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STATUS OF MANGROVE PRAWN FISHERIES IN THE ASEAN COUNTRIES

V.C. Chong[1], A. Sasekumar[2], W.S. Atmadja[3] and J.K.Y. Low[4]

[1] Institute of Advanced Studies
[2] Department of Zoology
University of Malaya, 59100 Kuala Lumpur, Malaysia
[3] Puslitbang Oseanologi-LIPI, Jl. Pasir Putih I, Ancol Timur, Jakarta, Indonesia
[4] Department of Zoology, National University of Singapore, Kent Ridge, Singapore 0511

ABSTRACT

The prawn resources which are very closely associated with coastal mangroves, represent a valuable food commodity for the ASEAN countries. This region has the richest prawn resources in the world, both in terms of species and annual production (ca. 370,000 tonnes). The major prawn fishing grounds occur predominantly in shallow waters (less than 40 m depth) that are adjacent to coastal mangrove vegetation. ASEAN prawn fishing is characterised by an inshore artisanal fishery and an offshore commercial fishery. Mangrove prawn stocks across ASEAN appear to be both biologically and economically overfished. The problems of managing the resource are multifaceted, involving biological, economic, social and political considerations.

INTRODUCTION

Tropical penaeid prawn landings amount to about 700,000 tons globally and their high value and strong demand in the markets of Europe, Japan and the U.S.A. have contributed to the rapid development of the prawning industry (Garcia 1989). The largest single factor resulting in the rapid development of the prawning industry in the ASEAN countries was the introduction of trawling in the mid 60s. The gear allowed for the first time an effective method of exploiting a largely demersal resource. The lucrative price of prawns, coupled with a favourable year-round fishery, intensified the search for prawns in the richer inshore waters.

The rapid development of the prawning industry has given rise to growing concern as the prawn resources may be overfished and depleted. The socio-economic problems that arise are of further concern as commercial trawlers infringe on the fishing grounds of artisanal fishermen. These have led to limited entry (varying from 3-8 km offshore) or a total ban of trawling in nearshore waters in all ASEAN countries.

As prawn prices continue to rise and the market demand remains insatiated, ASEAN's prawn stocks face both biological and economic overfishing. Since global prawn catches are not expected to increase substantially, prawn farming has gained prominence. Ironically, large tracts of mangrove forests which support coastal prawn (and fish) fisheries are being converted to prawn ponds at an alarming rate. The conversion of mangrove forests for prawn farming and other alternative uses is anticipated to further exacerbate the problem of stock depletion. This paper assesses the current status of the mangrove prawn fisheries across ASEAN and identifies the major management issues.

PRAWN STOCKS AND AREAS

The ASEAN countries sit right at the centre of the Indo-West Pacific region which has the richest penaeid prawn fauna in the world with 125 species. Eighty-five species are found in the Indo-Malayan subregion which covers the ASEAN countries and includes Vietnam, Taiwan, Papua New Guinea and the Solomon Islands (Dall *et al.* 1990).

The major prawning grounds in the ASEAN region occur predominantly in shallow water areas adjacent to coastal mangroves (Fig. 1). All ASEAN countries have extensive prawn fishing grounds, except the Philippines due to its narrow continental shelf. In peninsular Malaysia the coastal species of prawns are found in commercial quantities off its west coast at depths of less than 40 m. The highest trawl catch rates (mean of 6.7 kg hr^{-1}) were obtained in the depth range of 5-10 m but catch rates (0.5 - 3 kg hr^{-1}) dropped sharply beyond these depths (Ong & Weber 1977).

