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# RESOURCES AND FISHERIES OF THE GULF OF THAILAND

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prepared

by

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## 1. FOREWORD

The rapid expansion of trawl net fisheries in the Gulf of Thailand since the early 1960's and the later expansion of purse seine fisheries in the 1970's have brought the Gulf of Thailand into sharp focus as far as classical fishery problems, namely biological overfishing and overcapitalization, are concerned.

Foreseeing these problems as early as 1962, the Department of Fisheries of Thailand has since undertaken research and investigations on the biology and bionomics of certain species of fish of commercial value.

This study is prepared with the intention of summarizing the existing knowledge about the environment, the status of the fisheries, the state of the stocks of fish being exploited, and current resource and fishery management schemes for general readers as well as for the students of the resources and fisheries of the Gulf of Thailand.

In preparing this study the author is indebted to many fishery biologists of the Marine Fisheries Division, Department of Fisheries of Thailand. Without their kind cooperation and assistance this study would have lacked the essential information to make it a useful reference paper.

Thanks are due particularly to Dr. Veravat Hongskul, Director of the Marine Fisheries Laboratory, Mrs. Mathana Boonyubol, Chief of the Demersal Fisheries Unit, Mr. Boonlert Phasuk, Chief of the Pelagic Fisheries Investigation Unit, Mr. Thien Banasopit, Chief of the Invertebrate Fisheries Investigation Unit, and Mrs. Preeyanat Sukhavisidh, Fish Taxonomist of the Marine Fisheries Laboratory, who kindly supplied the information needed for this compilation. Mr. Sumon Swegwan, Chief of the Planning Unit, and Mr. Jumphol Nakavachara, Fishery Statistician, kindly prepared a set of fishery statistical data for this report.

It is the author's hope that this study will be of value in the consideration of fisheries development and management planning for the Gulf of Thailand's resources and fisheries.

Finally, the author wishes to express his heartfelt thanks to Miss Barbara Mountfield and Dr. K.I. Matics for their editorial work on the manuscript.

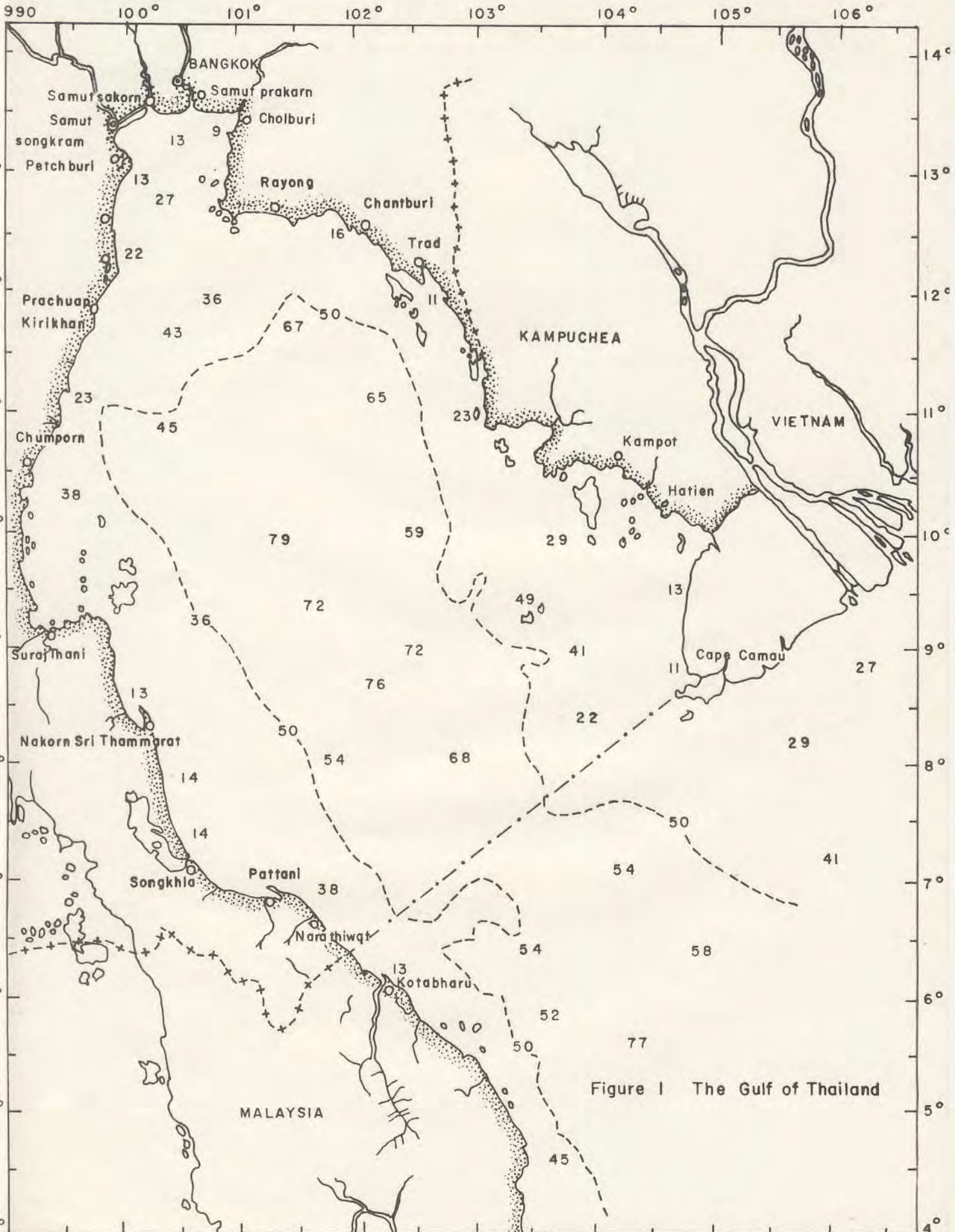



Figure 1 The Gulf of Thailand

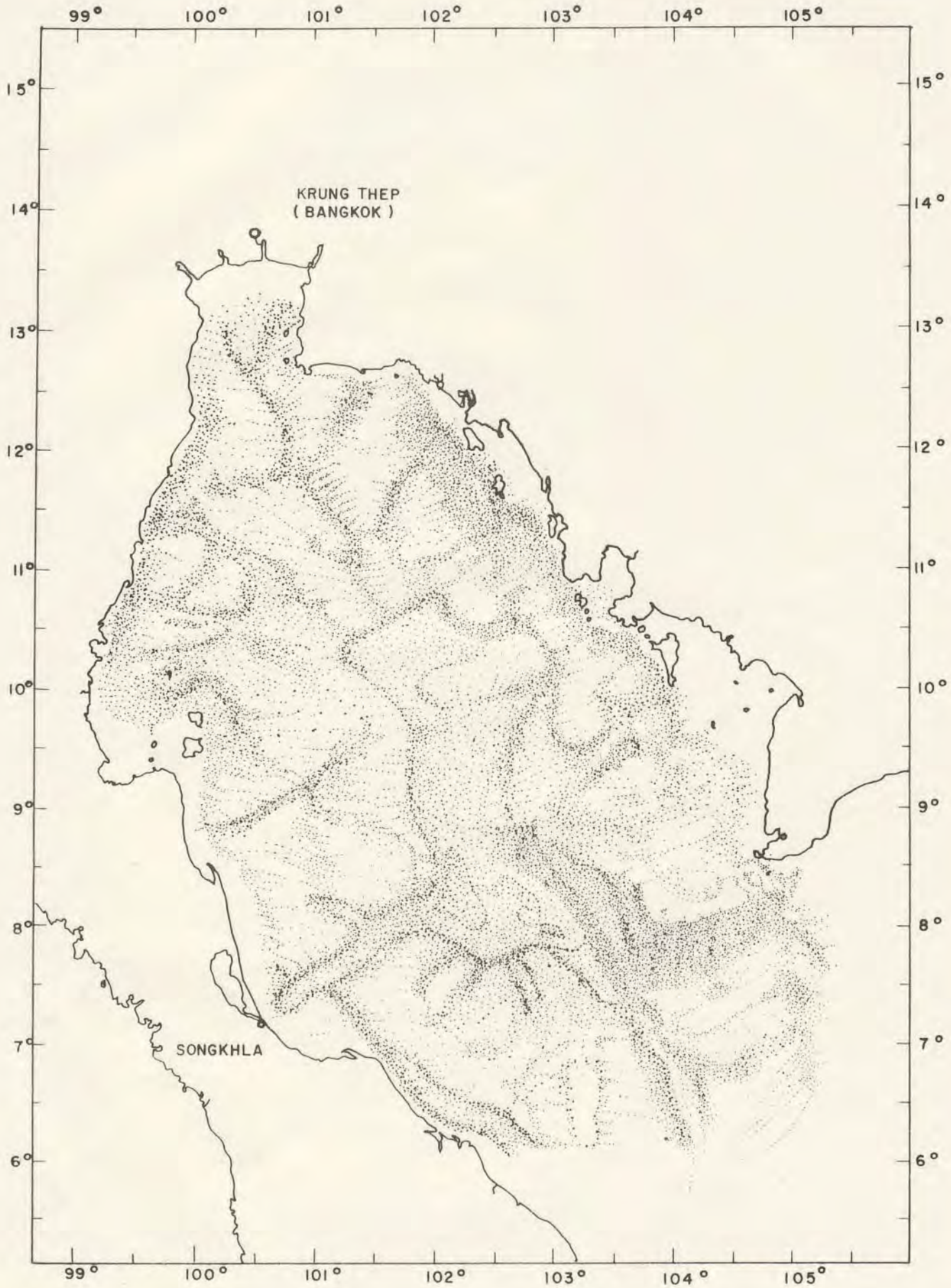



Figure 2 Relief drawing of bottom topography of the Gulf of Thailand (after Robinson, 1974 )

exposure of the shelf (Van Baren and Kiel, 1950). Studies of the sediments at different parts of the Gulf during a series of exploratory trawling and resources surveys carried out by the Department of Fisheries revealed that the bottom was covered with ooze, or mud mixed with sand or shells (Pasuk, 1969; Ritraksa, Thamaniyom and Sittichaikasem, 1968). The bottom of the inner Gulf, into which four rivers drain a considerable amount of sediment annually, is covered with loose mud. In the central basin, where the sediments are deposited, the bottom is again covered with soft mud.

Sandy areas are located in several exposed beaches along the coast seaward to about 5-6 km in depth.

In the outer part of the Gulf of Thailand the results of the exploratory fishing cruise of the Department of Fisheries showed that 88 percent of the surveyed area or 113,960 $km^2$ out of the total area of 129,500 $km^2$, had the bottom characteristics of soft or sandy mud (Anonymous, 1968).

## 2.3 Oceanography of the Gulf of Thailand

A systematic study on oceanographic conditions of the Gulf of Thailand was conducted during the NAGA Expedition, a cooperative survey sponsored by the Governments of South Vietnam, Thailand and the United States of America from 1959 to 1961. The research vessel Stranger of the Scripps Institution of Oceanography, University of California, which was employed during the Expedition, made six cruises in the Gulf. Oceanographic studies of the Gulf have also been carried out by the Hydrographic Office of the Royal Thai Navy (Pongsapipatt and Sapsomwong, 1973) and concurrently by the Department of Fisheries, particularly in the inner Gulf of Thailand (Bight of Bangkok), where a few observations were previously carried out during the NAGA Expedition (Hongskul, et al. 1979).

Robinson (ibid.), in summarizing the results of the NAGA Expedition, concluded that the Gulf is a two-layered shallow water estuary. This means that low salinity water which has been diluted by rainfall and fresh water runoff flows out of the Gulf at the surface, while high salinity and relatively cooler water from the South China Sea flows into the Gulf over the 67-meter sill at the mouth of the Gulf. Various forces arising from monsoon winds, heavy precipitation and tidal currents create complex circulation in the Gulf. There exist localized areas of divergence or upwelling, downwelling or convergence of waters.

Robinson further observed that the general circulation and physical properties of the water mass varied to some extent both during seasonal periods and also during short periods, and that the monsoon winds play a major role influencing the circulation in the Gulf of Thailand. In the inner Gulf area where four major rivers drain, there is a rapid confluence of river and Gulf waters.

The Southwest monsoon starting in March or April is usually well established in May and ends in September. This wind, after having blown across the Indian Ocean and the Bay of Bengal, brings rainfall to Thailand, Kampuchea and Vietnam between July and October. October is the lull between the Southwest and the Northeast monsoons from November to February. The Northeast monsoon winds, after having blown across the continent, bring low-moisture, cool air to Thailand and over the Gulf. March and April are the inter-monsoon months.

In general, surface salinities in the Gulf are between 30.5 per mille and 33 per mille. Salinities at the deepest part of the central basin, where South China Sea water flows in, are higher ranging, i.e., between 33 and 34 per mille or above.

Low oxygen concentrations (less than 2.5 ml/l) and high salinity of surface water in certain areas indicate localized areas of divergence or upwelling. Likewise, high oxygen concentration and low salinity found at a lower depth indicate localized areas of convergence or downwelling.

From a study of horizontal charts of temperature, salinity and sigma-t, it was concluded that in October the surface water flowed into the Gulf in a counter-clockwise direction, i.e., inflow along the east coast and outflow along the west coast of the Gulf; while at the central part, there was sluggish circulation. During the peak of the Northeast monsoon, water of low temperature and high salinity moved into the Gulf around cape Camau but did not penetrate deep into the Gulf; instead, the water flowed out of the Gulf, slightly west of its mouth. During the peak of the southwest monsoon (August), there was a strong flow into the Gulf along the east coast on the surface and at 30 meters, and a strong northward flow along the west coast. The survey carried out by H.T.M.S. Chanthara of the Hydrographic Office of the Royal Thai Navy during 1970 and 1971 indicated that there was an intrusion of water mass from the South China Sea along the western coast of the Gulf and an outflow of less saline but cooler water along the eastern coast of the Gulf (Pongsapipatt and Sapsomwong, ibid.)

Concerning the inner Gulf of Thailand (Bight of Bangkok), Hongskul, et al. 1979, summarized the results of a series of investigations carried out by the Department of Fisheries as follows:

The circulation in the inner Gulf was influenced more or less by tidal currents and the circulation of surface water was clockwise in direction at the beginning and at the end of the year (during the Northeast monsoon period) and counter-clockwise in the middle of the year (Southwest monsoon period). The average surface salinity was 27.1 - 29.8 per mille. At estuaries, during the peak of fresh water runoff (November - December), the salinity was quite low. Oxygen concentration at the surface was more than 4 ml/l but at the bottom it was very low, being 2.9 ml/l or less. The concentration of phosphate varied from 0.1 - 0.9 ugat P/L and of nitrite from 0.05 - 0.1 ugat N/L.

The steady trend of BOD in this area indicated that the water quality was becoming increasingly poor.

The amount of plankton, ranging from 200-1,000 ml/1,000 $m^3$, indicated that the inner Gulf of Thailand is one of the most productive areas of the world. The peak of the abundance of plankton was found to be in December. High plankton concentration areas are located in the inner Gulf of Thailand, at the estuaries of the four rivers and along the upper west coast of the Gulf.

Along the west coast of the Gulf, the peak of the abundance of plankton was found during March-August. Hence, off the west coast several species of fish spawn, and their larvae and young feed in this area until October when they move to a new feeding ground in the inner Gulf of Thailand.

The high productivity of the inner Gulf of Thailand was also revealed by a study on the primary production of the waters there. Luasinsap (1979) reported that the average primary production rate of sampled waters in the inner Gulf was 3.51 g $c/m^2$/day in 1978 and 3.45 g $c/m^2$/day in 1979.

## 3. EXISTING INFORMATION ON LIVING RESOURCES

### 3.1 General Description of Living Marine Resources

As mentioned earlier, the Gulf of Thailand, owing to its unique topography and general oceanographic characteristics governed

by prevailing climatic conditions, is one of the richest areas in the world. The Gulf is, therefore, abundant in living aquatic resources, which are typical of the Indo-Pacific fauna.

### 3.1.1 Plant resources

The plant resources referred to in this study are seaweed or marine algae. Marine algae plays an important role in the productivity of the Gulf. Some types serve as food for other marine organisms, while others are utilized by man as food or for industrial products.

Several expeditions have been made since 1886 to collect and identify marine algae in Thai waters. Nevertheless, knowledge on the biology, distribution and life history of many species is still wanting. Velasquez and Lewmanomont (1975) compiled a check list on the species of marine algae known to occur in Thai waters from these expeditions as well as from recent studies made by local scientists. This check list contains 167 species belonging to 32 families (Table 1).

Generally, seaweed resources in tropical waters are low. In Thailand, the most economically important species is Gracilaria confervoides (L), a red algae which can be used in the production of paste for textiles and agar. This seaweed occurs in shallow bays such as Songkhla Lake. Annual production of this species of seaweed in Thailand increased from 56 tons in 1963 to 154 tons in 1971 and to 608 tons in 1976, valued at US$ 50,000. There is definitely a potential for seaweed culture in Thailand to supplement the production from the natural stocks, provided that the waters are free from pollution (Shindo, 1970).

### 3.1.2 Sponges

This is a plant-like animal belonging to Phylum Porifera. Only one genus, Euspongia, is listed by Suvatti (1950). Samples of sea sponges may be collected from Koh Pangan and Koh Samui on the west coast and off Trad Province on the east coast of the Gulf of Thailand. As there has been no systematic study on sea sponges in the Gulf, it is expected that there may exist more than one genus of this organism.

### 3.1.3 Jelly Fish and Corals

These two groups of animals belong to Phylum Coelenterata. Suvatti (ibid.) reported that there were 8 families,

16 genera and 21 species of these organisms in Thai waters.

Recent taxonomic studies made by the Phuket Marine Biological Center revealed that there were more than 20 species of corals in Thai waters.

Coral reefs are considered economically important because they provide sanctuary and feeding grounds for animals of higher orders such as fish which can sustain small-scale fisheries. They play a vital role in supporting the productivity of the waters and in stabilizing the ecological balance. Furthermore, they are becoming important in attracting tourism into the country. In the Gulf of Thailand, Ang Tong Archipelago and Koh Tao in Chumporn Province have been declared as Marine National Parks of the country. The Phuket Marine Biological Center (P.M.B.C.) has identified 183 species of corals found along the west coast of peninsular Thailand.

Table 1
Number of species of marine algae known to occur in Thai waters

| Division | Family | No. of Species |
|---|---|---|
| Chlorophyta (Green algae) | Chaetophoraceae | 1 |
| | Cladophoraceae | 7 |
| | Ulvaceae | 5 |
| | Valoniaceae | 12 |
| | Codiaceae | 14 |
| | Dasycladaceae | 1 |
| | Caulerpaceae | 14 |
| Phaeophyta (Brown algae) | Ectocarpaceae | 2 |
| | Sphacelariaceae | 1 |
| | Encoeliaceae | 2 |
| | Punctariaceae | 4 |
| | Dictyotaceae | 17 |
| | Fucaceae | 5 |
| Rhodophyta (Red algae) | Bangiaceae | 1 |
| | Acrochaetiaceae | 1 |
| | Gelidiaceae | 6 |
| | Squamariaceae | 2 |
| | Corallinaceae | 10 |
| | Grateloupiaceae | 1 |
| | Gracilariaceae 1/ | 3 |
| | Hypneaceae | 4 |
| | Champiaceae | 1 |
| | Ceramiaceae | 3 |
| | Rhodomeliaceae | 18 |
| | Solieriaceae | 1 |
| | Rhabdoniaceae | 2 |
| | Delesseriaceae | 1 |
| Myxophyta (Blue-green algae) | Oscillatoriaceae | 7 |
| | Nostocaceae | 1 |
| | Scytonemataceae | 8 |
| | Stigonemataceae | 7 |
| | Rivulariaceae | 5 |

1/ Economically important marine algae
Source: Velasquez and Lewmanomont (1975)

As regards the jelly fish, we still have a very limited knowledge on its taxonomy, biology, life history and distribution. Among the jelly fish species, Stomolphus spp. and Rhopilema esculenta, both large size jelly fish, and their kindred species are economically important (Omori, 1978). According to the fishery statistics of the Department of Fisheries, (1977), Thailand harvested 2,353 tons of jelly fish valued at Baht 500,000 in 1974. The following year, the production of jelly fish rose to 4,369 tons valued at Baht 1 million. The main problem of jelly fish production in Thailand seems to be in the technical method of processing. With improved processing techniques, it is expected that the quality of the product will be enhanced, thus enabling Thailand to command a better price for exports. In 1975, Thailand exported 560 tons of dried jelly fish to Taiwan, Japan, Malaysia and other foreign markets valued at Baht 7.9 million.

