these findings, presented a set of practical recommendations for managing the fisheries. [These recommendations, not recalled here, became irrelevant when trawling was banned in Western Indonesia (Sardjono 1980, and see Martosubroto, this vol.); a move which also placed constraints on field sampling with trawls by MFRI scientists, due to strong objections by small-scale fishers].

Rather, we point at the compatibility of the results presented here, which as in the case of the Java Sea (Martosubroto, this vol.) integrate fisheries and survey data into a coherent whole.

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