The major prawn species that are commercially fished in the ASEAN countries are the white prawns (*Penaeus merguiensis* and *P. indicus*), tiger prawn (*Penaeus monodon*), greasyback prawns (*Metapenaeus affinis* and *M. ensis*), the yellow prawn (*Metapenaeus brevicornis*), the rainbow prawn (*Parapenaeopsis sculptilis*) and the sand prawns (*Parapenaeopsis hardwickii* and *P. coromandelica*); (Table 1). In peninsular Malaysia, 28 species of prawns belonging to 6 genera are landed commercially, with the following generic composition (by weight): *Metapenaeus* (64%), *Parapenaeopsis* (27%) and *Penaeus* (4%); (Lee 1972). In Indonesia, about 42 species are captured commercially, the major species being banana and tiger prawns (*Penaeus* spp.), endeavour prawns (*Metapenaeus* spp.), rainbow/cat prawns (*Parapenaeopsis* spp.) and pink prawns (*Solenocera* sp.); (Unar & Naamin 1984).

Table 1. Penaeid prawn species commercially exploited in ASEAN countries. (INA - Indonesia, MAL - Malaysia, PHI - Philippines, SIN - Singapore, THA - Thailand; xxx - major fishery, xx - medium level fishery, x - minor fishery).

	Countries				
Species	INA	MAL	PHI	SIN	THA
Penaeus merguiensis	xxx	xxx	xx	xxx	xxx
Penaeus indicus	xx	xx	xxx	xx	xx
Penaeus penicillatus	x	xx			x
Penaeus chinensis	xx				
Penaeus monodon	xxx	x	xxx	x	x
Metapenaeus affinis	x	xxx	xx		x
Metapenaeus ensis	xxx	xxx	xxx	x	x
Metapenaeus brevicornis	xx	xxx			xx
Metapenaeus lysianassa	x	xx			x
Metapenaeus intermedius	x	x			xxx
Metapenaeus elegans	xx	x			
Metapenaeus dobsoni	xx	x	x		x
Parapenaeopsis hungerfordi	x	xx			xx
Parapenaeopsis sculptilis	xxx	xxx	x		xx
Parapenaeopsis hardwickii	xx	xxx	x		xxx
Parapenaeopsis coromandelica	xxx	xxx			xxx
Parapenaeopsis maxillipedo	x	xx	x		x
Parapenaeopsis tenella	x	x	x		x
Trachypenaeus fulvus	x	x	x		
Trachypenaeus curvirostris		x			x
Metapenaeopsis barbata		x			x
Metapenaeopsis stridulans		x			x
Metapenaeopsis palmensis	x				x