### 3.1.4 Sea Urchins and Sea Cucumbers

These animals belong to Phylum Echinodermata. They are latent resources, which can be developed in the future.

Among the sea urchins, Diadema setosum Leske is the most important in Thailand. The gonads of the sea urchin, considered to be a delicacy, can be exported to Japan for a high price. It is believed that the maturity of the gonads of Thai sea urchins varies by season and locality. Therefore, studies should be carried out to assess the potential of these resources for future fisheries development (Shindo, ibid.).

Concerning sea cucumbers or beche-de-mer or trepang which are esteemed by Asians or Westerners alike, the Marine Fisheries Laboratory Taxonomic Unit of the Department of Fisheries listed 8 species known to occur in the Gulf of Thailand (Table 2). The most economically important species is Stichopus sp. which is 20 to 40 cm in length, 5 cm in width and has blue-black skin when shrunk. This species can be exported to Japan. The Japanese eat raw slices of sea-cucumber with lemon juice and soy-sauce. The internal organ of a sea cucumber can be fermented. It is then known as Konowata, which is one of the most expensive foods in Japan (Shindo, ibid.). In 1975, 150 tons of sea cucumbers valued at Baht 900,000 were harvested. It is believed that approximately 1,000 tons can be produced annually since this animal is widely distributed over the coastal areas of Thailand.

Table 2
Species of sea cucumber found in the Gulf of Thailand

| | Species | Locality | Density (No / $m^2$) | Length of fresh specimen (cm) | Color and distinct character |
|---|---|---|---|---|---|
| 1 | Pentacta quardrangularis (Lesson) | Rayong, Chanthaburi, Hua Hin | 4 | 12 - 15 | Orange-red dorsal and green ventral |
| 2 | Cucumaria frondosa (Gunnerus) | Chanthaburi, Rayong | - | 10 - 12 | Olive green with brown striped body |
| 3 | Holothuria scabra (Jaeger) | Songkhla, Krabae, Chanthaburi, Rayong | 2 | 36 - 40 | Dorsal blackish with scattered brown spots; abdomen with white spots |
| 4 | Holothuria scabra (white cucumber) | - " - | 2 | 20 - 30 | Grayish dorsal with yellow spots and scattered black dots |
| 5 | H. ocellata (Semper) | No. loc. | - | 20 | Dorsal grayish-brown |
| 6 | H. spinifera (Theel) | Trad | 3 | 20 - 30 | |
| 7 | Stichopus sp. | | 3 | 15 - 40 | |
| 8 | Ankyroderma roretzi (Von Marenzeller) | Trad | 1 | 8 - 16 | Lilac color with red spots |
| 9 | Opheodesoma australiensis (Heding) | Rayong | 1 | 100 | Tentacle digitate |

Source: Department of Fisheries, Marine Fisheries Laboratory. Unpublished manuscript.

3.1.5 Molluscs

Molluscs are a polymorphous Phylum called Mollusca, constituting the second largest phylum among invertebrates with more than 80,000 species known to exist in the world (Abbott and Zim, 1962). This Phylum was traditionally divided into (1) Amphineura (chitons) (2) Scaphopoda (tusk shells); (3) Gastropoda (monovalves); (4) Pelecypoda (bivalves) and (5) Cephalopoda (squids and cuttle fish). In Thai waters, Suvatti (ibid.) listed 102 families, 205 genera and 578 species of molluscs, which include fresh water and land molluscs.

(a) Chitin and tusk shells

As for Amphineura and Scaphopoda, only one species each were recorded by Suvatti (ibid.) to occur in the Gulf of Thailand. These were Chiton sp. (Lin Tale) and Dentalium sp. (Hoi-nga Chang).

(b) Monovalves and Bivalves

Chaithiemwongse (1979) reported on the collection of monovalves and bivalves found in Thai waters which is kept at the Marine Fisheries Division, Department of Fisheries. This collection consists of 44 families and 192 species of monovalves and 24 families and 120 species of bivalves. Out of 312 species only 153 species were found in the Gulf of Thailand (Table 3). This does not mean, however, that the Gulf of Thailand is limited in the number of species of molluscs since the identifications have been made only on samples of molluscs collected in connection with shrimp resources surveys carried out by the Invertebrate Fisheries Investigation unit of the Marine Fisheries Division.

The majority of the molluscs in the collection of the Marine Fisheries Division belong to the monovalve group, many of which are small in size. Several species of monovalves, particularly those of families Cypraeidae, Conidae and Strombidae, are ornamental and fetch a high price. Several species of bivalves belong to families Veneridae and Arcidae. The bibalves that are used as food and are harvested in substantial quantities in the Gulf of Thailand are:

1. Mussel : Mytilus viridis (Hoi malang pu)
   Modiolus senhauseni (Hoi kapong)

2. Cockler or arkshell : Anadara granosa (L). (Hoi krang)

Table 3
Monovalve and bivalve molluscs found
in the Gulf of Thailand

| Class | Family | English vernacular name | Thai vernacular name | No. of Species |
|---|---|---|---|---|
| Gastropoda | Patellidae | Limpet | hoi fa chi | 4 |
| | Trochidae | Periwinkle, top shell | hoi nom sao | 2 |
| | | Turban shell | hoi ud | 2 |
| | Haliotidae | Ear shell or abalone | hoi kong tale | 1 |
| | Neritidae | Nerite | hoi fun kratai | 1 |
| | Littorinidae | Periwinkle | | 1 |
| | Territellidae | Screw shell | | 1 |
| | Architectonicidae | Sundial shell | hoi wong wien | 1 |
| | Siliguariidae | Worm shell | hoi nom | 3 |
| | Potamididae | Creeper | hoi kee nok | 2 |
| | Cerithiidae | Giant knobbed | - | 1 |
| | Ovulidae | Elongated egg cowry | hoi bia kai | 1 |
| | Janthinidae | Violet snail | hoi si muang | 1 |
| | Kenophoridae | Stromb or conch | - | 5 |
| | Cypraeidae | Cowry | hoi bia | 1 |
| | Naticidae | Sand snail | hoi nang chi | 10 |
| | Cassididae | Helmet shell | hoi sang kratai | 1 |

Table 3 (cont.)

| Class | Family | English vernacular name | Thai vernacular name | No. of Species |
|---|---|---|---|---|
| Gastropoda | Cymatiidae | Triton | | 2 |
| | Bursidae | Frog shell | hoi kob | 2 |
| | Tonnidae | Tun shell | hoi ta pao | 3 |
| | Ficidae | Fig shell | hoi ma daer | 3 |
| | Eulimidae | Obelisk shell | - | 1 |
| | Muricidae | Murex | hoi sang, hoi mu | 5 |
| | Buccinidae | Babylon | - | 2 |
| | Nassaridae | Spindle shell | hoi pin klad pom | 1 |
| | Galeolidae | Volema | - | 1 |
| | Olividae | Olive shell | hoi kra dum | 1 |
| | Mitridae | Miter shell | - | 2 |
| | Harpidae | Harp shell | hoi ma phoeng | 2 |
| | Volutidae | Volute | hoi tang mo | 2 |
| | Turridae | Turrid shell | hoi pin klad pom | 3 |
| | Terebridae | Crenulated auger shell | hoi dog sawan | 3 |
| | Conidae | Cone shell | hoi tao poon | 3 |
| | Bullariidae | Bubble shell | hoi kai ngok krata | 1 |
| | Ellobiidae | Ear shell | - | 1 |
| Pelecypoda | Arcidae | Ark shell | hoi krang | 15 |
| | Isognomontidae | Pearl shell | hoi ka kai | 2 |

Table 3 (cont.)

| Class | Family | English vernacular name | Thai vernacular name | No. of Species |
|---|---|---|---|---|
| Pelecypoda | Pteriidae | Pearl shell | hoi mook or hoi chalap | |
| | Pinnidae | Pen shell | hoi job | 2 |
| | Mytilidae | Mussel | hoi ka pong | 5 |
| | Plicatulidae | Plicate oyster | - | 1 |
| | Pectinadae | Scallop | hoi shell or hoi pad | 8 |
| | Spondylidae | Thorny oyster | hoi nam durian | 4 |
| | Limidae | File shell | hoi ta bai | 1 |
| | Placunidae | Window shell | hoi ka chok | 2 |
| | Ostreidae | Oyster | hoi nang rom, hoi ta krom | 6 |
| | Cardiidae | Cockle | hoi krang | 4 |
| | Chamidae | Chama | hoi ngob | 3 |
| | Tridaenidae | Giant clam | hoi mu suer | 1 |
| | Veneridae | Venus shell | - | 12 |
| | Mactridae | Trough shell | - | 1 |
| | Psammobiidae | Sunset shell | - | 2 |
| | Semelidae | Semele | - | 1 |
| | Tellinidae | Telen | - | 4 |
| | Solenidae | Finger oyster | hoi lord | 3 |
| | Pholalidae | Wing oyster | hoi pim | 1 |

3. Baby clam : Paphia undulata (Born) (Hoi lai)

4. Hard clam : Meretrix meretrix (L) or
Meretrix lyrata (Sowerby)

5. Edible : Crassostrea commercialis
(Hoi nongrom)
Crassostrea belcheri (Hoi takrom)
Crassostrea lugubris (Hoi takrom)

Bivalves that are used for ornamental and decorative purposes include the window pane shell (Placuna spp), mother-of-pearl (Maxima pinctada) and giant clam (Tridacna spp).

Bivalve production in Thailand was approximately 108,000 tons in 1976 or 8 per cent of the total marine production of the country. The production of bivalves can be increased substantially with new technology and techniques employed in culturing them.

(c) Cephalopods

The cephalopods consist of octopus, squid, cuttle fish and chambered nautilus. Sithikorakul (1978) listed 8 families, 14 genera and 24 species found in the Gulf of Thailand (Table 4).

Among the Cephalopods, squids (Loligo spp. or "pla muk gluea" in Thai) and cuttlefish "pla muk kradong" are commercially important. With the development of trawl fishery in Thailand, the catch of "pla muk" has steadily increased with the production of 55,472 tons in the Gulf in 1976, valued at Baht 366 million. Squid and cuttlefish resources also support small-scale and inshore fisheries employing small types of fishing gear such as lift net or push net. About 2/3 of the catch is generally composed of squids, the rest being cuttlefish. In 1976, a total of 22,741 tons of frozen and dried squid and cuttlefish valued at Baht 771.6 million were exported to foreign markets. The quality of frozen cuttlefish is still not good and there is room for improvement in catching and processing techniques (Shindo, ibid.).

3.1.6 Crustaceans

These animals belong to a very extensive phylum, Arthropoda, which includes a multitude of species of insects, shrimps, crabs, sand bugs and water lice. Crustaceans comprise shrimps, crabs,

Table 4. Cephalopods of the Gulf of Thailand

| Family | Species |
|---|---|
| Argonautidae | Argonauta bottgeri Maltzan |
| Octopodidae | Cistopus indicus (d'Orbigny) |
| | Hapalochlaena maculosa (Hoyle) |
| | Octopus dollfusi Robson |
| | Octopus horridus d'Orbigny |
| | Octopus membranaceus Quoy & Gaimard |
| | Octopus parvus (Sasaki) |
| | Octopus spp. |
| Sepiadariidae | Sepiadarium sp. |
| Sepiidae* | Sepia aculeata Ferussac & d'Orbigny |
| | Sepia brevimana Steenstrup |
| | Sepia lysidas Gray |
| | Sepia pharaonis Ehrenberg |
| | Sepia recurvirostra Steenstrup |
| | Sepiella inermis (Ferussac & d'Orbigny) |
| Sepiolidae | Euprymna stenodactyla (Grant) |
| Spirulidae | Spirula spirula (Linnaeus) |
| Lologinidae* | Doryteuthis singhalensis (Ortman) |
| | Loligo duvauceltii d'Orbigny |
| | Loligo formosana Sasaki |
| | Lolilus rhomboidalis Burgess |
| | Loligo tagoi Sasaki |
| | Sepioteuthis Lessoniana Lesson |
| Nautilidae | Nautilus pompilius Linnaeus |

* Families of commercial importance

mantis shrimps and horse shoe crabs. The taxonomic study of crustaceans in Thai waters was started around 1899 when the Danish expedition was carried out. Subsequent studies were conducted by Dr. T.H. Annandale during 1904 - 1924 and Drs. H.M. Smith (1923 - 1935), Serene and Banner (1940-1960). The Marine Fisheries Laboratory has also undertaken taxonomic studies on commercially important crustaceans. As far as the fishery resources are concerned, only shrimps and crabs are of economic importance. Therefore, in this report only mysids, shrimps and crabs will be described.

(a) Mysids and Acetes

These organisms are small-sized shrimp and shrimp-like animals, sometimes considered as zooplankton. They are collectively referred to in Thai as "Kuey". The Fisheries Record of Thailand lists these groups of animals as Acetes. Actually mysids are Malacostracans, shrimp-like organisms, while Acetes are Macrurans, true shrimps. Suvatti (ibid) recorded two species of mysids (Family Mysidae) and five species of acetes (Family Sergestidae), which were known to occur in the Gulf of Thailand.

Mysids and acetes are used for high quality shrimp paste in Thailand, Kampuchea and Vietnam. The annual productions of mysids and acetes from 1972 to 1975 were as follows:

| Year | Quantity (tons) | Value (Million Baht) |
|---|---|---|
| 1972 | 19,129 | 19.1 |
| 1973 | 21,041 | 21.0 |
| 1974 | 11,745 | 14.7 |
| 1975 | 18,048 | 27.1 |

These organisms live in the inshore waters along the Gulf of Thailand,particularly in bays and estuaries and are caught mainly by small-scale fishermen, employing beach seines, lift net, baby trawl and push net.

(b) Shrimps or prawns

Among the Macrurans or true shrimps or prawns, three families are of commercial importance, namely: Penaeidae,

Palaemonidae and Palinuridae, of which Penaeidae is the most important family in terms of production and value.

In the reference collection maintained at the Marine Fisheries Laboratory, Marine Fisheries Division, there are 45 species of penaeid prawns (Chithiemwongse, 1975). Ten economically important species of penaeid prawns are listed in Table 5.

In 1963, the production of shrimps and prawns amounted to 23,300 tons. They were caught mainly by traditional gear such as push net, shrimp gill net, set bag net, stake traps and lift net. Since the introduction of trawl-net fishing in Thailand in 1962 and the rapid development of this fishery thereafter, production of shrimps has risen steadily with a total of 88,672 tons produced in 1976. Out of the total of 88, 672 tons, 8,491 tons were penaeid prawns caught in the Gulf of Thailand (10 per cent). In 1976, Thailand exported fresh and frozen shrimps, prawn and lobsters amounting to 15,217 tons, valued at Baht 1,347 million (SEAFDEC, 1978).

Among the Palaemonids, Macrobrachium rosenbergii de Man or giant river prawn is the most important. The mature animals may be found at the mouths of rivers and in estuaries where they breed. However, this species lives in fresh water.

Spiny lobsters or Palinurids can be found in the Gulf of Thailand. Suvatti (1950) listed 2 families and 3 species of spiny lobsters known to occur in the Gulf of Thailand. One of these species, the flat head lobster (Thenus orientalis), or "kang" in Thai, was caught in substantial amounts during the early 1960's by trawl fisheries. At present the production of "kang" is on the average 1,500 tons annually, valued at Baht 28 million.

(c) Crabs

There are numerous species of crabs found in Thailand including fresh water, marine and terrestrial species. Many of them are inedible. Rathbun (1909) recorded 204 species of crabs found in the Gulf of Thailand during the Danish Expedition. Suvatti listed 15 families, 99 genera and 227 species of crabs known to occur in Thailand. Tiensongrasmee (1972) subsequently listed 108 genera of crabs with more than 265 species found in Thailand. Among them, the majority of crabs which are edible belong to Family Portunidae and are known as swimming crabs. Table 6 shows two sub families, 5 genera and 28 species of the Portunids found in the Gulf of Thailand (Nainetr, 1977).

Table 5
Penaeid prawns of commercial importance

| Thai name | English name | Scientific name |
|---|---|---|
| Kung chair bua | White shrimp | Penaeus merguensis de Man |
| Kung chair bua | White shrimp | Penaeus indicus H. Milne-Edwards |
| Kung kula dum | Jumbo shrimp | Penaeus monodon Fabricius |
| Kung kula lai | Tiger shrimp | P. semisalcatus de Haan |
| Kung lueng hang fa | Yellow shrimp | P. latisulcatus (Kishinouye) |
| Kung lueng | Yellow shrimp | P. longistylus Kubo |
| Kung lai suer | Tiger shrimp | P. japonicus Bate |
| Kung takard kree jud | Pink shrimp | Metapenaeus ensis (de Haan) |
| Kung takard | Pink shrimp | M. mutatus (Lanchestor) |
| Kung takard kree dum | Pink shrimp | M. intermedius (Kishinouye) |

Source : Department of Fisheries,
Division of Marine Fisheries,
Invertebrate Fisheries Investigation Unit, 1979.

Table 6

Crabs belonging to Family Portunidae
found in the Gulf of Thailand

| Sub Family | Scientific name |
|---|---|
| Podophthalminae | Podophthalmus vigil (Fabricius) |
| Portuninae | Charybdis miles |
| | C. cruciata |
| | C. affinis |
| | C. anisodon |
| | C. hellerii |
| | C. lucufera |
| | C. annulata |
| | C. callianassa |
| | C. variegata |
| | C. natator |
| | C. hongkongensia |
| | C. truncata |
| | Portunus gracilimonus |
| | P. gladiator |
| | P. sanguinotentus |
| | P. pelagicus |
| | P. tenuipes |
| | P. brockii |
| | P. tweedici |
| | P. hastataides |
| | P. tuberculosus |
| | Thalamita sima |
| | Th. crenata |
| | Th. danae |
| | Th. prymna |
| | Th. picta |
| | Scylla serrata |

Source : Nainetr, 1977.

In Thailand, the crab production consists mainly of "pu ma" (Portunus pelagicus (L) and "pu lai" (Charybdis cruciata (Herbst), which account for approximately 80 per cent of the total crab landings annually. The rest is composed mainly of "pu tale" (Scylla serata) and a few other portunids such as P. gracilimanus (Stimson), P. sanguinolentus (Herbst), etc. The productions and values of crabs landed in the country from 1972 to 1975, which showed a decreasing trend of production, are given below:

| Year | Quantity (tons) | Value (million Baht) |
|---|---|---|
| 1972 | 56,391 | 169.2 |
| 1973 | 33,440 | 117.0 |
| 1974 | 28,023 | 141.0 |
| 1975 | 23,675 | 134.2 |

3.1.7 Fishes

Among the vertebrates, fishes have the highest number of species amounting to approximately 20,000 or about 48 per cent of the total number of vetebrates in the world. Herre (1953) recorded more than 2,000 species of fishes in the Philippine waters. FAO (1974) listed more than 800 species of bony fishes (Teleosts) in the Western Pacific, which includes the Gulf of Thailand. In the compilation of Fauna of Thailand, Suvatti (ibid.) listed 1,056 species of freshwater and marine fishes. These fishes belong to the Indo-Australian archipelago fauna.

In the Gulf of Thailand, the marine fish fauna is relatively rich. Banasopit and Wongratana (1967) reported that in the reference collection maintained at the Marine Fisheries Laboratory, Marine Fisheries Division, there were 124 families, 289 genera and 574 species. Subsequent studies by taxonomists at the Laboratory (Wongratana and Sukhavisidh, 1979) have added approximately 280 species to the list, thus making a total of more than 850 species known to occur in the Gulf of Thailand (Table 7).

Taxonomically, the living fishes may be divided into two major groups, namely, the sharklike fishes (Chondrichthyes) which possess a cartilaginous skeleton, among other distinct characteristics, and the higher bony fishes (Osteichthyes) of which teleosts

are a major component. However, in considering the economic role of fisheries, they may be divided into groups according to their habitats,namely: marine, freshwater, brackishwater, and migratory. The marine fishes may further be divided into two broad categories; i.e.,pelagic and demersal fishes.

The pelagic fishes are those that dwell and feed at the surface or in the water column. These fishes include sharks, mackerels, tunas, sardines, etc. The demersal fishes are those that live at or near the bottom of the sea, e.g. flat fishes, rays, breams, snappers, etc. Because of their dwelling and feeding behavior, pelagic species are generally caught by lift net, purse seine, surface gill net and other surrounding nets, while demersal species are caught by bottom trawl net, bottom gill net, push net (in inshore waters), etc. Pelagic fishes are usually fast swimming with a fusiform body and fork or lunate tail, living in schools. Demersal fish are, in general, slow moving with a different shaped body and have a truncate or fan tail. Early stages of several demersal species may assume pelagic behavior. They may live in schools or individually. Examples of pelagic and demersal fishes are illustrated in Figure 3.

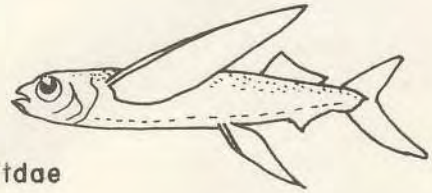
(a) Pelagic fish resources

Among the pelagic fish resources, the following species or groups of species are caught in substantial quantities: "pla tu" "pla lung" (Rastrelliger spp.), "pla tu kak" (Decapterus spp.), "pla insee" (Scomberomours spp.), "pla mali" or "sai ton" (Stolephorus spp.), "pla lung keo" or "ok lae" (Sardinella spp.) and "pla o" (tunas).

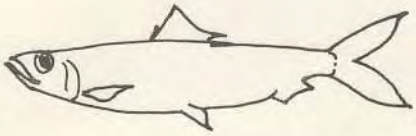
Three species of mackerel (Rastrelliger spp.) are caught in the Gulf of Thailand,namely: "pla tu" (R. brachysoma), "pla lung" (R. kanagurta), and "pla tu pak ching chok" (R. faughni). "pla tu" or Indo-Pacific mackerel is a coastal species, while the Indian mackerel, "pla lung" and "pla tu pak ching chok", are offshore species.

Scad (Decapterus spp.) fishery has been developed during the past three or four years in the offshore waters of the Gulf of Thailand. There are four species caught, namely, D. macrosoma, D. russeli, D. maruadsi and D. pinnulatus. D. maruadsi or flat-bodied scad is dominant in the Decapterus catch from the Gulf of Thailand and round scad (D. macrosoma) is dominant in the Andaman Sea catch (Sukhavisidh, personal communication).

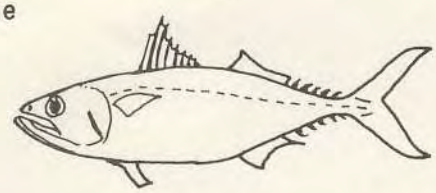
Pelagic Fishes



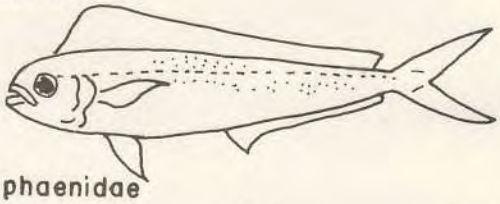
Flying fish,
Family Exocoetidae



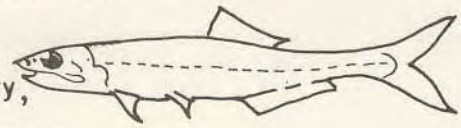
Round herring
Family Clupeidae



Indo-Pacific
mackerel,
Family Scombridae

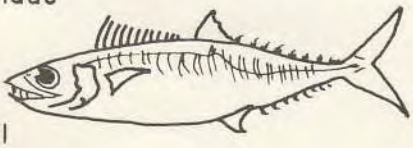


Dolphin,
Family coryphaenidae



Indian anchovy,
Family Engraulidae

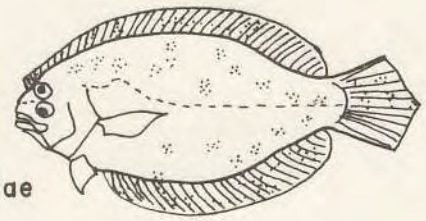
Dorab,
Family chirocentridae



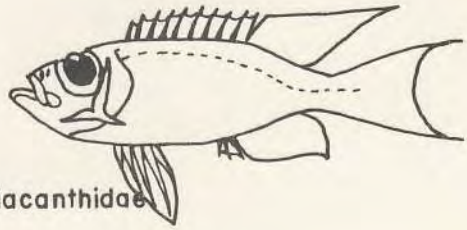
Spanish mackerel
Family Scomberomoridae

Tuna,
Family Tunnidae

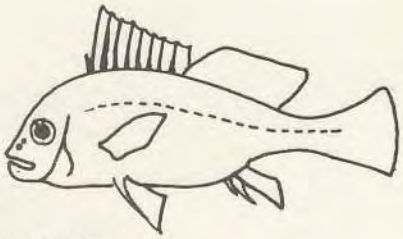
Demersal Fishes



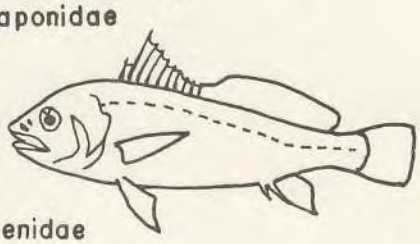
Flounder,
Family Bothidae



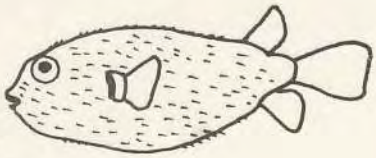
Big eye,
Family Priacanthidae



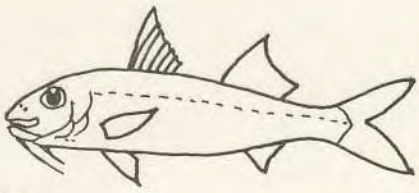
Grunt,
Family Theraponidae



Jew fish,
Family Sciaenidae



Porcupine fish,
Family Diodontidae



Goat fish,
Family Mullidae

Figure 3 Examples of pelagic and demersal fishes caught in the Gulf of Thailand.

There are three species of Spanish mackerel: (Scomberomorus spp.) caught in the Gulf; i.e. "insee-bung" (S. commersoni), "insee jud" (S. guttatus) and "insee kow tok" (S. lineolatus) of which S. commersoni is the most common, constituting about 80 per cent of the Spanish mackerel catch. These mackerels inhabit offshore waters of the Gulf.

Among the anchovy (Stolephorus spp.) caught, ten species are commonly found, and S. heterolobus is the most common, accounting for 86.8 per cent of the total anchovy catch (Taweesit, 1979). These fish live in the inshore waters of the Gulf of Thailand.

As regards sardines (Sardinella spp.)resources, eight species are commonly landed with S. gibbosa being the dominant species, accounting for 93 per cent of the total catch of sardines (Chulasorn, 1979). These fish inhabit the coastal waters of the Gulf.

Three species of tunas are commonly caught in the Gulf, namely: longtail tuna (Thunnus tonggol)- in Thai,"o dum" or "o mhor"; little tuna (Euthynnus affinis)- in Thai, "o lai"; and frigate mackerel (Auxis thazard)- in Thai, "o lai" or "o gluey". These are coastal species of tunas.

There has been a trend of increasing catch of pelagic fish in general with an average production of approximately 250,000 tons during 1973-1976, valued at more than 1.4 billion baht.

(b) Demersal fish resources

A large quantity of the so-called demersal fish resources is caught by bottom trawl nets. Several species inhabiting coral reefs are also considered as demersal and are usually caught by trap and bottom long line. Many demersal species, being small in size, are included in the so-called 'trash fish' category and are reduced to fish meal or are used as duck, poultry and freshwater fish feed. In the trawl fishery of the Gulf of Thailand, trash fish, including juveniles of several commercially important species, constitute at present more than 60 per cent of the total demersal landing.

In the Gulf of Thailand and off the east coast of West Malaysia, approximately 30 families comprising more than 300 species of demersal fish of economic value have been identified (Wongratana, 1968). However, the most common groups of demersal fish of economic value in the Gulf include the following species or groups of species: Lutianus spp., Epinephelus spp., Nemipterus spp., Scolopsis

spp., Saurida, Tachysurus spp., Priacanthus spp., Lactarius[1] spp., Sphyraena spp., Sciaena spp., Chirocentrus spp., Polynemus spp., Pomadasys spp., Caranx[2] spp., Leiognathus spp., sharks and rays, conger eels and Muraenesox spp. (Isarankura, 1976).

Since the successful introduction of trawl net fishing by the Department of Fisheries with the technical assistance rendered by the Government of the Federal Republic of Germany, there has been a spectacular increase in the amount of demersal fish caught. During 1972-1976, the average annual landing of demersal fish amounted to 878,000 tons, valued at more than 2 billion baht.

3.1.8 Reptiles

The marine animals under this grouping are crocodiles, marine turtles and sea snakes. For crocodiles, Suvatti (ibid.) listed only one species which inhabits mangrove swamps and river estuaries, particularly along the southern part of peninsular Thailand. This is the brackishwater crocodile (Crocodylus porosus Schneider). This species was found in south Thailand at Bandon, Surathani and Nakorn Srithamarat. It is becoming rare (see threatened species of this report).

Another species is 'takong' (Tomistoma schlegeli) which is also rare. It inhabits the mouths of rivers and the inland sea of the Thai peninsula.

There are five species of marine turtles in the Gulf of Thailand (Figure 4) namely (1) Leathery turtle or Luth (Dermochelys coriacea (Linnaeus) which does not have a true hard shell: (2) Green turtle (Chelonia mydas); (3) Loggerhead turtle (Caretta caretta (Linnaeus); (4) Hawksbill turtle (Eretmochelys imbricate); (5) Ridley turtle (Lepidochelus olivacea (L).

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1/ Lactarius spp. are now becoming rare in trawl catch compared with the early years of the trawl fishery in the Gulf.

2/ Caranx spp. have a pelagic form but are usually caught in large quantities by trawl net fishing.

3/ Leiognathus spp. are now included in the trash fish statistics. If they are well processed, they can be valuable export products, particularly to Japan.

Table 7
Marine fishes found in the Gulf of Thailand

| Major Group | Family | English name | Thai name | Number of species |
|---|---|---|---|---|
| Shark and Shark like fishes | Orectolobidae | Cat shark | chalam kob | 5 |
| | | Nurse Shark | chalam hin | |
| | Carcharhinidae | Tiger shark | chalam nu | 7 |
| | Sphyrnidae | Hammer head Shark | chalam huo koin | 3 |
| | Rhinobatidae | Fiddle shark | ronun | 6 |
| | Pristidae | Saw-fish | chalam pak lam | 1 |
| | Trygonidae | Stingray | kaben | 10 |
| | Myliobatidae | Eagle ray | kaben kang kao | 3 |
| | Rhinopteridae | Cow ray | kaben yeeson | 1 |
| | Torpedinidae | Electric ray | kaben fai fa | 5 |
| | Triakidae | - | - | 1 |
| Teleosts | Elopidae | Giant herring | talurk | 1 |
| | Megalopidae | Tarpon | talurk | 2 |
| | Abulidae | Banana fish | klue | 1 |
| | Chupeidae | Herring, Sardine | lung kuea og lac | 20 |
| | Dussumieridae | Round herring | kulae kluea | 4 |
| | Dorosomidae | Gizzard shad | kok | 4 |
| | Engraulidae | Anchovy | mali, saitun | 15 |
| | Chirocentridae | Welf herring | dab lao | 2 |
| | Chanidae | Milk fish | nuanchan tale | 1 |
| | Synodontidae | Lizard fish | pak kom | 10 |
| | Myctophidae | Lantern fish | - | 1 |
| | Plotosidae | Sea catfish | - | 2 |
| | Tachysuridae | Catfish | kodtale | 19 |
| | Anguillidae | True eel | too na | 1 |
| | Muraenidae | Moray | lai | 12 |
| | Muraenesocidae | Conger eel | mung korn, yod jak | 3 |
| | Congridae | Conger eel | pla lod | 3 |
| | Neenchelidae | - | - | 1 |
| | Ophichthyidae | Snake eel | lai ngu | 6 |
| | Belonidae | Gar fish | katung have tale | 7 |
| | Hemiramphidae | Half beak | katung, pla kemtale | 7 |
| | Exocoetidae | Flying fish | nok ka jork | 9 |
| | Bregmacerotidae | Unicorn-cord | kurau krae | 1 |
| | Fistularidae | Trumpet fish | pak trae | 1 |
| | Centriscidae | Razor fish | kang sai | 2 |
| | Syngnathidae | Sea horse, pipe fish | jim fan jora ke | 9 |

(con't)

| Major Group | Family | English name | Thai name | Number of species |
|---|---|---|---|---|
| | Holocentridae | Soldier fish | kao mau num tuk | 5 |
| | Sphyraenidae | Barracuda | nam dok mai, sak | 6 |
| | Mugillidae | Mullet | krabok | 9 |
| | Atherinidae | Silverside | hua kang, hua takua | 3 |
| | Polynemidae | Tassel fish | kurao | 9 |
| | Latidae | Cock-up, sea perch | kapong kao | 2 |
| | Ambassidae | Perchlet | kao mou | 6 |
| | Kuhliidae | - | - | 1 |
| | Serrannidae | Grouper | karang | 29 |
| | Diploprionidae | Two banded sea perch | kapong lueng | 1 |
| | Theraponidae | Theraponid | kang ta pao | 4 |
| | Priacanthidae | Bigeye | to to | 4 |
| | Apogonidae | Cardinal fish | pla om kai | 10 |
| | Sillaginidae | Sand whiting | pla hed khon | 5 |
| | Lactariidae | White fish | pla kanun, yuen | 1 |
| | Carangidae | Trevally | pla si gun, juijin | 42 |
| | Emmelichthyidae | Horse mackerel | | 1 |
| | Rachycentridae | King fish | pla chon tale | 1 |
| | Menidae | Moon fish | Baipo, phrachan | 1 |
| | Coryphaenidae | Dolphin | eto morn | 1 |
| | Lutianidae | Snapper | pla ka pong | 23 |
| | Caesiodidae | Fusilier | pla lueng | 10 |
| | Nemipteridae | Thread fin bream | sai daeng | 14 |
| | Labotidae | Triple tail | ka pong hin<br>ka pong lai | 2 |
| | Gerridae | Silver perch | dok mak | 8 |
| | Leiognathidae | Slip mouth | pla pan | 16 |
| | Pomadasyidae | Grunter | ka pong smae | 4 |
| | Scolopsidae | Monode bream | sai kao | 9 |
| | Plectorhynchidae | Sweetlip | kang ta pao | 5 |
| | Sciaenidae | Jew fish | juad | 29 |
| | Lethrinidae | Pigface bream | mu si | 9 |
| | Pentapodidae | Large-eyed bream | e kud | 2 |
| | Sparidae | Bream | e kud | 2 |
| | Mullidae | Goat fish | pae | 13 |
| | Monodactylidae | Butterfly fish | pee sue ngern | 1 |
| | Pempheridae | Sweeper | kadee tale | 4 |
| | Toxotidae | Archer fish | sue | 1 |
| | Kyphosidae | Rudder fish | salid tale | 3 |

(con't)

| Major Group | Family | English name | Thai name | Number of species |
|---|---|---|---|---|
| | Ephippidae | Spade fish | kao mau | 1 |
| | Platacidae | Bat fish | hoo chang | 4 |
| | Drepanidae | Sickle fish | hoo chang, kang por | 2 |
| | Pomacentridae | - | - | 1 |
| | Scatophagidae | Spade fish | ta krub | 1 |
| | Pomacanthidae | Angle fish | sin samut | 3 |
| | Chaetodontidae | Butterfly fish | pee sue | 17 |
| | Cepolidae | | | 2 |
| | Pomacentridae | Damsel fish | salid hin | 20 |
| | Labridae | Wrasse | nok khun tong | 35 |
| | Scaridae | Parrot fish | nok kaeo | 14 |
| | Cirrhitidae | Golden curlyfin | salid tong | 1 |
| | Parapercidae | Grub fish | ta ngang | 7 |
| | Ammodytidae | | | 1 |
| | Uranoscopidae | Star gazer | oop tai | 2 |
| | Ophisthognathidae | | | 1 |
| | Blenniidae | Blenny | teen tab | 7 |
| | Xiphasiidae | Haire tailed Blenny | krabee | 1 |
| | Carapidae | Pearl fish | kai muk | 3 |
| | Brotulidae | | | 1 |
| | Ophididae | | | 2 |
| | Callionymidae | Dragonet | mungorn noi | 12 |
| | Siganidae | Rabbit fish | salid tale | 9 |
| | Zanclidae | Moorish-idol | pee sue tevaroop | 1 |
| | Nomeidae | | | 1 |
| | Acanthuridae | Surgeon fish | ketang ped | 13 |
| | Trichiuridae | Hairtail, ribbon fish | dab nguen | 3 |
| | Scombridae | Mackerel | pla tu, pla lung | 5 |
| | Thunnidae | Frigate mackerel | pla o | 4 |
| | Scomberomoridae | Spanish mackerel | pla in see | 5 |
| | Istiophoridae | Sail fish | ka tong tang | 1 |
| | Stromateidae | Pompano, pomfret | jaramed | 4 |
| | Eleotridae | Gudgeon | pla bu | 14 |
| | Gobiidae | Goby | pla bu | 14 |
| | Periophthalmidae | Mudskipper | kachang, jumpruad | 2 |
| | Apocrypteidae | Pointed tail goby | boo | 6 |
| | Taenioididae | Goby | kua kang yun | 4 |
| | Trypauchenidae | Burrowing goby | pruad | 4 |
| | Tetragonidae | Wasp fish | karang hua khon | 4 |
| | Scorpaenidae | Scorpion fish | sing to | 10 |

(con't)

| Major Group | Family | English name | Thai name | Number of species |
|---|---|---|---|---|
| | Synanceidae | Stone fish | karanglhua khon | 8 |
| | Triglidae | Gurnad | mung korn | 3 |
| | Platycephalidae | Flathead | chang yearp | 14 |
| | Dactylopteridae | Flying gurnard | nok hook | 2 |
| | Psettodidae | Indian halibut | chakraphan | 1 |
| | Pleuronectidae | Flounder | lin ma | 2 |
| | Bothidae | Flounder | lin kwai | 15 |
| | Soleidae | Sole | seek due | 13 |
| | Cynoglossidae | Tongue sole | yod muang | 17 |
| | Echeneidae | Remora | pla tid | 3 |
| | Balistidae | Trigger fish | pla kwang | 9 |
| | Kurtidae | - | - | 1 |
| | Triacanthidae | Tripod fish | pla vor nam yao | 2 |
| | Aluteridae | File fish | nguar | 12 |
| | Anacanthidae | File fish | nguar | 1 |
| | Ostraciontidae | Trunk fish | kradooh | 3 |
| | Diodontidae | Porcupine | pak pao | 2 |
| | Canthigasteridae | Porcupine | pak pao | 1 |
| | Lagocephalidae | Puffer | pak pao | 1 |
| | Anternnariidae | Frag fish | kob | 3 |
| | Pegasidae | Dragon fish | jorake hin | 2 |
| | Tetraodontidae | Blow fish | pak pao | 8 |
| | Batrachoididae | Toad fish | kob, kang kok | 1 |

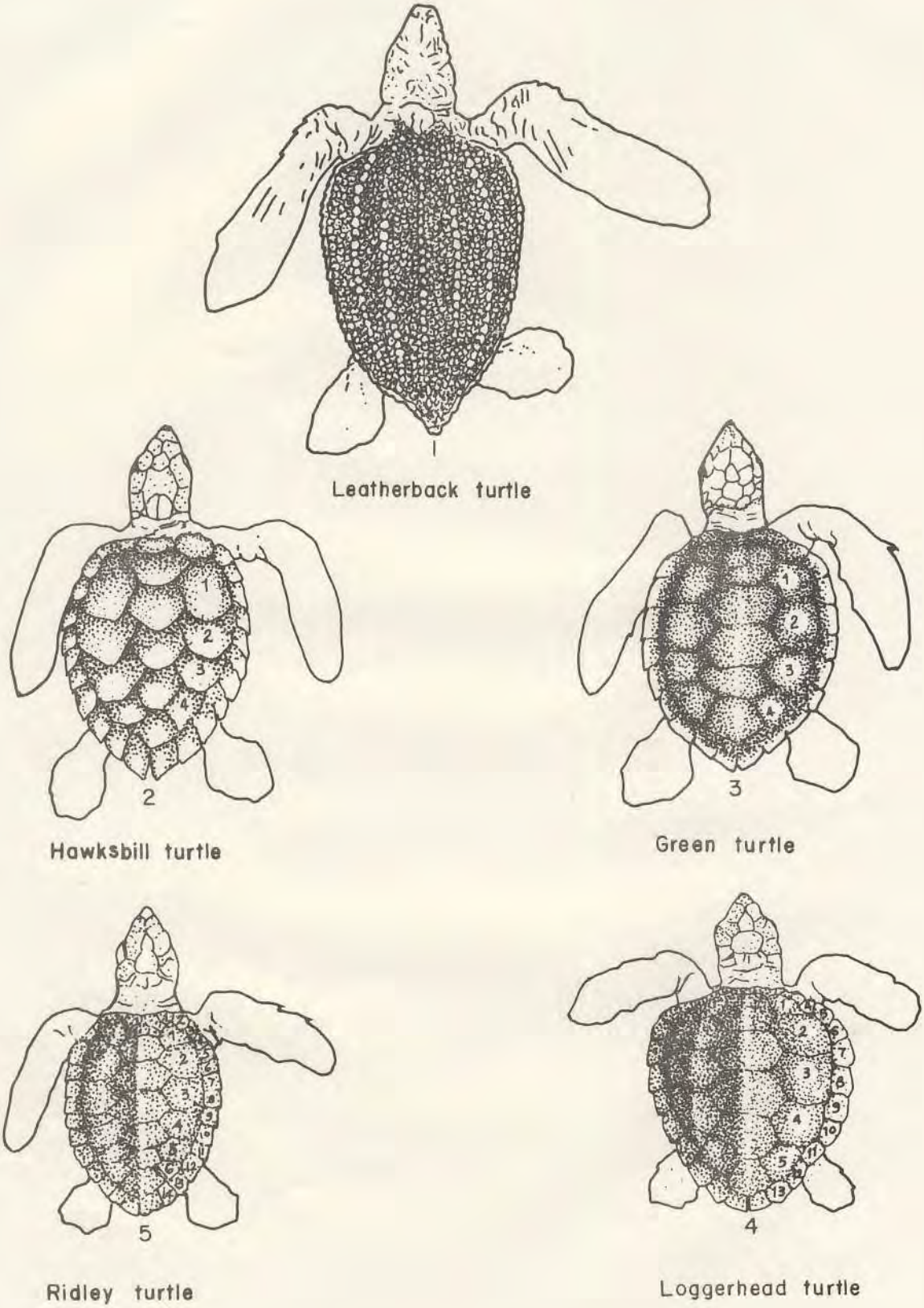


Figure 4 Marine turtles of the Gulf of Thailand.