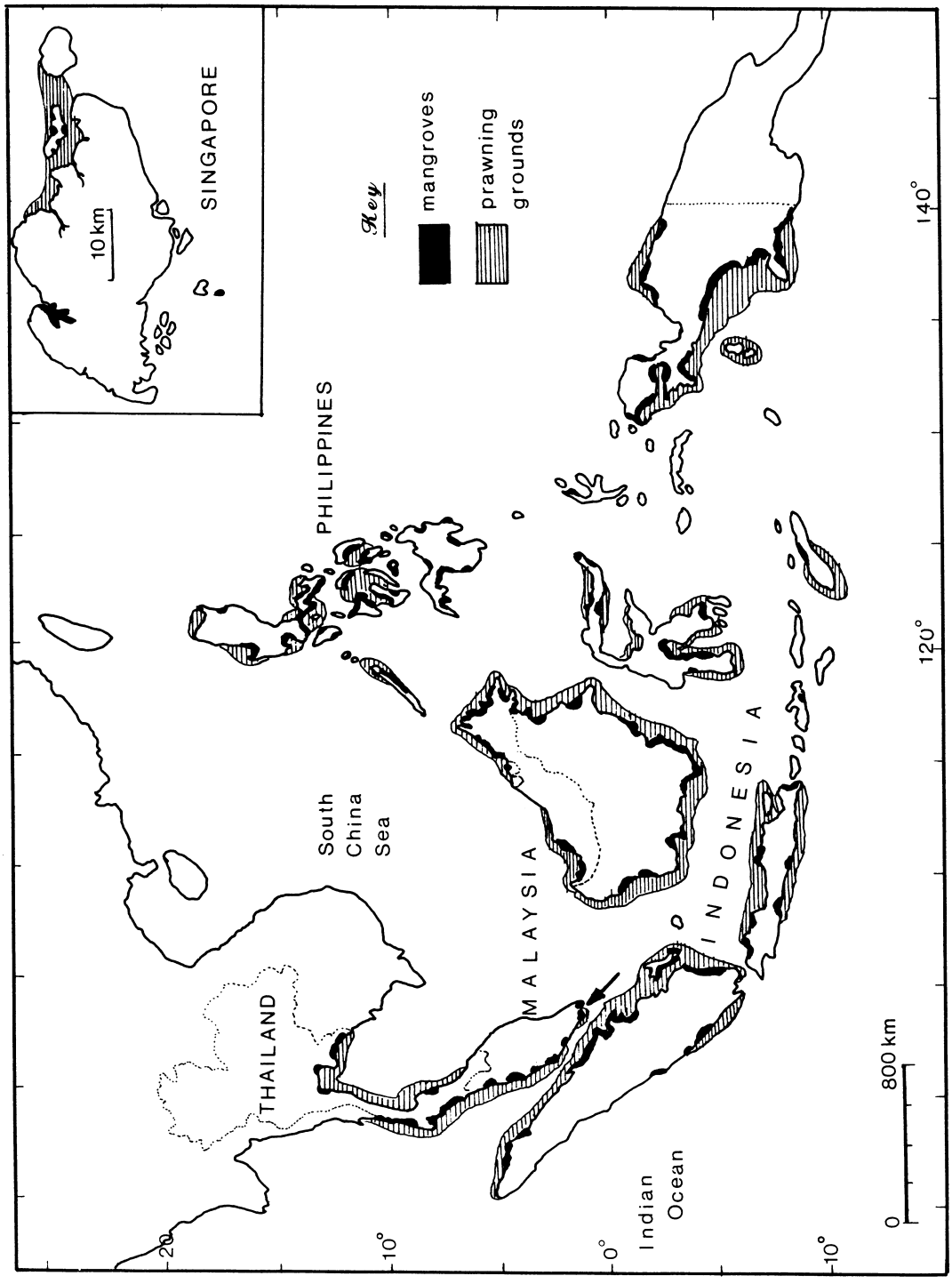

Figure 1. The major mangrove areas and prawn fishing grounds of the ASEAN countries.
Inset shows Singapore (arrowed in map). Information extracted from Gomez (1980), Chullasorn and Martosubroto (1986), Chan (1987), Naamin (1987) and Low and Chou (1993).

THE PRAWN FISHERY

The ASEAN prawn fishery can be classified into:

- Inshore fishery, where prawns are captured in shallow nearshore waters, usually less than 8 km offshore. This is the principal fishery where over 80% of the total fishing effort is expended. The fishery is however characterised by small boats (usually < 5 gross tonnage or GT) using a variety of artisanal or traditional gears, such as gill nets, bag nets, seine nets, scoop nets, push nets, cast nets and fishing stakes. The use of these gears varies with the locality and the nature of the environment. The prawns exploited are largely juveniles and subadults.

- Offshore fishery, where prawns are captured in deep waters exceeding 8 km offshore. Fishing boats are large (> 25 GT) using mainly trawl and gill nets. Subadult and adult prawns, including deep water species, are exploited.

STOCK ASSESSMENT

Until more recently when analytical length-based methods came into use, assessments of prawn stocks in ASEAN countries were based mainly on approximate methods (e.g. from biomass estimates from exploratory fishing) or on surplus production models based on the minimum of fishery information (e.g. total catch and effort). While approximate methods only provide preliminary guidelines at the start of the exploitation, the shortcomings of production methods have been pointed out by Garcia and Le Reste (1981). The most serious are the assumption of equilibrium conditions (which normally do not exist), multispecies interactions and gear heterogeneity. Nevertheless, production models have often been used due to the lack of good fishery data. The estimates of the maximum sustainable yield (MSY) from these methods are apparently valid only if a long time series of data are used in order to reduce climate-associated variations. Large year to year fluctuations in prawn catches are observed, which can be explained by the resource being an annual crop and hence, (its recruitment) strongly influenced by both environmental (Garcia & Le Reste 1981) and biotic (Pauly 1982a) factors.