Turtles (2) to (5) have a true hard shell. The Thai names are "tao tanu", tao tadaeng", "tao kra" and "tao ya" respectively.

As regards sea snakes which belong to the family Hydrophiidae, Suvatti (ibid.) listed 29 species. Tu (1974) in his investigation on sea snakes in the Gulf of Thailand reported that there were 14 species identified, and Pelamis hardwickii was the most abundant, i.e., 8 per cent of collected sea snakes. Praescutata viperina and Aipysurus eydouxii were the second most common sea snakes comprising up to 3.3 per cent of all sea snakes captured. Hydrophis cyanocinctus accounted for 2.6 percent of the total catch. Others captured included H. ornatus, H. torquatus, H. diadema, Kerilia jerdonii siamensis and Pelamis platurus.

Sea snakes generally inhabit estuaries and inland seas with a muddy bottom, particularly in shallow areas and mangrove swamps. Only one species, Pelamis platurus, lives in the open sea, e.g. the middle of the Gulf of Thailand and the South China Sea. They are considered unimportant commercially.

Among the reptitles, marine turtles are commercially important. In 1976, the eggs of these turtles amounting to 161,000 were collected with a value estimated at Baht 640,000. The marine turtles' eggs are collected mainly for local consumption.

### 3.1.9 Marine Mammals

Marine mammals include whales, dolphins and sirens. Suvatti (ibid.) recorded a small Indian fin whale (Balgenoptera edenii (Anderson) in the Gulf. Two species of dolphins, namely the Indian porpoise (Orcaella brevirostris (Owen) - "pla loma hua bard", and the long nosed dolphin (Sotalia sinensis (Flower) "pla loma hua kuad") are known to occur in the Gulf.

As regards the sirens, only one species, Halicore dugong (Erxliben) or sea cow in English and "payoon" or "mu nam" in Thai, was recorded by Suvatti (ibid.). Lekakul (1970) stated that the dugong once inhabited the coast of Sriracha and Rayong. Because of its gentle nature and slow movement they may be accidentally caught by trawl nets and die. This species is considered very rare. The Fisheries Law of Thailand prohibits the catching of this species.

## 3.2 Threatened Species of Marine Fauna

Several species of the fauna of Thailand are becoming rare and are on the verge of extinction owing to the increased destructive activities of man, resultant changes in the environment and ineffective conservation and/or enforcement measures.

Regarding threatened species of marine fauna, even though only higher groups of animals such as reptiles and mammals have been listed as rare or threatened species, it is believed that several species of marine fish and invertebrates are becoming scarce, particularly those inhabiting coral reefs which are being destroyed by intense fishing or other unwise practices.

The marine fauna, which is officially listed as threatened species, is given in Table 8.

There is a dearth of knowledge on the biology and bionomics of threatened species which hinders the formation and implementation of effective conservation programs. Nevertheless, limited research concerning the propagation of some species of marine turtles has been conducted by the Phuket Marine Biological Center, and a project for the conservation of marine turtles in the Gulf of Thailand in compliance with the wishes of Their Majesties has been formulated by the Department of Fisheries. This five-year project is expected to commence in 1980.

## 3.3 Commercially Important Species

In selecting species or groups of species that are considered commercially important, the magnitude of catch, the wholesale value, and the export potential are taken into consideration. Some resources have not yet been exploited commercially but they have potential for future development; they are also included in the list of commercially important species or groups of species in Thailand which appears as Table 9.

## 3.4 Biology and Bionomics of Certain Commercially Important Species

Information on the biology and bionomics of several commercially important pelagic and demersal species is rather limited. However, during the past two decades, through the efforts of fishery agencies and fishery research institutions in the region, we have gained increasing knowledge on the biology and ecology of some of these species. This section summarizes some of this knowledge.

Table 8
List of threatened species of marine fauna of Thailand

| Major group of animals | Thai common name | English common name | Scientific name | Remarks |
|---|---|---|---|---|
| Fish | Pla Ta pad | Scleropages | Scleropages formosus | Inhabiting fresh and brackish waters |
| Reptiles | Jorake nam kem | brackish water crocodile | Crocodylus porosus | Brackish water |
| | Ta khong | Long-nosed crocodile | Tomistoma schlegeli | Brackish water species |
| | Tao ma pheang | Leathery turtle | Dermochelys coriacea | Marine |
| | Tao kra | Hawksbill turtle | Chelonia imbricata | Marine |
| | Tao ta daeng | Loggerhead turtle | Caretta caretta | Marine |
| | Tao ya | Ridley turtle | Lepidochelus olivacea | Marine |
| Mammal | Mu nam ngurg, | Dugong, or sea cow | Halicore dugong | Brackish/ Marine |

Sources: Lekakul, B. (1968)
Suvatti, C. and D. Menasveta (1968)

Table 9

Commercially important resources, the magnitude of the catch and values thereof in Thailand 1/

| Main Group | Species or Group of Species | Landings in 1975 or 1976 (ton) | Value (million baht) | Remarks |
|---|---|---|---|---|
| Seaweed | Gracilaria spp. | 608 | 1.0 | Potential for culture. |
| Jelly fish | Rhopilema spp. | 4,369 | 1.0 | Need improvement in capture and product development. |
| Sea urchin and Sea cucumber | Diadema set to tum and Stichopus spp. | 150 | 0.9 | Latest resources. |
| Molluscs (edible) | Mytilus viridis<br>Modiolus<br>Anadara granosa<br>Paphia spp.<br>Meretrix spp. | 108,481 | 151.9 | Including cultured shellfish.<br>Room for increased production through culturing |
| Cephalopods | Loligo and Sepia spp. & related spp. | 64,825 | 427.4 | |
| Crustaceans | Mysids & Acetes spp. | 18,048 | 27.1 | |
| | Penaeus and Metapenaeus spp. | 88,672 | 1,500.0 | Production from natural stocks may be limited. |
| | Portunus spp.<br>Charybdis spp. | 23,675 | 134.2 | |
| Pelagic fish | sec 2.1.7(a) | 237,374 | 1,068.4 | Wide fluctuation in the catch. |
| Demersal fish | sec. 2.1.7(b) | 848,844 | 1,764.2 | |

1/ Total landings in Thailand

Source: Department of Fisheries, Fisheries Records of Thailand, 1976.

### 3.4.1 Pelagic fishery resources

A few commercially important pelagic resources in the Gulf of Thailand have been subjected to intensive studies. Those that have been studied include the Rastrelliger resources in the Gulf of Thailand.

(a) Rastrelliger resources

In section 2.1.7 (a) three species of the Rastrelliger are listed. Among them "pla tu" (R. brachysoma) has been studied extensively by the Pelagic Fisheries Investigation Unit of the Division of Marine Fisheries, Department of Fisheries. Menasveta et al. (1973) summarized the studies on the mackerel of the Gulf of Thailand, which are given below.

Jones and Silas (1964) consider R. brachysoma to be synonymous with R. neglectus (van Kampen). However, de Beaufort and Chapman (1951) pointed out some slight differences in the external morphology between the two species. In previous Thai literature, R. brachysoma is referred to as R. neglectus. R. faughni is synonymous with Scomber (= Pneumatophorus) australasicus according to Matsui (1967). It is distinguished from R. brachysoma by several characteristics including pointed nose, and fewer and shorter gill rakers. R. faughni, an off shore water fish, is now caught in substantial quantities by luring purse seines and trawl nets (Dhebtaranon and Chotiyaputta, 1974).

Rastrelliger is widely distributed in the Indian and Western Pacific Oceans. In the Gulf of Thailand it is observed that "pla lung" (R. kanagurta and pla tu pak ching chok R. faughni) are open sea species while R. brachysoma occurs inshore. The latter often frequent estuarine waters where the salinity is less than 28 per mille. R. kanagurta and R. faughni are found in the water of higher salinity (30-33 per mille).

The size at first maturity for "pla tu" in the Gulf of Thailand has been reported as 17.5 cm., dorsal extreme length. The fish attaining this length is about one year old. The spawning season of "pla tu" is long as pelagic eggs of this fish are found throughout the year. However, two peaks of spawning have been observed, the first between February and March and the second from June to August (Boonprakorb, 1965).

The annual egg surveys undertaken by the Pelagic Fisheries Investigation Unit reveal that"pla tu" spawn in the waters along the coasts of the Gulf. Along the west coast of the Gulf, the highest density of larvae was located in waters 10-40 miles off Prachuab Kirikhan and Chumporn Provinces. Ready-to-spawn fish stay near the bottom at a 18-25 m depth and the trawl fishery catches a large quantity of mature fish there (Boonprakorb,1972).

The fecundity of "pla tu" was estimated to be about 200,000. This number includes immature eggs of less than 0.01 mm in diameter. During a spawning season, a female releases eggs in batches of approximately 20,000. The eggs hatch within a period of 23-28 hours depending on the ambient water temperature (Dhebtaranon and Chotiyaputta, 1972).

"Pla tu" feed mainly on phytoplankton. Growth of the fish is very rapid. Hongskul (1974) indicated that immature fish grow very rapidly, attaining a length of 15 cm five months after hatching. After one year of age, growth becomes slower; it is rare to find fish that are two years old since most of them are caught during the first year. Rearing "pla tu" in floating pens revealed that the species does not live more than three years (Somjaiwong et al. 1969).

The growth of "pla tu" in the Gulf of Thailand is expressed by Von Bertanilanffy's growth equation as follows (Hongskul, 1974):

$$l_t = 20.9 \left( 1 - e^{-0.28 (t+0.03)} \right)$$

The movement of "pla tu" on the west coast of the Gulf of Thailand has been studied through analysis of tagging data (Somjaiwong and Chullasorn, 1972), monthly catches, and the size composition of the fish sampled from the fishing grounds. After hatching during April-May mackerel larvae are transported by currents into inshore waters to feed. During June-July the fish start moving northward along the west coast into the inner Gulf, where they feed extensively and are exposed to the purse seine fishery of the upper part of the west coast and of the Inner Gulf. The fish stay in the inner Gulf until October-November after which they gradually move southward to spawn in the waters off Prachuab Kirikhan and Chumporn Provinces, where they are fished extensively by purse-seiners during November-January (Fig. 5).

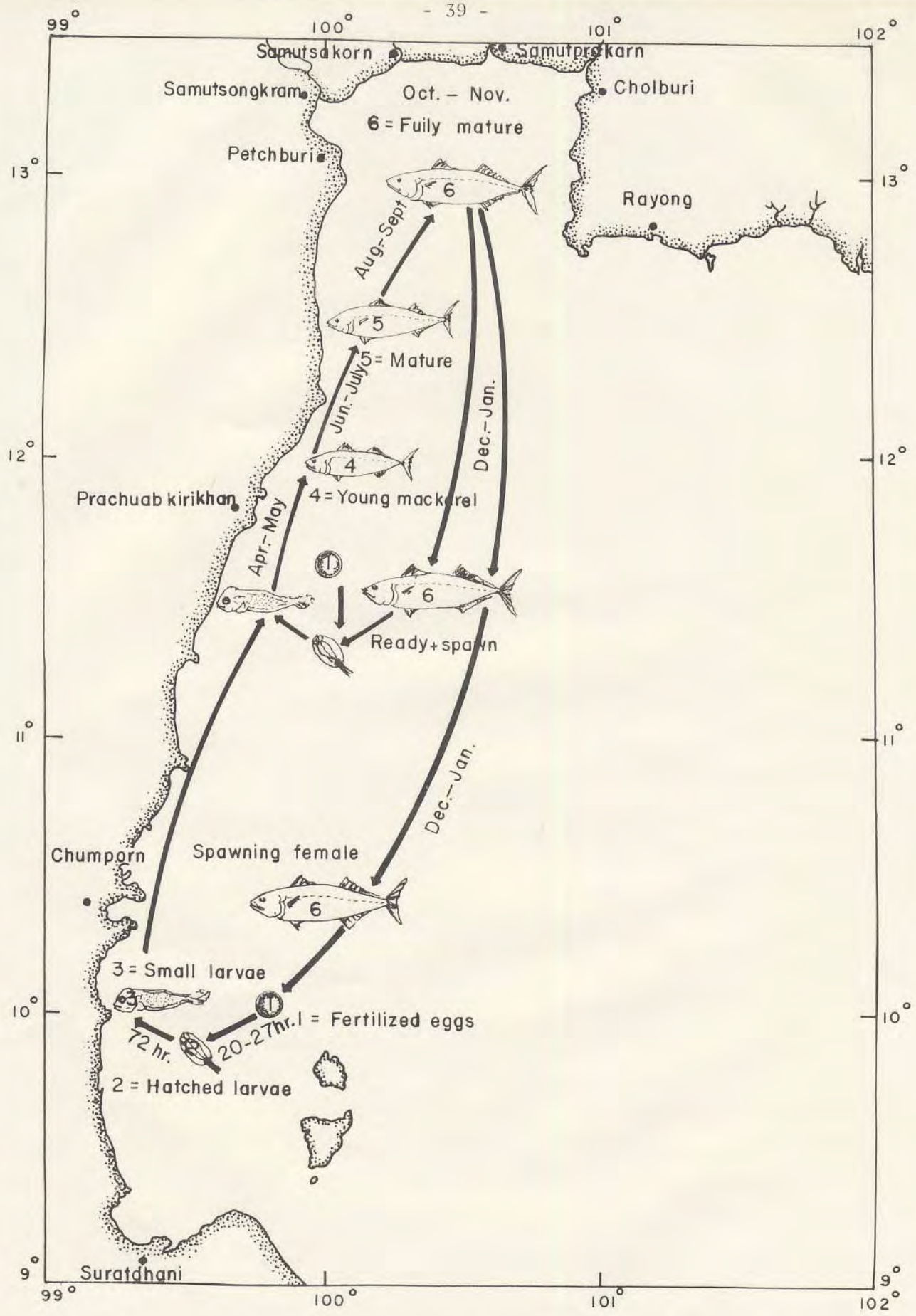


Figure 5 Life cycle of the Indo — Pacific mackerel in the Gulf of Thailand ( courtesy of the Marine Fisheries Division )

Figure 5 Life cycle of the Indo–Pacific mackerel in the Gulf of Thailand

( courtesy of the Marine Fisheries Division )

From the results of a series of tagging experiments carried out by the Department of Fisheries, it is believed that there exist at least two stocks of "pla tu", one on the west coast and the other on the east coast of the Gulf. The east coast stock is subjected to the fisheries of Vietnam, Kampuchea and Thailand while the west coast stock is fished entirely by the Thai fishing fleet.

As far as "pla lung" (R. kanagurta) is concerned, there have not yet been any extensive studies on the biology and ecology of the species. The recent development of using off-shore luring purse seiners in the central part of the Gulf has resulted in increased catch of this mackerel. It is believed that this species is widely distributed in the off-shore areas of the Gulf.

The size at first maturity of this species in the Gulf was reported to be 19.5 cm. Spawning may take place all year round with peaks of spawning off Prachuab Kirikhan during July-August and off Surat Thani Bay during January-March. The fecundity was estimated to be 200,000 eggs. Like "pla tu", "pla lung" is a fractional spawner with 20,000 eggs per batch.

"Pla lung" is an omnivorous species with a marked preference for zooplankton. The maximum length of the fish was found to be 19-22 cm ($L_{\infty}$) and the exponential growth coefficent (K) was 0.26 (Tantiswetaratna, 1979).

Information on the biology and bionomics of R. faughni is not available.

(b) "Pla in see" (Scomberomorus spp.)

Limited studies on the biology and ecology of this fish have been carried out by the Pelagic Fisheries Investigation Unit (Tongyai, 1967; Chullasorn, Chotiyaputta and Chayakul, 1973; Vattanachai, 1978). These species are commonly found in the Gulf of Thailand, with "pla in see bung" (S. commerson) being the predominant species.

In the Gulf of Thailand the specimens caught by various types of fishing gear ranged from 11-99 cm.

The size at first maturity of S. commerson was reported to be 58.5 cm. The study of the gonad development in relation to the size of the fish (GI) revealed that this species

may spawn in the Gulf during February-April and June-September. The fish spawn in the vicinity of Prachuab Kirikhan and Chumporn Provinces on the west coast about 10-15 m. On the east coast, fully mature fish have been found off Sattahip in Rayong Province and off Chantaburi and Trad Provinces. Vattanachai (1978) reported the high density of Spanish mackerel eggs in the vicinity of Koh Chuang and Koh Kam, Rayong Province, in April. The fecundity of a female about 74 cm in length was estimated to be 1.7 million eggs. The fish lay eggs in batches of approximately 400,000. The diameter of this pelagic egg is at least 0.8 mm.

Spanish mackerel is carnivorous in habit. Prey consist of crustaceans, squid, cuttlefish and small-sized fish. It was estimated that the fish with an average length of 67 cm would be one year old and those 86.0 mm in length two years old, and 90 cm three years old. The study of the growth of the fish (Supongphan,1979) has resulted in the tentative growth parameters as follows:

| | |
|---|---|
| Maximum length ($L_\infty$) | 90.0 cm |
| Growth Coefficient (K) | 0.13 |
| Hypothetical age of the fish at zero length ($t_o$) | 0.45 |

(c) "Pla tu kak" (Decapterus spp.)

"Pla tu kak" or scads have been subjected to intensive studies by biologists in the Philippines. In Thailand the study on the biology and bionomics of Decapterus spp. was begun in 1974 when the luring purse seine fishery started to develop in the Gulf of Thailand. Among the three species listed in the previous section. D. maruadsi, the flat bodied scad, is predominant. The scads are found in the off-shore waters of the Gulf particularly around the edges of the central basin of the Gulf where the salinity is above 30 per mille.

The Gulf scads mature when about 16-17 cm in length. The fecundity averages 135,000 eggs. The breeding season is long with two peaks, the first being from February-March and the second from July-August. The spawning grounds are located 60 miles south-west of Koh Chang and 100 miles east of Chumporn Provinces. Small fry of Decapturus spp. are distributed widely during January-February and June-July of each year.

(d) "Pla lung keo" (Sardinella and kindred species)

Until recently, sardines were considered as by-catch because of their low value in the market. Since the introduction of luring purse seine fishery in the Gulf in the early 1970's, the catch of sardines and related species has risen from 5,000 tons in 1970 to 92,000 tons in 1976. As indicated in the previous section, S. gibbosa is a predominant species constituting over 90 per cent of the total sardine fish caught. However, very little work has been done on the biology and bionomics of Sardinella spp. Some information can be obtained from the synopsis of sardine biology (mainly on S. aurita) by Li (1960) and on the Sardinella by Ronquillo (1960) and Soerjodinoto (1960).

As regards S. gibbosa of the Gulf of Thailand, Chullasorn (1979) summarized the findings as follows:

The fish is distributed widely along the coast of the Gulf at a depth ranging from 5-50 m. The size at first maturity was found to be approximately 13.3 cm. The fish spawn all year round with the concentration of eggs and larvae found in the inner Gulf during October-November, January-March and June-July. It is believed that the fish spawn off-shore where the water is more than 20 m deep. Larvae and fry up to 3 cm in length are found feeding near shore but the large-sized fish (5-17.5 cm) are generally found off-shore.

(e) "Pla ka tak" (Stolephorus spp.) or anchovies

These fish are distributed widely in the inshore waters of tropical seas. In the Gulf, 10 species are found in the catches with S. heterolobus being dominant, and constituting 87 per cent of the total anchovy catch (Taweesit, 1979).

Dhebtaranon (1974) reported that this fish matured when it reached 60 mm in length. Sitthichokphand (1974) stated that the eggs of this fish were found every month during the surveys carried out in 1968 and 1969. However, the peaks of the abundance of eggs and larvae were found during March - April and July - September in the waters about 10-30 miles off the coast at a depth of approximately 15 m.

Analysis of the fishes' stomach contents revealed that they fed on lucifer, mysids,copepod, euphausids, crustacean larvae, etc.

Tiews et al. (1970) studied the growth of S. heterolobus in the Philippines waters and concluded that the life span of the fish was not more than 3 years. The maximum length of the fish was reported to be approximately 90 mm. During the first year the fish may grow up to 30 mm in length and during the second year up to 60 mm in length.

(f) "Pla o" (Tunas)

"Pla o" are widely distributed in the Gulf of Thailand. The age and growth of the three species commonly caught in the Gulf were summarized by Klinmuang (1979) as follows:

| Species | Age (yr) | 1 | 2 | 3 |
|---|---|---|---|---|
| | | Fork Length in cm. | | |
| Thunnus tonggol | | 31 | 49 | 60 |
| Euthynnus affinis | | 27 | 41 | 53 |
| Auxis thazard | | 26 | 38 | 47 |

The fecundity of Thunnus tonggol, 44-49 cm in length was estimated to be 1.4 million, and that of E. affinis 39.5-51 cm in length 1.7 million. The spawning season of the former species is reportedly from March to September and of Auxis thazard from February to July.

(g) Squids and cuttlefish

Although squids and cuttlefish are caught mainly by trawl nets, because of their pelagic behavior and habitat, they are considered pelagic species. Among the cephalopods listed in Table 4, ten species of squids (Loligo and Sepioteuthis spp.) and cuttlefish (Sepia and Sepielle spp.) are commonly found in the catches (Invertebrate Fisheries Investigation Unit, 1979). Surveys carried out by the said Unit indicated that these species are widely distributed in the Gulf. Sepia aculeata and Sepiella inermis are found mostly at depths from 10-19 m. Sepia brevimana are found at depths from 40 to 49 m. Loligo and Octopus spp. are usually found at depths from 20-29 meters.

Preliminary investigations on the biology of Loligo and Sepia spp. carried out by the above-mentioned Unit during 1976-77 indicated that L. duvaucellii, L. formosana and S. aculeata spawned all year round. The fecundity of the three species was estimated to be 1,000-4,000, 800-7,000, and 2,000-6,000 respectively depending on the sizes of the animals. Analysis of the samples of stomach contents of L. duvaucellii revealed that these animals fed mainly on squid and cuttlefish, with fish and crustaceans constituting lesser components. S. aculeata, on the other hand, feed mainly on crustaceans, and fish to a lesser extent. Biological information on the major pelagic species of the Gulf of Thailand is summarized in Table 10.

### 3.4.2 Demersal fishery resources

Information on the biology and early life history of several demersal fish species of economic importance is still wanting. However, since 1963, the Demersal Fishery Investigation Unit of the Marine Fisheries Division, Department of Fisheries, has carried out preliminary studies on the growth, spawning seasons and spawning grounds, feeding habit, and on certain biological aspects of some demersal species in the Gulf of Thailand, which include the following species:

| Thai name | English name | Scientific name | Author(s) |
|---|---|---|---|
| Pla see kun | Pampano or Travelly | Caranx leptolepis | Naiyanetr (1963); Morsuwan (1970) |
| Pla sai daeng | Threadfin bream | Nemipterus hexodon | Isarankura and Pariyanong (1963); Isarankura (1970); Ragvichai (1977). |
| Pla pak kom | Lizard fish | Saurida undosgua mis | Intong (1970); Sinoda and Intong (MS) |
| Pla yod jak | Congerpike eel | Muraenesox spp. | Tongyai (1967) |
| Pla pan mu | Slipmouth | Leiognathus brevirostris | Vadhanakul |

Table 10. Summary of biological information on the major pelagic species of the Gulf of Thailand

| Species | Spawning season | Recruitment month | Recruitment length (cm) | Growth increment cm/month | Maximum length (cm) | Mean length in catch (cm) | Sex ratio M/F | Stomach contents (%) | Length-weight relationship | Authors |
|---|---|---|---|---|---|---|---|---|---|---|
| Rastrelliger brachysoma | All year round; peaks: Jan.-Mar., June-Aug. | May-June | 10.0 | 1-2 | 20.9 | 15 | 1:1 | phytoplankton | M : $W = 0.000005732\ L^{3.1463}$<br>F : $W = 0.000006578\ L^{3.1235}$ | Sucondharmarn et al. (1970) Hongskul(1974 Sriroengcheep (1979) |
| Rastrelliger kanagurta | All year round; peaks: July-Aug., Jan.-March | May-June | 11.0 | 1 | 22.9 | 16 | 1:1 | zooplankton | M : $W = 0.0000001958\ L^{3.7653}$<br>F : $W = 0.000009454\ L^{3.0375}$ | Tantiswetratn (1979) |
| Stolephorus heterolobus | All year round; peaks: Mar. Apr. July-Sept. | every month | 3.0 | 0.1 | 9.0 | 3.1-8.5 | 1:1 | lucifer, copepods, mysids, crustaceans | $W=0.000002064L^{3.2414}$ (inner Gulf)<br>$W=0.000007089L^{2.9329}$ (east coast) | Taweesit(1979 |
| Decapterus maruadsi | Feb.-Mar., July-Aug. | Feb.-Mar. Jul.-Aug. | 7.5 | 1 | 23.07 | 12.7-13.5 | 1:1.2 | mysids, zooplankton | $W=0.00005L^{2.811}$ | Chullasorn & Usuksawad(197 |
| Sardinella gibbosa | All year round | every month | 8.5 | - | 18.0 | 10.0 | 1:2.3 | - | - | Chullasorn (1979) |
| Scomberomorus commerson | Feb.-April; June-Sept. | Mar.-May Jul.-Sept. | 12 | 4 | 92.0 | 50 | 1:1 | fish, crustaceans, mollusc | $W = 0.01278\ L^{2.8870}$ | Suphongphan (1979) |
| Squid & cuttlefish | All year round | every month | - | - | 9.0 | 7.0 | 1:1.5 | squid & cuttlefish, Fish and crustaceans | M: $W=0.008175L^{1.819}$<br>F: $W=0.002132L^{2.132}$ | Invertebrate Fish Invest. Unit (1979) |
| a. L. duvaucelii | | | | | | | | | | |
| S. aculeata | All year round | " | - | - | 9.9 | 7.9 | 1:1.5 | crustaceans, fish | M: $W=0.000623L^{2.607}$<br>F: $W=0.000488L^{2.677}$ | |

Source: Pelagic Fisheries Investigation Unit,
Marine Fisheries Division
Department of Fisheries, Bangkok, Thailand

| Thai name | English name | Scientific name | Author(s) |
|---|---|---|---|
| Pla ta to | Big eye | Priacanthus tayenus | Chomjurai (1970); Wetchagarun (1971) |
| Pla sai kao | | Scolopsis taeniopterus | Thamniyom & Charnprasertporn (1977) |
| Pla juad | Jewfish | Sciaena russelli | Phettongkam and Thasananukulkit (1972) |
| Pla jak pan | Flatfish | Psettodes erumei | Kiihlmorgen - Hille, G. (1976) |
| | | Gerres oyena | Phettongkam (1976) |

Biological information on the major demersal species of the Gulf of Thailand is summarized in Table 11.

## 4. EXISTING INFORMATION ON THE FISHERIES

### 4.1 General

Rice and fish constitute the main dietary components of the Thai diet. The importance of fish as food has been recognized for generations in this country. This can be deduced from the late thirteenth century inscription on a stone slab erected during the reign of King Ramkamhaeng which reads, "in the water there are fishes and in the field there is rice", which bears witness to the abundance of food during those early days of Thailand.

In fact, up to the present, fisheries have played a vital role in the national economy of the country. Fish provides highly nutritious, and relatively cheap, animal protein for the multitude of Thai people, the so-called "poor majority". During the past two decades fisheries development has gained momentum with the introduction of efficient types of fishing gears such as purse

Table 11. Summary of biological information on the major demersal species of the Gulf of Thailand.

| Species | Spawning season | Recruitment month | Recruitment TL (cm) | Growth increment cm/month | Maximum length (cm) | Mean length in catch (cm) | Sex ratio M/F | Stomach contents (%) | Length-weight relationship | Author (s) |
|---|---|---|---|---|---|---|---|---|---|---|
| Caranx leptolepis | March<br>Jul.-Aug. | Jun.-Sep<br>Jan. | 12.0<br>13.0 | - | M 19<br>F 19 | - | - | - | Log $W_F$=3.2569 log $L_F$ -5.5669<br>Log $W_M$=3.6288 log $L_M$ -6.3689 | Naiyanetr (1963) |
| Cerres oyena | Throughout the year with the peak in Sep.-Feb. | - | | (2-1) | M 21<br>F 21 | M 16.66<br>F 17.22 | 0.81 | polycheate small shrimp debris and small fish and squid | Log $W_M$=2.75521 log $L_M$ -4.3118<br>Log $W_F$=2.5983 log $L_F$ | Phettongkam (1976) |
| Leiognathus bindus | 1. May<br>2. Sep.-Oct.<br>3. Dec. | Jan.<br>Aug.<br>Jul. | 3<br>3.5<br>5 | .4-.5 (length is about 7.5 cm in its first year) | 11 | 5.1 | - | - | - | Amarugsa (1965) |
| Leiognathus brevirostris | Jul.-Dec. with the peak in Oct. | Jan.<br>Jun.<br>Sep. | 9.5-10<br>10 | - | M 12<br>F 13.5 | M 10.06<br>F 10.55 | 1:1 | zooplankton (Mysids, copepods, Amphipod and Macruran larvae) Polycheate and Molluscs | - | Vadhanakul (1976) |
| Leiognathus leuciscus | 1. Jan.<br>2. Apr.<br>3. Jul.<br>4. Oct. | Feb.<br>Mar.<br>Aug.<br>Sep. | 5.5<br>5<br>6<br>4.5 | .5-.6 (length is about 9 cm in it its lst yr.) | 12 | 7.0 | - | - | - | Amarugsa (1965) |
| Luteanus lineolatus | Oct.-Jun. with the peak in Jun. | Jun.<br>Feb.<br>Apr. | 8<br>8.5<br>7.0 | (2-1) | M 18<br>F 19 | M 13.92 | 1:1 | 63% were fish of which most were Leiognathus elongatus, Saurida spp. larvae, 21% small shrimp, 31% squid | - | Vadhanakul (1976) |

Table 11 (cont.)

| Species | Spawning season | Recruitment month | Recruitment TL (cm) | Growth increment cm/month | Maximum length (cm) | Mean length in catch (cm) | Sex ratio M/F | Stomach contents (%) | Length-weight relationship | Author(s) |
|---|---|---|---|---|---|---|---|---|---|---|
| Nemipterus hexodon | All year round; peaks: Jan.-Apr. Jun.-Aug. | Male | | 2-1 | M 27.3 | M 16.46 | 0.97 | - | $W_M=0.11608L^{3.04}$ | Ragvichai (1977) |
| | | May | 10.5 | | F 24.4 | F 15.12 | | | $W_F=0.01765L^{2.924}$ | |
| | | Aug. | 11.5 | | | | | | | |
| | | Nov. | 9.5 | | | | | | | |
| | | Mar. | 10.5 | | | | | | | |
| | | Female | | | | | | | | |
| | | Aug. | 12.5 | | | | | | | |
| | | Nov. | 11.5 | | | | | | | |
| | | Jan. | 11.5 | | | | | | | |
| | | May | 11.5 | | | | | | | |
| Nemipterus peronei | Feb.-Apr. | Male | | - | M 27.5 | M 22.9 | 0.84 | shrimps 33<br>young fish 24<br>crabs 20<br>worms 18<br>squid 4 | West coast<br>$W_M=0.01219L^{2.9882}$<br>$W_F=0.01186L^{3.004}$<br>East coast<br>$W_M=0.01044L^{3.0451}$<br>$W_M=0.00773L^{3.1341}$<br>gm/cm | Isarankura (1963, 1968) |
| | | Mar. | 15.5 | | F 27.0 | F 21.6 | | | | |
| | | Jul. | 14.5 | | | | | | | |
| | | Sep. | 15.0 | | | | | | | |
| | | Dec. | 16.0 | | | | | | | |
| | | Female | | | | | | | | |
| | | Apr. | 15.5 | | | | | | | |
| | | Jul. | 16.0 | | | | | | | |
| | | Sep. | 16.5 | | | | | | | |
| | | Dec. | 16.0 | | | | | | | |
| Priacanthus tayenus | All year round; peak: Jan. through Mar. | Male | | 2-2.5 | M 27 | - | 1:1 | crustaceans<br>fish<br>squid | $W_M=3.16 \times 10^{-6}\ 2.9190$<br>$W_F=2.606 \times 10^{-6}\ 2.8930$ | Chomjurai (1970) Wetchagarun (1971) |
| | | May | 11 | | F 25 | | | | | |
| | | Oct. | 11 | | | | | | | |
| | | Dec. | 12 | | | | | | | |
| | | Mar. | 10 | | | | | | | |
| | | Female | | | | | | | | |
| | | June. | 10 | | | | | | | |
| | | Oct. | 11 | | | | | | | |
| | | Dec. | 12 | | | | | | | |
| | | Mar. | 11 | | | | | | | |

Table 11 (cont.)

| Species | Spawning season | Recruitment month | Recruitment TL (cm) | Growth increment cm/month | Maximum length (cm) | Mean length (cm) | Sex ratio in catch (cm) | Stomach contents (%) | Length-weight relationship | Author(s) |
|---|---|---|---|---|---|---|---|---|---|---|
| Saurida elongata | Jan.-Mar.<br>August | Male<br>May-Jul.<br>Nov.<br>Female<br>Jun.-Jul.<br>Nov. | | - | M 34<br>F 40 | M 26.31<br>F 30.56 | 1:1 | - | - | Chomedej (1961) |
| Saurida undosquamis | Dec.-Jan.<br>May-Sept. | Jun.<br>Nov.<br>Feb. | 13.5<br>15.0<br>13.5 | 2 | M 36.5<br>F 26.5 | M 17.80<br>F 18.31 | 0.567 | Mostly small fish, others: Cephalopods, crustaceans | $W_M=1.75 \times 10^{-5}\ 2.83$<br>$W_F=3.52 \times 10^{-6}\ 3.13$ | Intong (1971, 1976)<br>Masatosi and Intong (1977) |
| Sciaena nusselli | All year round;<br>peak: Dec.-Feb. | March<br>June<br>Sept.<br>Nov.<br>Jan. | | 1 | M 16<br>F 15.5 | M 11.97<br>F 11.52 | 1:1 | - | $W=1.10^{-6}L^{2.9927}$<br>$W=1.259 \times 10^{7}L^{2.9927}$ | Phettongkam et al. (1972) |
| Scolopsis taeniopterus | All year round; peaks:<br>Dec.-Jan.<br>Apr.; Aug.<br>fecundity<br>55 000 | Jun.-Jul.<br>Nov.-Dec.<br>Feb. | | - | M 27.0<br>F 25.0 | 1968<br>M 20.03<br>F 13.95<br>1969<br>M 18.83<br>F 14.83<br>1970<br>M 21.70<br>F 14.57 | 1968=7.8<br>1969=11.7<br>1970=6.97 | Crustaceans 50-60 | $W_M=1.08 \times 10^{-4}L^{2.6201}$<br>$W_F=6.17 \times 10^{-5}L^{2.7178}$ | Dhamniyom (1975)<br>Chanprasertporn et al. (1977) |

Source : Demersal Fisheries Investigation Unit,
Marine Fisheries Division
Department of Fisheries, Bangkok, Thailand

seine, gill nets and trawl nets. Especially trawl net fishery, commencing around 1962, is now a highly developed fishery, with a distant water trawl fleet operating off the coasts of Kampuchea, Vietnam, Malaysia, Indonesia, Burma, Bangladesh and India. The past two decades have seen a spectacular increase in marine fishery production (90 per cent or more of the total landing catch), which was mainly contributed by trawl net fishery.

The steadily mounting demand for fish and the increase in the efficiency and size of fishing boats and gear are among key factors in this notable rise in fish catch. The phenomenon is illustrated in Figure 6, which shows that prior to 1960 the total production remained at about 200,000 metric tons annually with approximately 50,000 tons being the inland production. From 1960 onwards there has been a spectacular increase in production to about 1.7 million metric tons in 1973. However, the total production dropped to around 1.5 million metric tons in 1974. This was due to the fuel oil crisis. Nevertheless, production rose again in 1976 to 1.7 million metric tons as a result of contributions derived from pelagic and mollusc resources. For the inland fisheries, the average production over the past few years has been approximately 150,000 metric tons. Production was not higher, as anticipated, owing to rising costs of fertilizers and fish feed in freshwater culture as well as unusual weather conditions in the central plains and the northeast during 1976/77.

The average consumption of fish by Thai people is said to be 21.5 kg/man/year. However, if we include the amount of fish used in the production of feeds for various types of animals such as poultry and pigs, in addition to highly priced fish cultured in fish farms, the actual total amount consumed would be about 39 kg/man/year (SCSP, 1976).

The Department of Fisheries (1975) gave a projection on the domestic demand for fish, influenced by both population and income growth. The forecast in total demand for all food fish is estimated at 1,146,555 tons in 1980 and 1,403,645 tons in 1985. This compares with the projected figures of 1,147,200 and 1,310,400 tons respectively, as calculated by the South China Sea Programme (SCSP) (1976), using the per capita consumption figure of 24 kg.

The fisheries of Thailand produced fish valued at Baht 10,863 million in 1977. This was approximately 3.3 per cent of the gross domestic product at factor cost or 10.3 per cent of the gross agricultural product.