Indonesia. Prawn catches in 1972-1979 fluctuated from 49,000 to 133,000 tonnes (Unar & Naamin 1984). More recent catch statistics indicated only marginal increase in production; the prawn catch in 1983-1990 varied between 100,000 to 144,000 tonnes (Affif *et al.* 1990); (Table 2). Based on analyses using the linear and exponential production models, it has been found that prawn stocks in the Malacca Strait (east Sumatra), south and east of Kalimantan, Cilacap (Java) and the Arafura Sea (Irian Jaya) are fully or over-exploited (Unar & Naamin 1984).

Malaysia. Current penaeid prawn production in Malaysia amounts to approximately 90,000 tonnes (Table 2). The prawn catch in the Straits of Malacca amounts to approximately 60,000 tonnes (Annual Fisheries Statistics, 1990). The resource here appears to be overfished since Chong (1984), using the exponential production model, estimated a potential yield of 57,000 tonnes in inshore waters (with an additional 13,000 tonnes if the deeper offshore waters are fished). Chong (1984) who based his estimate on a time series of 18 yr observed that large fluctuations in annual prawn catches occurred, and that the prawn fishery appears to be insensitive to increasing fishing efforts. These conclusions however should be treated with some reservations because the analysis did not distinguish between the variety of species involved, or between different areas. For example, a length-based analysis of the prawn catches in the Larut-Matang district of Perak indicated that overfishing has not occurred yet, although the fishery is developed (Nuruddin & Lim 1993). However, there are signs of 'growth' overfishing as push and bag net operations are depleting the juvenile stocks in shallow waters.

Philippines. Prawn stocks are believed to be fully or over-exploited. The total prawn production peaked in 1986 (42,000 tonnes), but had declined since then (ADB/INFOFISH, 1991a); (Table 2). A yield-per-recruit analysis for *Metapenaeus ensis* in the San Miguel Bay showed that the penaeid prawn resource was overfished (1,044 tonnes) in the early 80s in the sense that an increase in effort (by trawl or artisanal fishery) would not result in an increased catch (Pauly 1982b). In Manila Bay, the relatively high values of mortality and

exploitation rates of *Penaeus indicus* obtained through length-frequency analysis indicate that the species is over-exploited (Agasen & Del Mundo 1988). In Lingayen Gulf, prawn (and fish) stocks are also believed to be overfished, with 82 trawlers and about 12,500 artisanal fishermen catching almost 3 times more than the MSY (Luna 1991).

Singapore. Only banana (*P. merguiensis*) and kuruma (*P. japonicus*) prawn landings were reported (FAO 1993). The former is mangrove-associated, but landings are low and declining (Table 2).

Thailand. From 1982 onwards, a declining trend in prawn landings was evident, i.e. from 178,500 tonnes to 107,400 tonnes in 1990 (ADB/INFOFISH, 1991b); (Table 2). Although this is partly due to EEZ restrictions, the decrease in catch per unit effort is suggestive of overfishing (Phasuk 1993). Overfishing of highly-priced prawn stocks (*Penaeus* spp.) probably occurred earlier in the 70s, which was followed later by the smaller, less-favoured species (*Metapenaeus* spp.). Based on catch and effort data from exploratory and commercial fishing, the virgin biomass of *Penaeus indicus* in the Gulf of Thailand have been estimated at 2,664 tonnes (Pauly 1982a). Exploitation of the prawn at first depleted the standing stock to about 10% of the virgin biomass in 1968, but the standing stock biomass subsequently and paradoxically increased to about 30% in 1972. This has been explained solely by biotic factors, since fishing also removed the prawn's competitors and predators (fishes) which resulted in an overall increase in prawn recruitment (Pauly 1982a). In Ban Don Bay, western Gulf of Thailand, the dominant prawn species, *Metapenaeus affinis*, was estimated to have a MSY of 763 tonnes which was reached in 1982 (Vibhasiri 1988).

Table 2. Annual penaeid prawn landings (in tonnes) in 5 ASEAN countries from 1986-1991.