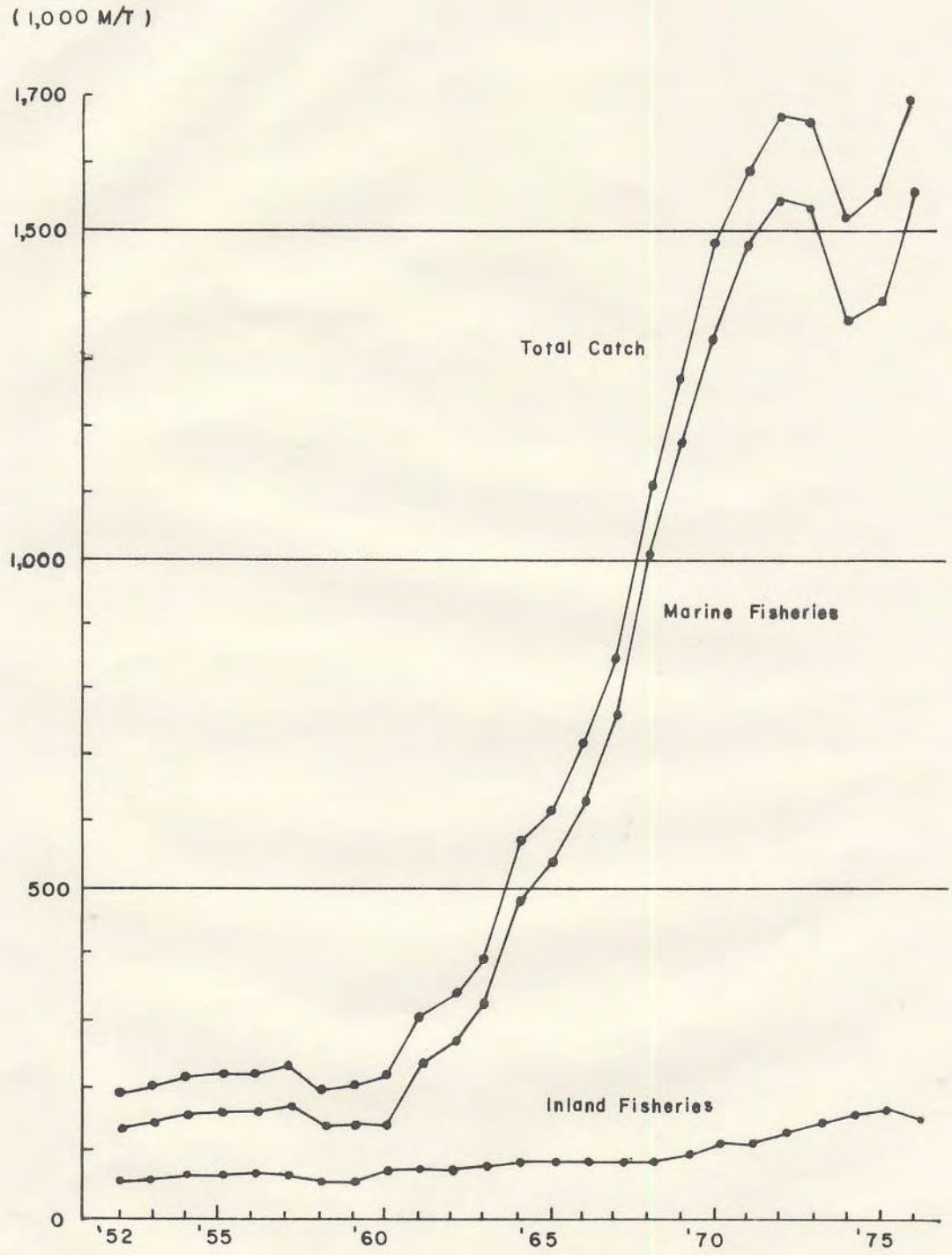


Figure 6 Annual fishery production of Thailand

Source: Department of Fisheries, Fisheries Records of Thailand, 1976

Fisheries create job opportunities not only in the fishing industry but also in other related industries, such as post-harvest technology, net-making, cold storage and ship building.

Finally, fisheries contribute to the country's foreign exchange earnings. The amount of exports rose from 88,221 metric tons valued at Baht 1,549 million in 1974 to 133,454 metric tons valued at Baht 3,085 million in 1976. The major export products that contributed to the substantial increase in the export value were frozen shrimps, frozen squid and cuttlefish, fish meal and frozen fish fillet. During the span of 1975-76 the value of exported fishery products rose 31 per cent. The value of shrimp and cuttlefish products exported rose by 33 and 19 per cent, respectively.

Recognizing the importance of fisheries to the economy of the country, the Government has integrated fisheries development programs as high priority components in its overall National Economic and Social Development Plan.

In order to achieve the basic national objectives, the Department of Fisheries has formulated a policy for fisheries development during the said period, as follows (Department of Fisheries 1977):

1. To promote the production of aquatic organisms to satisfy the population's demand;
2. To emphasize aquatic resources conservation and to rehabilitate natural bodies of water in the country;
3. To accelerate the development of brackish water fisheries with emphasis on coastal aquaculture;
4. To increase maximum benefit from marine fishery resources;
5. To develop fish processing technology with a view to make the best economic use of the resources;
6. To accelerate inland fisheries development for increased production;
7. To develop the economic and social aspects of fisheries with particular emphasis on the raising of the standard of living of subsistance fishermen.

In terms of marine fisheries development, various measures are being implemented. These include:

1. Development of pelagic fishery resources;

2. Introduction of suitable management schemes such as an improved licensing system for fishing vessels aimed at the restoration of demersal fish stocks in the Gulf of Thailand;

3. Revision of existing laws and regulations relating to fisheries in order to conserve the natural fishery resources;

4. Reduction of post harvest technology losses through improvement of fish handling methods and processing technology;

5. Joint ventures in marine fisheries with neighboring countries.

## 4.2 History of Marine Fisheries

Prior to the Second World War, the fisheries of Thailand were confined to the utilization of fresh water aquatic organisms in inland waters and to marine fish and invertebrates in the in-shore waters along the coast (Tiews, 1962). Fishing boats employed in in-shore fisheries prior to the Second World War were mainly non-powered sail boats. In the 1930's, purse seines made of cotton twine, introduced from China and therefore still known as Chinese purse seine, were used to catch schools of pelagic fish such as short bodied mackerel in in-shore waters.

During 1945-1960, besides traditional fishing gears such as hand and troll lines, lift nets, cast nets and push nets which were of minor importance, new types of fishing gears contributed to the substantial amount of approximately 150,000 metric tons of marine catch. These include purse seine, bamboo fish corrals (stake traps) and nylon gill nets.

Three different types of purse seines can be distinguished. The Chinese purse seine mentioned above has a length of 200-300 m, a depth of 50-60 m and stretched mesh size of approximately 3.5 cm. The gear is operated during dark moonless nights by two row boats.

The Aun-Dam purse seine or Aun Cha Lom (so called Thai purse seine) has a length of 250 m and a depth of 40-50 m. The gear is operated by a fishing boat, with no row boat.

The Aun-Lad purse seine measures 320 m in length and reaches only 20 m deep. The gear is employed mainly in shallow in-shore waters of the inner Gulf of Thailand.

Bamboo fish corrals (stake traps) locally known as "Poh" used to be very common in the in-shore fishery of the country with a total number of about 1,500 during 1945-1962. However, the number of this type of fishing gear has decreased drastically during the past two decades because it cannot compete with more efficient mobile gears such as purse seines or trawl nets.

Gill nets employed by Thai fishermen are set nets, drift nets and encircling nets.

After the Second World War, increased numbers of motorized boats using monofilament nylon and gill nets of various sizes were introduced into Thailand through the technical assistance of the US Government. These nets have gained popularity among Thai fishermen up to the present day.

The main fisheries of the country during 1945-1960 were carried out by about 1,400 motorized vessels and about 1,440 non-motorized vessels (less than 14 meters long), while the number of fishermen during the said period was estimated by the Department of Fisheries to be 32,000. However, if small scale fishermen had been included, the number would have been higher (Tiews, 1962).

The past two decades have seen a distinct and remarkable change in the structure of the marine fisheries sector. With the successful introduction of trawl net fishing into Thailand in 1962 by the Government with technical assistance rendered by the Government of the Federal Republic of Germany, there has been a spectacular increase in marine catch during 1963-1976 (Figure 6). This has resulted in overfishing of demersal fish stocks both in the Gulf of Thailand and in the Andaman Sea. The rapid development of trawl fisheries has placed Thailand among of the ten major fishing nations in the world with a long distance fishing fleet comparable to those of developed countries (SCSP, 1976).

Figure 6 further illustrates the magnitude of the catch of marine species (including production from coastal aquaculture such

as oysters, cockles and prawns) and the catch of freshwater species (including production from fresh water culture such as carps and catfishes).

Table 12 shows the breakdown of the country's fishery production during 1972-1976 into three major components, i.e. marine (capture only), inland (capture only) and aquaculture. During this period, the marine catch reached the peak of 1,475,000 metric tons in 1973 and declined in 1974-1975 to about 1.3 million metric tons and rose again to 1.4 million metric tons in 1976. During the same time span, production from inland waters remained relatively stable at about 117,000 metric tons. Although there was an apparent trend of increased production due to aquaculture, the substantial amount from this (over 80 per cent) came from cockle and mussel culture. For 1977, the marine landing catch reached 1.7 million metric tons (based upon personal communication with the Chief of the Fisheries Economic and Planning Sub-Division, Department of Fisheries). This may indicate that a substantial amount of catch might have been taken elsewhere outside Thai territorial waters.

There are many factors which have influenced the rapid expansion of marine fisheries during the past decades besides the progressive development of trawl fisheries. These factors include:

1. Increased efficiency of fishing gears employed and the greater capacity of fishing boats. In recent years not only did trawlers became larger and more efficient in fishing but also purse seines were rapidly modernized.

2. Discoveries of new fishing grounds such as round scad (Decapterus sp.) grounds in the middle of the Gulf of Thailand.

3. Improved infrastructure of Thailand.

4. Increased demand for fish food due to the quickly expanding population of the country.

### 4.3 Structure of the Marine Fishing Industry of Thailand

Prior to 1960, the fishing industry of Thailand consisted virtually of small-scale fishing households. While more than 80 per cent of inland fishermen were actually farmers, probably 50 per cent of coastal fishing households had more than one main source of income

Table 12

Annual Fishery Production of Thailand
by major types of Fisheries
(metric tons)

| Year | Total Production | Marine | Inland | Aquaculture 1/ |
|---|---|---|---|---|
| 1972 | 1,679,540 | 1,429,803 | 101,383 | 148,354 |
| 1973 | 1,673,901 | 1,474,742 | 110,885 | 93,274 |
| 1974 | 1,510,466 | 1,297,174 | 127,931 | 85,361 |
| 1975 | 1,555,300 | 1,284,810 | 130,717 | 139,773 |
| 1976 | 1,699,086 | 1,388,239 | 113,263 | 197,584 |
| Average | 1,624,000 | 1,375,000 | 116,800 | 132,900 |

Production from Aquaculture
1976 (metric tons)

| | |
|---|---|
| Brackish water | 163,553 |
| Freshwater | 34,031 |
| Total | 197,584 |

1/ Both inland (freshwater fish and prawn culture) and brackish water culture (sea prawn, sea bass, cockle and mullusc culture).

Mullusc culture contributes 80 per cent of the total aquaculture products.

Source: SEAFDEC (1978), Fishery Statistical Bulletin for the South China Sea Area 1976, Southeast Asian Fisheries Development Center, Bangkok.

(National Statistical Bureau, 1963). Characteristically, they operated within their family unit and rarely hired outside help. They used small, uncomplicated primitive gears which produced relatively low yields.

Since 1962, when otter board trawling methods were introduced, the marine fishery of Thailand experienced rapid growth with a considerable change in the structure of the fishing population. This fact was brought out in the Report of the South China Sea Programme Mission (SCSP, 1976) which stated.

"The marine fishery of Thailand is (now) basically commercial rather than small-scale or artisanal-oriented. Prior to the advent of otter board trawling in the mid and late 1960's, the main catch was composed of small pelagic species caught in-shore by fixed types of gear and several types of simple purse seines, as well as artisanally caught invertebrates and the collection of several kinds of molluscs. Artisanal fishing methods still prevail in some coastal areas, most notably among the Muslim population in provinces close to the Malaysia border, but documentation of this sector of fishery is almost non-existent. With a ten-fold increase in the marine catch from less than 150,000 tons in 1960 to over 1,500,000 tons in 1972, such an increase is only possible with a change from labour to capital intensive investment, employing modern technology and equipment."

The changes mentioned above have more or less affected the marine fishing industry employment structure. As indicated in Table 13, the total number of fisheries households decreased from 50,968 in 1967 to 40,198 in 1976. During this period enterprise fisheries increased significantly from 2752 in 1967 to 6311 in 1976. A change is also reflected in the reduced number of non-motorized vessels from 14,710 in 1967 to only 5,367 in 1976 as compared with the increase in the number of motorized vessels from 18,871 in 1967 to 20,768 in 1976.

As with the prior 1960 figure for the number of fishermen said to be approximately 70,000, this may be underestimated and the true amount, including small scale fishermen, may actually be substantially higher than the figure given by the Department of Fisheries (SCSP, 1976).

Another trend in the changing fisheries employment structure is that brought about by the size of fishing vessels employed by the industry. It should be noted that the number of

Table 13

Marine Fishing Industry Employment

| | 1967 | 1970 | 1973 | 1976 |
|---|---|---|---|---|
| Fisheries households | | | | |
| Enterprise[1/] | 2,752 | 2,660 | 5,524 | 6,311 |
| Subsistence[2/] | 35,940 | 29,151 | 26,063 | 25,558 |
| Employee | 12,276 | 11,709 | 7,115 | 8,329 |
| Total fishery households | 50,968 | 43,520 | 38,702 | 40,198 |
| Fishing Population | | | | |
| (Fishermen and independents) | 315,897 | 271,132 | 249,618 | 264,361 |
| Fishermen | | | | |
| Extent of employment | 75,676 | 74,086 | 64,227 | 69,927 |
| Solely | - | 56,708 | 48,519 | 51,198 |
| Mainly | - | 11,985 | 12,027 | 13,754 |
| Partly | - | 5,393 | 3,731 | 4,975 |
| No. of Fishing boats | 33,581 | 27,521 | 26,439 | 26,135 |
| Non-motorized boats | 14,710 | 8,313 | 6,918 | 5,367 |
| Motorized boats | 18,871 | 19,208 | 19,521 | 20,768 |

1/ Household that has more than 3 employees.
2/ " " " two employees or less.

Source:: Department of Fisheries, Statistics on the population of marine fishermen (1978).

fishermen shows a decreasing trend and small vessels have been replaced by larger and more efficient ones.

Finally, the rise in the number of high cost gear such as trawl nets, and the decline in the number of traditionally non-mobile gear, for instance, traps and set bag nets, are clear indicators that during the past twenty years the pattern of fisheries has shifted from primarily subsistence to enterprise or commercial fisheries.

The Mission of the South China Sea Programme (SCSP, 1976) observed that the fisheries enterprise could be considered as the backbone of the marine fishing industry of Thailand. It further concluded that the development of the marine fishing industry of Thailand had reached its peak in employment, boat building and production. Hence, at present this industry must look forward to expanding its activity in the high seas with a view to reaping benefits and to obtaining investment returns as soon as possible.

## 4.4 Major Fisheries in the Gulf of Thailand

The marine landing statistics of Thailand can be broken down into those from the Gulf of Thailand and those from the Andaman Sea. The annual landing from the Gulf of Thailand is approximately 80 per cent of the total marine landing of the country. However, it should be noted that some of the catch taken outside the Gulf was reported as being caught in the Gulf because of existing maritime regulations.

### 4.4.1 Trawl Fisheries

With the rapid development of trawl fisheries since 1960, inshore gear such as push nets, set bag nets and bamboo stake traps account for a negligible proportion of the total catch of demersal species.

These types of trawls are presently employed in demersal or trawl fisheries. These are otter board trawls, pair trawls and beam trawls. The major portion of the demersal species (over 75 per cent) is caught by otter board trawls. Beam trawls fish mainly for shrimps in the inshore waters along the coast. Their catches are quite low as compared to those of the otter board and pair trawls. Table 14 shows the number of registered trawlers operating in the Gulf of Thailand,which rose from 99 in 1960 to

5,834 in 1977. The increase in the member of trawlers resulted in the increased demersal catch, which rose from 55,200 metric tons in 1960 to 1,031,132 metric tons in 1977. The majority of the trawlers in operation were otter trawlers of less than 14 m in length (Table 15). Only 100 trawlers were 25 m in length or longer. Hence, it is assumed that intense fishing took place in the waters not far from the coast, i.e. within a depth of 50 m.

The dimensions of the trawl gears depend on the size of the vessels and on whether they are using the 2-sheet German trawl or the 4-sheet Japanese trawl. The headline lengths and cod-end mesh sizes of Thai trawlers are shown in Table 16.

Among the multitude (over 200 species) of demersal fish caught, less than 15 species are predominant in the demersal catch. These include threadfin bream (Nemipterus spp.), goat fish (Mullidae), lizard fish (Synodontidae), big-eye (Priacanthidae), sea catfish (Taehysaridae), sharks and rays, travelly (Carangidae), bass (Lutjanidae), baracudas and wolf herring (Chirocentridae).

Trawl gears catch not only demersal fish but some pelagic fish and invertebrates such as molluscs, crustaceans, spanish mackerel and Indo-Pacific mackerel.

In recent years, shrimps (Penaeus and Metapenaeus spp.), squid and cuttlefish, caught by trawl net fishing have contributed substantially to the income of trawlers in general. Table 17 shows the catch composition (% by weight) of Thai trawlers in 1976, and indicates that 0.7 per cent of the catch by otter trawlers and 4 per cent by pair trawlers were pelagic species. This table also clearly indicates that almost 70 per cent of the catch of otter trawl, 64 per cent of the catch of pair trawl and 42 per cent of the catch of beam trawl were trash fish. This is because the majority of the Thai trawlers use small cod-end mesh sizes of less than 2.6 cm. It should be noted that the so-called trash fish include juveniles and fry of several economically important species.

The rapid expansion of trawl fisheries has resulted in several developments in Thai marine fisheries, which include:

1. The depletion of the fishing grounds in the Gulf of Thailand and in the Andaman Sea (off the Thai coast).

Table 14

Number of registered trawlers operating in the Gulf of Thailand, and catches in metric tons

| Year | No. of trawlers registered | Catch |
|---|---|---|
| 1960 | 99 | 55,200 |
| 1961 | 201 | 115,500 |
| 1962 | 976 | 139,600 |
| 1963 | 2,026 | 215,800 |
| 1964 | 2,360 | 347,600 |
| 1965 | 2,393 | 373,700 |
| 1966 | 2,695 | 419,800 |
| 1967 | 3,077 | 460,300 |
| 1968 | 3,182 | 524,400 |
| 1969 | 3,185 | 548,400 |
| 1970 | 3,144 | 550,238 |
| 1971 | 3,338 | 575,801 |
| 1972 | 4,114 | 925,048 |
| 1973 | 5,284 | 928,110 |
| 1974 | 4,885 | 837,500 |
| 1975 | 4,962 | 533,351 |
| 1976 | 4,833 | 792,197 |
| 1977 | 5,834 | 1,031,132 |

Source: Department of Fisheries,
Fisheries Records of Thailand, 1977.

Table 15

Number of trawlers registered in 1977 and operating in the Gulf of Thailand

| Type | Total | less than 14 m | 14-18 m | 18-25 m | 25 m or longer |
|---|---|---|---|---|---|
| Total | 5,834 | 3,125 | 1,741 | 867 | 101 |
| Otter trawlers | 4,536 | 2,637 | 1,331 | 468 | 100 |
| Pair trawlers | 878 | 68 | 410 | 399 | 1 |
| Beam trawlers | 420 | 420 | - | - | - |

Source: Department of Fisheries,
Thai Fishing Vessels Statistics, 1977.

Table 16

Headline lengths and cod-end mesh sizes of Thai otter board trawlers, otter board beam trawlers and pair trawlers

| Vessel length (m) | Otter board trawlers | | | | Otter board beam trawlers | | Pair trawlers | | |
|---|---|---|---|---|---|---|---|---|---|
| | 14 m | 14-18 m | 18-20 m | 20 m+ | 13 m | | 13-18 m | 18-20 m | 20 m + |
| Length of 2 sheets | 22.9 | 25- | 24 | 37.7 | 23.2 | 26.5 | 27.6 | 30.7 | 32.6 |
| Headline & sheets | 18.3 | 24.3 | 23.5 | 28.1 | 21.5 | 17.0 | 24.7 | 30.0 | 34.6 |
| Cod-end 25 sheets | 1.9 | 1.8 | 1.7 | 2.6 | | 2.5 | 2.6 | 2.6 | 3.0 |
| Mesh size 45 sheets | 1.5 | 2.3 | 2.6 | 2.6 | | 2.0 | 2.1 | 2.1 | 2.9 |

Source: South China Sea Programme (1978)

Table 17

Catch composition (per cent by weight) of Thai trawlers, 1976

| | Otter Trawl | | Pair Trawl | | Beam Trawl | |
|---|---|---|---|---|---|---|
| | Metric tons | % | Metric tons | % | Metric tons | % |
| Demersal food fish | 109,194 | 15.6 | 30,847 | 17.2 | 149 | 3.4 |
| Demersal trash fish | 479,689 | 68.7 | 114,348 | 63.6 | 1,830 | 41.6 |
| Shrimps | 59,031 | 8.5 | 580 | 0.3 | 1,983 | 45.1 |
| Other crustaceans | 9,567 | 1.4 | 1,474 | 0.8 | 331 | 7.5 |
| Pelagic fish | 4,764 | 0.7 | 7,420 | 4.1 | - | - |
| Cephalopods | 35,755 | 5.1 | 25,074 | 13.9 | 102 | 2.3 |
| Total trawl catch | 698,000 | 100 | 179,743 | 100 | 4,395 | 100 |

Source: Department of Fisheries, Fisheries Records of Thailand, 1976.

2. The development of medium and large-sized trawlers (18 m or more) and the formation of a distance fishing fleet of trawlers operating off the coast of Kampuchea, Vietnam, Malaysia, Indonesia and recently in the Bay of Bengal and India. It was estimated that up to 660,000 metric tons of demersal fish were caught in the international waters outside Thai waters (SCSP, 1976).

3. The increase in the export of some fisheries products, notably frozen shrimps and squid as well as fish fillets.

4. The increase in the amount of trash fish which is used for fish meal, and by the duck farming and fish culture industries of Thailand.

4.4.2 Purse seine fisheries

Prior to the Second World War, pelagic species were mainly caught in inshore waters of the Gulf using stationary gear such as bamboo stake traps and set bag nets. The Chinese purse seine was introduced to Thailand around 1925, employing a sail boat with two small row boats for setting the net.

Since the end of the Second World War, nylon gill nets have been used widely and the Chinese purse seine fishing method has been modified. Instead of using two row boats to set the net, the main boat, which is now motorized, sets the net by itself. This method is called Thai purse seining. The Thai purse seine fishing method is now widely practised in Thailand for capturing pelagic fish and can be considered as an enterprise fishery since the purse seiners have recently become larger in scale. The gear employed is also larger on the average than that used two decades ago. Large-sized purse seiners are now equipped with power-saving devices such as the purse line winch, thus enabling a boat to reduce its crew nearly by half, from previously 22 to only 12. In addition, more medium and large-sized purse seiners are now equipped with radar, fish finders, wireless equipment and refrigeration units (Yamazaki, 1978).

However, in contrast to trawl fishery with some large-sized trawlers now fishing in distant waters, pelagic fishery is still practised in the waters of Thailand. Several other types of gear employed by small-scale fishermen, such as gill nets, traps and small seines, also contribute substantially to the pelagic catch. Table 18 shows the number of registered purse seiners of various types in operation in the Gulf of Thailand from 1972 to 1977. The number of Chinese purse seiners reduced from 28 in 1972 to nil in 1977. The number of Thai purse seiners also reduced from 317 in 1972 to 138 in 1977. Since 1973, with the introduction of luring techniques using palm leaves by day and lamps by night, the production of pelagic catches, mainly sardines and scads, has increased sharply, and the number of luring purse seine vessels rose from 100 in 1973 to 410 in 1977. In 1977 luring purse seine nets caught approximately 90 per cent of the total pelagic catch in the Gulf of Thailand (Table 19).

In 1977 the catches by weight of scads (Decapterus spp.) and sardines (Sardinella spp.) accounted for 28 per cent and 46 per cent, respectively, of the total pelagic fish catch in the Gulf of Thailand while the mackerel accounted for only 12 per cent of the total pelagic catch from the Gulf. (Table 20) The latter table also indicates that as a whole the pelagic catch increased from 90,819 metric tons in 1972 to 462,994 metric tons in 1977.

Figure 7 illustrates the development of trawl and purse seine fisheries in the Gulf of Thailand with a spectacular increase in both demersal and pelagic fish production amounting to more than 1,400,000 tons in 1977.

### 4.4.3 Shellfish fisheries

These fisheries include the collection of mussels from bamboo poles, which are used in the construction of bamboo stake traps, and from various collecting devices as well as from culturing activities. The trawl gears play a minor role in the collection of shellfish. The production of shellfish from 1965 to 1977 is listed in Table 21 and Figure 8. The average production during 1975/77 was 129,000 metric tons. Table 22 indicates that the major contribution to the production of shellfish comes from sea mussel (Mytilus spp.). This species accounted for 61 per cent of the total shellfish production from the Gulf of Thailand in 1977.


Figure 7 Trawl and purse seine catches in the Gulf of Thailand.

Table 18

Number of registered purse seiners operating in the Gulf of Thailand

1972-1977

| Type | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 |
|---|---|---|---|---|---|---|
| Thai purse seine | 317 | 347 | 298 | 289 | 262 | 138 |
| Chinese purse seine | 28 | 3 | 2 | 1 | 2 | - |
| Anchovy purse seine | 48 | 66 | 46 | 30 | 45 | 14 |
| Luring purse seine | - | 100 | 152 | 193 | 300 | 410 |
| Total | 393 | 516 | 498 | 513 | 609 | 562 |

Source: Department of Fisheries, Thai Fishing Vessels Statistics, 1977.

Table 19

Pelagic catches made by various types of purse seines in the Gulf of Thailand, 1972-1977

(in metric tons)

| Type | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 |
|---|---|---|---|---|---|---|
| Thai purse seine | 24,675 | 25,486 | 50,892 | 68,620 | 83,781 | 37,095 |
| Chinese purse seine | - | - | - | - | - | - |
| Anchovy purse seine | 8,052 | 11,466 | 4,326 | 10,324 | 5,019 | 1,552 |
| Luring purse seine | - | 44,286 | 69,217 | 74,979 | 185,432 | 384,633 |
| Total | 32,727 | 81,238 | 124,435 | 153,923 | 274,232 | 423,280 |

Source: Department of Fisheries, Marine Fisheries Production Survey, 1977.

Table 20

Catch of pelagic fish in the Gulf of Thailand
1972-1977
(in metric tons)

| Species | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 |
|---|---|---|---|---|---|---|
| Indo-Pacific mackerel | 37,976 | 45,644 | 35,567 | 60,892 | 50,630 | 26,581 |
| Indian mackerel | 10,998 | 19,473 | 15,375 | 16,391 | 20,501 | 30,826 |
| Bonito | 5,508 | 6,519 | 8,715 | 9,048 | 7,892 | 11,296 |
| Scad | 2,014 | 13,054 | 33,377 | 25,226 | 82,686 | 129,897 |
| Torpedo trevally | 1,557 | 3,138 | 3,717 | 4,481 | 14,537 | 25,599 |
| Trevally | 8,265 | 11,627 | 8,778 | 10,506 | 21,360 | 16,594 |
| Sardine | 8,034 | 29,942 | 56,140 | 60,542 | 100,236 | 211,094 |
| Anchovy | 16,467 | 22,170 | 19,697 | 13,293 | 16,408 | 11,107 |
| Total | 90,819 | 151,567 | 181,366 | 200,379 | 314,250 | 462,994 |

Source: Department of Fisheries,
Marine Fisheries Production Survey,
1977.

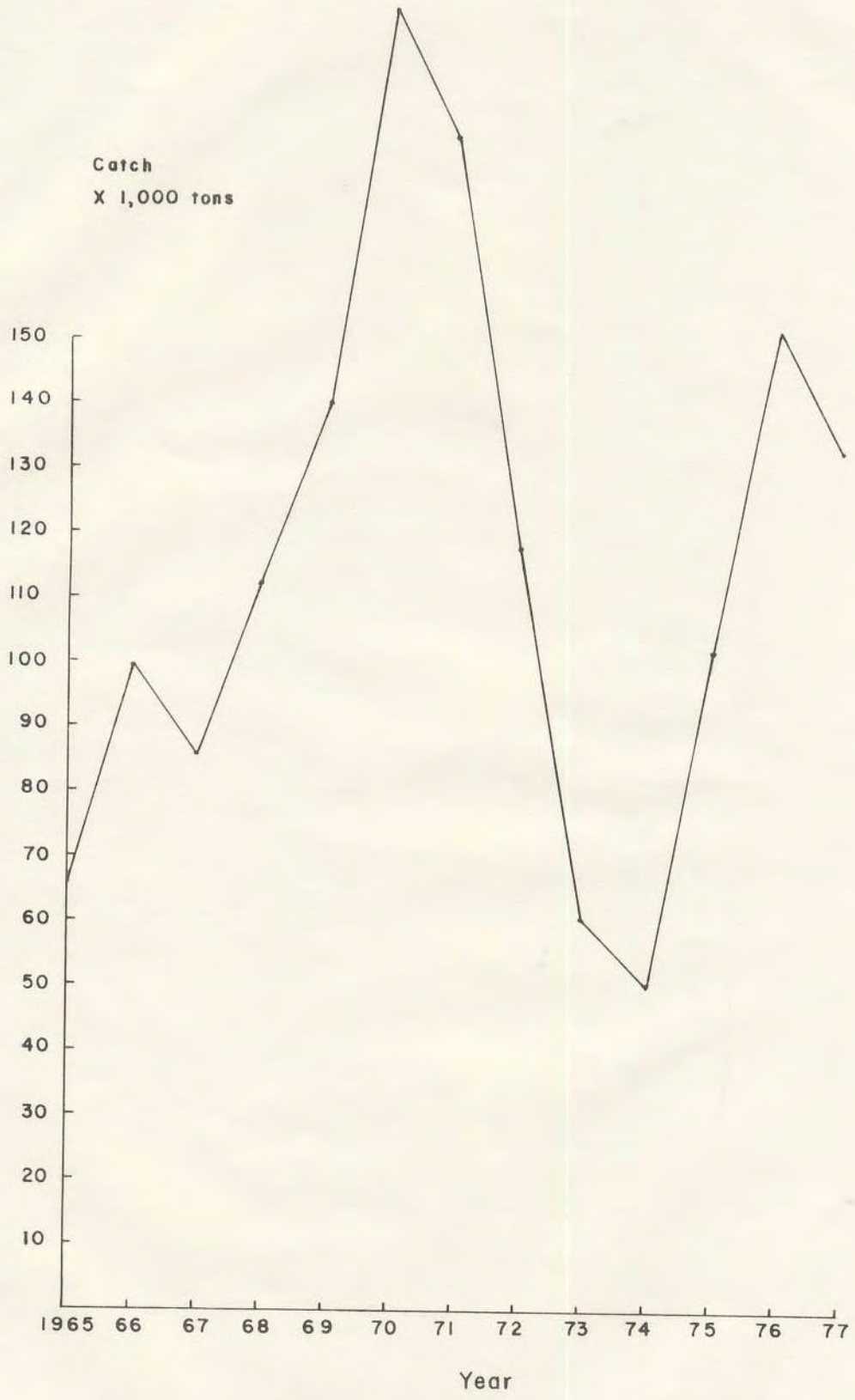


Figure 8 Shellfish production in the Gulf of Thailand, 1965 - 1977.

Source: Department of Fisheries, Fisheries Records of Thailand, 1977.

Table 21

Production of shellfish in the Gulf of Thailand, 1965-1977
(in metric tons)

| Year | Production |
|---|---|
| 1965 | 66,939 |
| 1966 | 98,808 |
| 1967 | 86,063 |
| 1968 | 112,164 |
| 1969 | 139,860 |
| 1970 | 207,987 |
| 1971 | 181,019 |
| 1972 | 118,081 |
| 1973 | 60,242 |
| 1974 | 50,468 |
| 1975 | 102,891 |
| 1976 | 151,443 |
| 1977 | 133,203 |

Source: Department of Fisheries,
Fisheries Records of Thailand,
1977.

Table 22

Production of shellfish by species in the Gulf of Thailand
(in metric tons)

| Species | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 |
|---|---|---|---|---|---|---|
| Ark-shell | 4,263 | 4,795 | 2,117 | 2,547 | 3,287 | 4,949 |
| Sea mussel | 71,053 | 10,958 | 13,473 | 46,916 | 72,542 | 81,855 |
| Oysters | 3,560 | 4,320 | 3,768 | 5,072 | 6,303 | 15,492 |
| Horse mussel | 16,194 | 16,708 | 12,887 | 29,645 | 43,233 | 15,489 |
| Surf clams | 14,095 | 17,950 | 13,806 | 14,307 | 23,275 | 17,360 |
| Others | 8,916 | 5,511 | 4,417 | 4,404 | 2,803 | 58 |
| Total | 118,081 | 60,242 | 50,468 | 102,891 | 151,443 | 133,203 |

Source: Department of Fisheries, Marine Fisheries Production Survey, 1977.

### 4.4.4 Squid and Cuttlefish fisheries

Squid and cuttlefish fisheries have become one of the most important fisheries in the Gulf of Thailand. Squid and cuttlefish are caught mostly by trawl gear in the offshore waters, and by push nets and lift nets with light in the inshore and coastal waters of the Gulf. The production of squid and cuttlefish captered in the Gulf increased from approximately 12,000 metric tons in 1965 to over 77,000 metric tons in 1977. (Fig.9, and Table 23). Thailand exported approximately 23,000 metric tons of squid and cuttlefish to foreign markets, valued at Baht 762 million in 1976.

### 4.4.5 Shrimp fisheries

Shrimps are caught mainly by trawl nets of various types. Gill nets and push nets are used by subsistence fishermen in inshore waters. Many small trawlers or baby trawl and beam trawls are used to catch shrimps in coastal waters in the Gulf of Thailand. Table 24 indicates that there is an increasing trend of shrimp catch with a total of 105,618 tons caught in 1977 in the Gulf of Thailand (see also Fig. 10).

The major species in the catch are white shrimps (Penaeus merguensis), Green tiger shrimp (Penaeus semisulcatus) and Metapenaeus spp. Mixed species, which could not be sorted out, contributed approximately 76 per cent of the total production from the Gulf in 1977 (Table 25).

The Fisheries Records of Thailand for 1976 published by the Department of Fisheries indicated that 16,718 metric tons of frozen shrimps were exported to foreign countries valued at Baht 1,431 million.

### 4.4.6 Summary of the major fisheries in the Gulf of Thailand

The catches and values of marine species caught in the Gulf of Thailand by major types of fisheries are summarized in Table 26. It is evident that trawl fisheries are the most important fisheries of the Gulf contributing 56.3 per cent in production and 56.7 per cent in value, while purse seines of various types are the second most important fisheries contributing 23.2 per cent in production and 19.6 per cent in value. Other types of fishing activities contributed less than 10 per cent in production and 12 per cent in value.

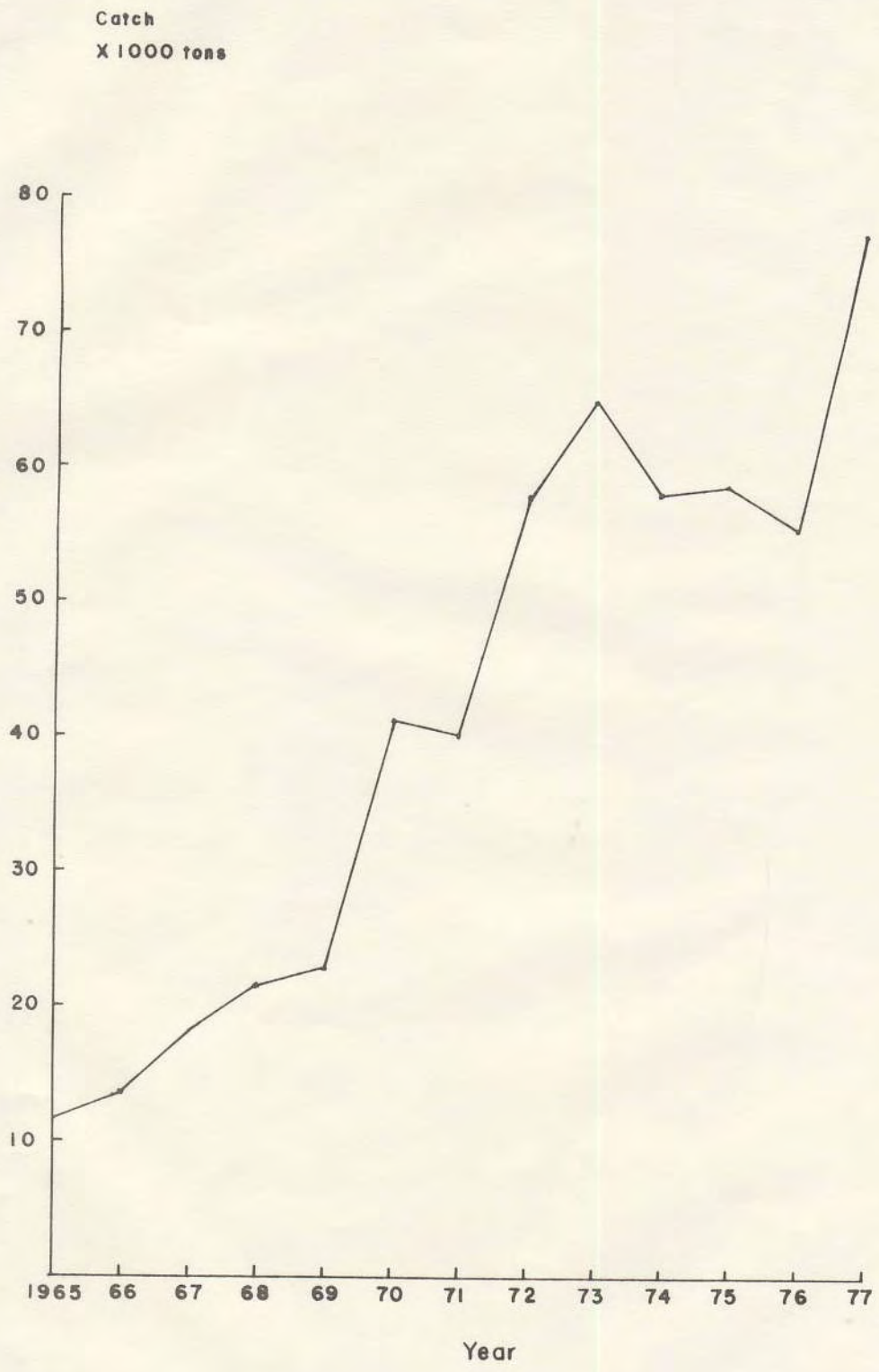


Figure 9 Squid and cuttle fish production in the Gulf of Thailand, 1965 – 1977.

Table 23

Production of squids and cuttlefish in the Gulf of Thailand 1965-1977 (in metric tons)

| Year | Production |
|---|---|
| 1965 | 11,602 |
| 1966 | 13,854 |
| 1967 | 18,452 |
| 1968 | 21,650 |
| 1969 | 22,587 |
| 1970 | 41,315 |
| 1971 | 40,325 |
| 1972 | 57,976 |
| 1973 | 64,901 |
| 1974 | 58,063 |
| 1975 | 58,729 |
| 1976 | 55,472 |
| 1977 | 77,308 |

Source: Department of Fisheries, Marine Fisheries Production Survey, 1977.