COUNTRY	1986	1987	1988	1989	1990	1991
Indonesia[1]	116,450	130,962	152,487	142,344	143,993	-
Malaysia[2]	82,773	84,418	93,608	90,480	90,640	86,377
Philippines[3]	41,613	28,147	24,974	25,709	22,830	15,149
Thailand[4]	123,300	128,100	110,200	110,800	107,400	-
Singapore[5]	118	106	73	54	78	55
Total	364,254	371,733	371,269	369,387	364,941	-

[1] Affif *et al.* (1990);
[2] Annual Fisheries Statistics (1986-1991);
[3] ADB/INFOFISH (1991a);
[4] ADB/INFOFISH (1991b);
[5] FAO (1993) [banana prawns only].

MANAGEMENT ISSUES

The rapid and unprecedented development of the prawn fisheries has given rise to many problems inherent in the exploitation of any common-property resource. The general outlook with regard to the current status of the prawn resource as a whole is that overfishing has occurred, at least in most ASEAN countries.

Gear competition. Common to all ASEAN and many Third World countries, trawl fishing has also introduced many social problems and conflicts within the fishing community. Because the shallow waters are richer in prawn resources, encroachments into the traditional fishing grounds by small trawler boats (5-25 GT) are rampant. Multigear competition for the same resource has been one of the major management problems. The original trawl when first introduced as a fishing gear has gone through various modifications, many of which are destructive, to make it more efficient for prawn fishing in shallow waters. The trawlers are primarily responsible for the stagnation and decline of the inshore artisanal sector (Chong & Marshall 1981).

Malaysia after experiencing several years of continuing conflicts between artisanal and trawl fishermen, finally banned trawl fishing within 8 km from its shore; no new trawling licences are issued at present except for boats exceeding 70 GT which are required to fish beyond 19 km offshore. Indonesia by a presidential decree banned trawling completely, first in Java in 1980 and then in Sumatra in 1981 (Sardjono 1980). However, managed trawl fishing is allowed in less populated areas off Kalimantan and west Irian Jaya. In the Philippines, trawl fishing grounds have been closed for various reasons, usually when the artisanal fishery is threatened by commercial trawl boats, as for example, in the Samar Sea in late 1976 (Saeger 1981) and in the San Miguel Bay in 1982 (Smith & Pauly 1983). In the Gulf of Thailand the largely offshore trawl fishery contracted in the early 80s due to the EEZ declaration by neighbouring states and rising fuel prices. Many large trawlers moved into the coastal grounds where some 6,000 small boats were forced to withdraw from fishing; the government however did not ban trawling altogether, but instead restricted trawl fishing to more offshore waters. This restriction had proven impossible to enforce (see Thomson 1980).

The zoning of prawn fishing across ASEAN countries apparently exacerbates the conflict between juvenile and adult exploitation. Artisanal fishing catches young prawns before they are sexually matured, whereas commercial fishing (trawling) catches the subadults and adults. Juvenile exploitation can adversely affect the recruitment to offshore stocks (growth overfishing). Indeed, reduced offshore stocks are the main reason why trawlers still make illegal runs into artisanal fishing grounds in spite of the heavy penalties imposed.

Economic overfishing. In west coast of peninsular Malaysia, the fishery is characterised by over-capitalisation with fishermen both in the trawler and artisanal sectors making only marginal benefits (Munro & Chee 1978; Yap 1980). However, this is enough to sustain many poor fishing households (Nuruddin & Lim 1993). Artisanal fishing in the Larut-Matang area (Malaysia) appears not to maximise economic benefits and is responsible for growth overfishing; however, extreme management measures requiring the elimination of these gears are not justified because the earnings of many fishing households would fall below the poverty level (Nuruddin & Lim 1993).

A socioeconomic analysis of the San Miguel Bay (Philippines) fishery has shown the uneven distribution of benefits, with small trawlers (representing 3% of the fishing force) earning 50% of the profits; and that government-subsidised diesel fuel which particularly benefited the trawlers had a negative impact on the artisanal fishery (Smith & Pauly 1983). The findings also indicated that the earnings of the trawlers were highly concentrated; 5 families owned 50% of the trawler fleet, whereas the earnings of the artisanal sector were spread thinly over 2,000 households.

Despite the control of trawl fishing, economic overfishing seems to permeate the entire artisanal fishery of ASEAN countries. Pauly (1988) painted a gloomy picture of too many boats chasing too few fish; that the intense fishing has led to ecosystem overfishing (i.e. altering the balance of species, often to the advantage of nonresource bottom invertebrates), and finally to a kind of 'Malthusian' overfishing where, in desperation, the fishermen used destructive fishing methods in an effort to maintain their incomes.

Multispecies management. Conflict exists between the prawn trawl fishery and the fin-fish fishery. The prawn trawl captures prawns and fish alike. Low-value young fish and inedible fish (bycatch) form a major portion of the trawl catch and are considered as trashfish. It has been found in Malaysian waters that for every unit weight of prawns captured by the trawl, about 2-4 times its equivalent weight of trashfish were captured, and that the trawl caught about 15 times more trashfish annually than traditional gears such as bag nets and seine nets (Chong 1984). In Indonesian waters, the ratio of prawn to fish catch is a function of the distance fished from the shore; near estuaries and lagoons the ratio was 1:1 but further off shore the ratio changed dramatically to 1:20 (Unar & Naamin 1984). Trash fish are often discarded at sea, with negative repercussions on the fin-fish fisheries if young fish are continuously removed in this manner. However, the value of trashfish and their possible depletion are questionable. The edible portion comprised mainly of economically unimportant species of the families Pomadasyidae and Leiognathidae, and they appear to be ubiquitous from depths of 5 - 50 m (Latiff *et al.* 1974; Ong & Weber 1977). Trashfish abundance may be a result of intense fishing of their larger predators or food competitors (Gulland 1976).

Stock enhancement. Fishery yields may be enhanced by increasing juvenile populations through aquaculture and the seeding of postlarvae/juveniles into their nursery grounds. However, the success of this method has not been clearly shown, as for example in Japan (see Garcia & Le Reste 1981).

Habitat management and conservation. This is a long-term management strategy which takes into consideration the carrying capacity of coastal mangroves and mud flats which are known nursery habitats for juvenile prawns (Staples *et al.* 1985; Chong *et al.* 1990). Massive destruction of mangrove forests for alternative land uses is detrimental to the long term interest of the prawn (as well as fin-fish) resource. There is a linear correlation between the increase of *tambak* (prawn ponds) areas and the decrease in prawn catch in Indonesia (Naamin 1987). Rehabilitation of degraded mangrove areas or mangrove reforestation can have a positive effect on prawn production. Increased prawn production in west Java has been attributed to coastal mangrove replanting (Naamin 1987).

Channelling, dredging and coastal dumping of dredged sediments may alter the natural advective processes (e.g currents) responsible for moving larvae into their nursery grounds. Modifications of river courses such as by the construction of barrages or dams can have significant impacts on estuarine biotic capacity and recruitment. Other constraints to successful prawn recruitment are environmental degradation of the prawn's habitats through pollution, chiefly by petroleum hydrocarbons, agricultural (e.g. pesticides, oil-palm and rubber effluents) and industrial pollutants (e.g. heavy metals); prawn larvae are especially susceptible. An interesting study of stock enhancement *vis-a-vis* habitat degradation in the Seto Sea, Japan, has shown that artificial prawn seeding has little success in enhancing fishery catches if the nurseries are being degraded, as for example by pollution (Doi *et al.* 1973).

CONCLUSIONS

Mangrove prawn stocks across the ASEAN countries are generally overfished. The prawn fishery is largely inshore and artisanal, which is characterised by a large number of small fishing vessels. The trawl ban/ restriction and governments' sympathy towards artisanal fishermen (on social-economic grounds) have contributed to increasing inshore fishing effort. Economic overfishing is inevitable and hence, prawn fishing may exist only as a make-even operation. The problems of prawn stock depletion appear to be further exacerbated by development, the more serious being habitat loss through mangrove forest conversion, and habitat degradation by pollution.

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