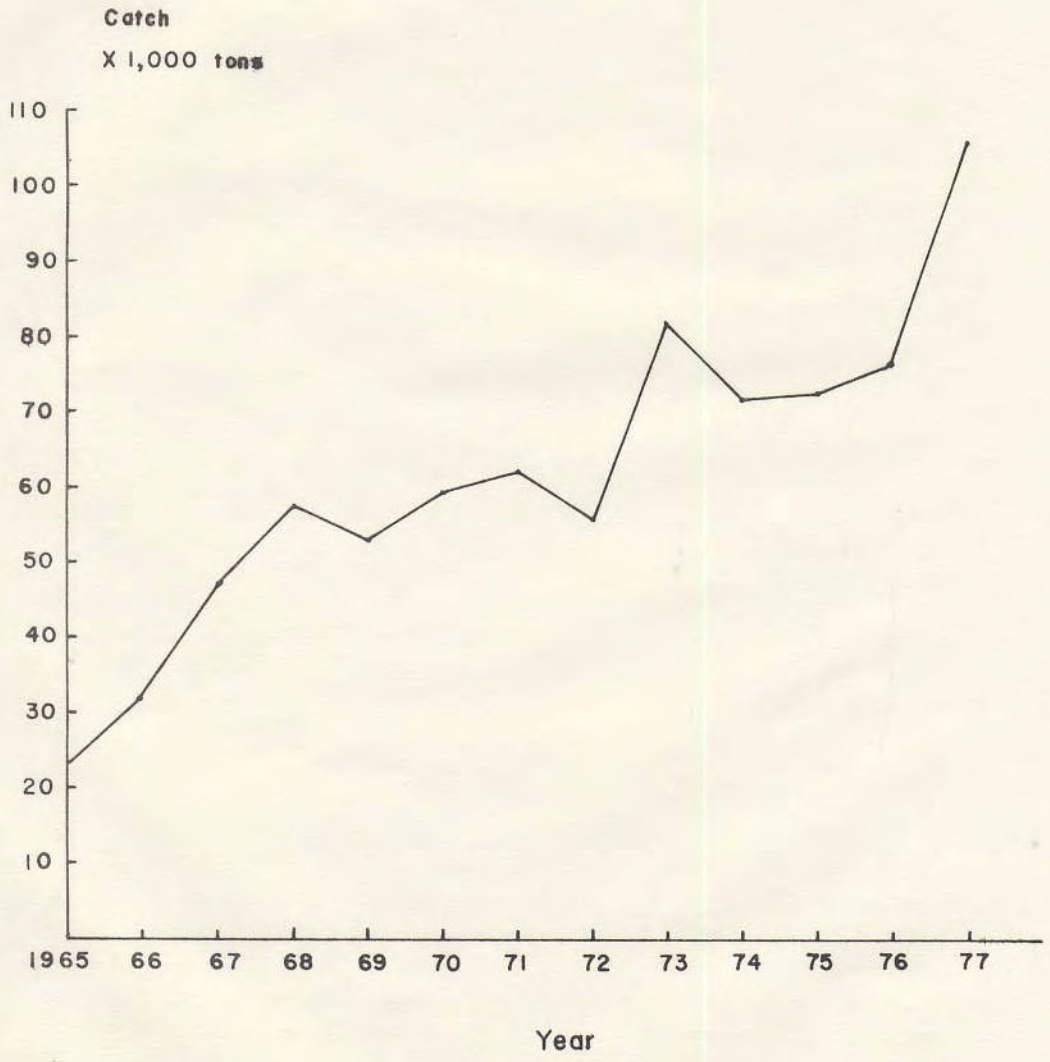


Figure 10 Shrimp production in the Gulf of Thailand, 1965 - 1977

Table 24

Shrimp production in the Gulf of Thailand
1965-1977
(in metric tons)

| Year | Production |
|---|---|
| 1965 | 23,112 |
| 1966 | 31,878 |
| 1967 | 47,143 |
| 1968 | 57,474 |
| 1969 | 53,419 |
| 1970 | 59,014 |
| 1971 | 62,002 |
| 1972 | 55,336 |
| 1973 | 81,814 |
| 1974 | 71,388 |
| 1975 | 71,734 |
| 1976 | 76,088 |
| 1977 | 105,618 |

Source: Department of Fisheries, Marine Fisheries Production Survey, 1977.

Table 25

Shrimp production in the Gulf of Thailand, by species
1972-1977
(in metric tons)

| Species | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 |
|---|---|---|---|---|---|---|
| White (P. merguensis) | 4,910 | 7,810 | 7,827 | 8,083 | 7,686 | 8,279 |
| Black tiger (P. monodon) | 162 | 832 | 65 | 321 | 57 | 393 |
| Green tiger (P. Semisulcatus) | 1,525 | 2,498 | 2,156 | 1,632 | 1,241 | 2,742 |
| King (P. latisulcatus) | 542 | 1,144 | 1,136 | 1,001 | 1,091 | 1,420 |
| Metapenaeus spp. | 9,684 | 14,135 | 13,293 | 14,865 | 11,563 | 13,041 |
| Others | 38,713 | 55,395 | 46,911 | 45,832 | 54,450 | 79,743 |
| Total | 55,536 | 81,814 | 71,388 | 71,734 | 76,088 | 105,618 |

Source: Department of Fisheries,
Marine Fisheries Production
Survey, 1977.

Table 26

Production by type of fishing gear employed in the fisheries in the Gulf of Thailand 1977

| Type of fishing gear | Quantity | % | Value (1,000 baht) | % |
|---|---|---|---|---|
| Trawls | 1,031,132 | 56.3 | 4,066,455 | 56.7 |
| Purse seines | 423,280 | 23.2 | 1,404,218 | 19.6 |
| Gill nets | 77,857 | 4.3 | 869,666 | 12.1 |
| Miscellaneous nets | 37,606 | 2.1 | 135,738 | 1.9 |
| Hook and line | 6,068 | 0.3 | 49,782 | 0.7 |
| Stationary gear | 37,892 | 2.1 | 244,209 | 3.4 |
| Collecting shellfish 1/ | 133,935 | 7.3 | 220,160 | 3.1 |
| Shrimp culture | 3,164 | 0.2 | 63,880 | 0.9 |
| Others | 77,059 | 4.2 | 114,818 | 1.6 |

1/ Including cultured shellfish.

Source: Department of Fisheries, Marine Fisheries Production Survey, 1977.

## 4.5 Status of Fishery Resources

Attempts have been made by scientists both in and outside the region to assess the potentials of demersal and pelagic fishery resources in the South China Sea and in the Malacca Strait during the past decade. Gulland (1968) concluded that the Gulf of Thailand waters had above average productivity. He gave the estimate of total potential of demersal fish stock along the Thailand coast as 4000,000 metric tons, Kampuchea and Vietnam coasts as 250,000 tons and in the central part of the Gulf (waters beyond the 50 m line) as 250-400,000 tons.

Gulland (1972) using the data given by Menasveta (1968) of the total demersal landings by Thai vessels and the catch per unit of effort by survey vessels gave the estimate of the total potential of the waters along the coast (0-50 m) as 500,000 tons. Israrkura (1969) presented an estimate on the potential of demersal fish catch in the Gulf of Thailand comparable to the figure given by Gulland. However, Shindo (1973) in his reassessment of the available data on catch and effort up to 1970 presented the estimated figure of the potential demersal fish catch as 714,000 tons.

As regards the states of the stocks of pelagic fish, Menasveta et al. (1973) gave the preliminary estimate of the potential yield of pelagic fish (excluding Spanish mackerel and tunas) as 380,000 tons.

Hongskul (1974) in his study of the population dynamics of "pla tu", Rastrelliger brachysoma, in the Gulf of Thailand concluded that the "pla tu" population in the Gulf of Thailand, subject to the level of fishing prior to 1968, did not appear to be in a state of over-exploitation; however, the fishing intensity should not be increased beyond the 1966 level.

Recently, the FAO/UNDP South China Sea Fisheries Development and Coodinating Programme organized three Workshops: the first one on fishery resources of the Malacca Strait (29 March - 2 April 1976); the second on the demersal fishery resources of the Sunda Shelf (31 October - 4 November 1977); and the last one on the biology and resources of mackerels (Rastrelliger spp.) and round scads (Decapterus spp.) in the South China Sea (7-11 November 1977).

Subsequently, the Marine Fisheries Division of the Department of Fisheries organized a seminar on achievements made in

1978 in fisheries research by various research units of the Division during 10-12 January 1979. The estimated potential yields of various fish stocks derived from the relationship between catch and effort, and catch per unit of effort (CPUE), and from assessment of the catch trend obtained from those workshops and the above-mentioned seminar are compiled in Table 27.

The Table indicates that the exploitation of demersal fishery resources, particularly those in the 0-50 m depth in the Gulf of Thailand and off the west coast of peninsular Thailand, have been very intense, and overfishing is evident in both areas, e.g. the significant reduction in the catch per unit of effort. For the demersal resource below 50 m depth in the Gulf (i.e. in the middle part of the Gulf), it is anticipated that there are still some demersal resources available for further development. However, the ground in the middle part of the Gulf is generally very irregular, consisting mainly of soft mud, and is thus not suitable for conventional trawling. Hence, other suitable gear should be developed for these resources, e.g. bottom hand line or the use of better trawling techniques.

As regards pelagic fishery resources in the Gulf of Thailand, there is still room for further fishery development of round scads and other species. However, the mackerel resources on the west coast of the Gulf of Thailand have been subjected to intense fishery and thus may be overfished. On the Andaman Sea side the exploitation of mackerel resources has approached its maximum potential yield.

In brief, for future development of the fisheries, we can increase the production from pelagic resources in the Gulf of Thailand by approximately 150,000 tons and from the Andaman Sea by about 40,000 tons. It is unlikely that we can increase the production of demersal resources from the present fishing grounds at the 0-50 m line. However, increased production from the deeper part of the Gulf might be possible with improved fishing technology.

## 5. FISHERIES AND RESOURCES MANAGEMENT

Three sets of Laws are implemented in the marine fisheries and resources management and development of Thailand. These are (1) the Fisheries Act B.E. 2490 (1947), including its implementing regulations and notifications; (2) the Thai Vessels Act of B.E. 2481 (1938) and (3) the Law on Navigation in Thai Waters B.E. 2456 (1913).

Table 27

Level of exploitation and potential yields of marine fishery resources in the Gulf of Thailand

| Species | Level of exploitation (metric tons) 1974 | 1975 | Estimated potential yields (metric tons) |
|---|---|---|---|
| Pelagic mackerel (*Rastelliger* spp.) | 36,900 | 73,000 | 35,000 for Indo-Pacific mackerel; 20,000 for Indian mackerel and 7,000 for Indo-Pacific mackerel on the west coast of the Gulf. Total 62,000 tons. |
| Round scad (*Decapterus* spp.) | 33,100 | 26,000 | Over 100,000, slightly exploited |
| Anchovies | 19,959 | 15,040 | Approx. 20,000 |
| Sardines | 56,159 | 62,042 | Probably 150,000 or more |
| Spanish mackerel | 2,307 | 4,498 | Probably 5,000 |
| Small tunas | 8,715 | 10,684 | Undetermined; probably 10,000 or more |
| Other pelagic | 6,000 | 5,000 | Approx. 33,000 |
| Total pelagic | 163,000 | 196,000 | 380,000 (approx.) |
| Demersal fish | 555,800 | 705,000 | Water depth 0 - 50: 687,000 |
| including shrimps | 4,900 | 6,000 | " " over 50: 140,000 |
| Total | 723,700 | 907,000 | 1,207,000 (approx.) |

Table 27 (cont.)
Level of exploitation and potential yields of marine fishery resources in the Andaman Sea

| Species | Level of exploitation (metric tons) 1973 | 1974 | Estimated Potential yields (metric tons) |
|---|---|---|---|
| Pelagic | | | |
| Mackerel | 45,844 | 18,366 | 50,000 |
| Anchovies | 4,580 | 7,357 | 10,000 |
| Round scads | 811 | 1,425 | 5,000 |
| Hard tail | 2,373 | 1,538 | 5,000 |
| Sardines | 1,683 | 417 | 3,000 |
| Small tunas | 1,401 | 1,210 | 5,000 |
| Spanish mackerel | 201 | 217 | 4,000 |
| Wolf herrings | 100 | 100 | 2,000 |
| Mullets | 150 | 150 | 3,000 |
| Others | 300 | 300 | 2,000 |
| Total pelagic | 57,400 (approx.) | 31,000 (approx.) | 90,000 (approx.) |
| Demersal fish | 216,007 | 209,496 | 200,000 |
| Shrimp | 16,728 | 7,860 | 10,000 |
| Total | 290,000 (approx.) | 248,000 (approx.) | 300,000 (approx.) |

Sources :
1. Marr, 1976, Fishery and resource management in Southeast Asia
2. SCS/GEN/78/17
3. SCS/GEN/78/6
4. SCS/GEN/78/18
5. SCS/GEN/76/2
6. Data from Department of Fisheries, Division of Marine Fisheries, Pelagic Fishery Unit, 1979.

Under the Fisheries Act B.E. 2490, several Ministerial Regulations and Notifications have been issued with the objective of preserving and/or conserving marine fishery resources, which include, inter alia:

1. Prohibition of the use of intoxicants or toxic substance, electricity and explosive for fishing.

2. Determination of the sizes and kinds of fishing implements that are permitted in fisheries.

3. Prohibition of fishing of certain rare species such as marine turtles and dugong.

4. Establishment of spawning and nursery seasons of particular commercially important species such as "pla tu" and prohibition of the use of certain types of fishing gear during the said seasons.

5. Prohibition of the use of certain types of fishing gear in certain areas.

5.1 Mackerel Fishery Regulations

During the past 26 years, the Ministry of Agriculture and Cooperatives has issued 5 Ministerial Regulations with the aim of controlling the fisheries during the spawning and nursery seasons of "pla-tu", based on the recommendations of the Pelagic Fishery Research Unit of the Marine Fisheries Division.

The most recent regulations dated 7 November 1975, under Article 32 (1)(2)(5) of the Fisheries Act stipulate the following:

A. During the spawning season of "pla tu"

1. The "pla-tu" spawning season is set from 1 January to 31 March annually.

2. During the spawning season, the following types of fishing gear are prohibited in the fishery:

2.1 all surrounding nets which have purse lines such as Chinese purse seine, Thai purse seine, luring purse seines, etc.;

2.2 gill nets.

3. Fishing operations during the said season are, however, allowed, subject to the approval of the Director-General of the Fisheries Department Those who receive permission for fishing must record their catch and effort in a log book provided by the Department of Fisheries.

B. During the nursery period of "pla tu"

(1) The nursery season of "pla tu" is set from 15 April to 14 July annually.

(2) During the nursery season, the following types of fishing gear are prohibited:

2.1 all types of surrounding nets which have purse lines;

2.2 gill nets and drift nets.

(3) The following types of gear may be operated: all types of gill net which have the average stretched mesh size of 4.7 cm or larger (measured from knot to knot when the mesh is stretched).

(4) Fishing is allowed only if permission is granted by the Director-General and the grantee must record his catch in the log book provided by the Department of Fisheries.

As it was discovered that trawl nets had been used by fishermen to catch mature "pla tu" in substantial quantities particularly during the past decade, the Ministry of Agriculture and Cooperatives,therefore,issued the Ministerial Regulations dated 13 October 1972 prohibiting the used of all types of trawl nets used with motorized fishing boats from sunrise to sunset from 1 February to 31 March annually in the waters off Prachuab Kirikhan, Chumporn, Surathani and Nakorn Srithammarat Provinces.

There have been no studies on the effect of these Regulations on the stocks of "pla tu", particularly those along the west coast of the Gulf. Although there has been a wide fluctuation in the abundance of "pla tu" along the west coast of the Gulf of Thailand; a declining trend in the abundance is evident.

The catch of "pla tu"/"pla lung" in 1977 was only about 50 per cent of that in 1974. Enforcement of these Regulations is not yet effective due to the lack of manpower, facilities and supporting funds on the part of the enforcement agencies and the lack of cooperation among certain groups of fishermen.

5.2 Trawl Fishery Regulations

Trawl nets are very effective gear. With the small cod-end mesh size of approximately 2.6 cm or less used generally by commercial trawlers, trawl gears catch a lot of small fish, including juveniles of several commercially important species. Hence, the so-called trash fish generally predominate in the trawl catch. Recognizing that juveniles and fry of several demersal species feed in the inshore waters along the coasts and in order to reduce the conflict between inshore subsistence fishermen and trawlermen, the Ministry of Agriculture and Cooperations issued the Ministerial Notification of 20 July 1972 prohibiting the use of trawl nets of various types such as push nets and shrimp push nets, which are used with motorized fishing boats, within 3,000 meters from the shore line and within the radius of 400 meters from stationary gear which have been licensed by the Department of Fisheries in the seas or bays of coastal provinces.

Clam dredges used with motorized vessels are also prohibited within 3,000 meters from the shore lines of all coastal provinces.

Trawl net fishing in not allowed to be operated in the Songkhla Lake all year round, and in the waters of Cholburi Province from 1 September to the end of February annually.

It is apparent that the present trawl fishery regulations are not effective as the major cause of decline in the abundance of demersal resources is due to high fishing intensity in the Gulf of Thailand. The occurrence of over-fishing has been recognized by research workers of the Department of Fisheries since 1968. The Trawl Committee set up by the Department of Fisheries then recommended urgent management measures, including limitation on entry for

trawl fisheries in the Gulf of Thailand. Because of special circumstances prevailing at that time the trawl fishing industry was allowed to expand. However, the recommendation of the trawl Committee was reiterated by the South China Sea Programme mission in 1975 (SCSP, 1976) and recently by the FAO mission on the implications of the extension of national jurisdiction into the high sea.

The Government is obliged therefore to give serious consideration to finding suitable measures to regulate the trawl fisheries in the Gulf of Thailand. In so doing, a request was made to the South China Sea Programme to provide a suitable consultant to undertake the review of the existing laws and regulations used in Thai fisheries management, with a view to recommending appropriate management measures. Moore (1978), who served as consultant for this project, recommended interim measures to limit the entry of trawl fisheries into Thai waters, which include the issuance of a Ministerial Notification placing a moratorium on the granting of new trawl licences, and the amendment of survey rules under the law on Navigation in Thai Waters.

Moore (ibid.) also suggests measures to control Thai vessels operating in foreign waters and the establishment of a permanent new licensing system.

In view of the change in the pattern of fisheries of Thailand from subsistence inland and inshore fisheries to commercial or enterprise businesses both in aquaculture and marine fisheries, he recommended that the Fisheries Act should be completely revised, and a new and comprehensive act be formulated. In this process the review should not be restricted only to the Fisheries Act but should include various legal issues including, inter alia, legal and institutional methods of promoting the development of small-scale fisheries, including fishermen's organizations, the maritime shipping regulations, credit, marine insurance, etc.

These recommendations are being studied by the authorities concerned in Thailand. Owing to the urgency of the matter, particularly during this period of change in the sea regime, it is hoped that a suitable licensing system will be adopted in order to effectively regulate the number of fishing boats, including those used in pelagic fisheries in the Gulf of Thailand.

## 6. SUMMARY AND CONCLUSIONS

Available information on the oceanography of the Gulf of Thailand and on the resources thereof indicates that the Gulf's productivity is very high, comparable to several rich areas in the world. Hence fishery resources are rich in variety and quantity as indicated in Section 2 of this report.

With advanced technology imported into Thailand in the early 1960's, fisheries development, particularly the trawl fisheries of the Gulf of Thailand, gained rapid momentum. In the last decade pelagic fisheries have also expanded rapidly employing various sophisticated fishing and navigation aids. The fishing boats used, the majority of which are motorized, become bigger and more efficient, capable of producing more catch per boat. Although the production has increased more than tenfold, the demand for fish still exceeds the supply. Since fisheries have become profitable with a satisfactory rate of return, it is natural that more investment in still being made in marine fisheries and the fleet expands rapidly.

The rapid expansion of the fisheries,both demersal and pelagic,has put great pressure on the available resources in the Gulf of Thailand. In the trawl fisheries, the overall stock size of demersal fish decreased drastically, as shown in the reduction of catch rate of the research vessels of the Department of Fisheries from approximately 290 kg/hr trawling in 1963 to less than 60 kg/hr trawling in 1976. Overfishing in the Gulf of Thailand was reported by scientists of the Department of Fisheries as early as 1968. However, no appropriate action has yet been taken to effectively manage these demersal resources.

As far as the pelagic fisheries are concerned, the stock of "pla tu" inhabiting the west coast of the Gulf of Thailand may be over-exploited. However, there is room for further development of the "pla tu" fisheries on the east coast of the Gulf. The development of fisheries for other pelagic species may be possible, however, e.g. "pla tu kak" (scads), "pla lung keo" (Sardinella spp.), and "pla ka tak" (anchovies). However, these fish should be used for direct human consumption instead of being reduced to fish meal. The development of pelagic fisheries should be carefully controlled and managed since, by nature, there exist wide fluctuations in the abundance of these pelagic species especially if they are subjected to intense fishing pressure.

Another manacing problem affecting the well-being of the resources is pollution, which is reported in other sections of this study series. Increasing pollution in the inner Gulf of Thailand from domestic, industrial and agricultural sources will certainly affect the nursery areas of several important brackish water and marine species. This will require both short and long-term actions to abate the pollution in order to enable these waters to maintain their natural quality and productivity.

It is indicated in section 3.5 of this study that the Gulf of Thailand resources could sustain the harvest of up to about 1.2 million metric tons and that increased production from the 1975 level of 900,000 metric tons could come only from the pelagic resouces. Hence, studies should be made on the suitable types of gear and other fishing implements, which will enable the resources to be harvested with a minimum of wastage.

In order to increase the productivity of demersal resources to a satisfactory level, i.e.,to enable them to produce the maximum sustainable yield of about 687,000 metric tons in waters from 0-50 m depth, action should be taken without delay to discourage the entry of new vessels into the fisheries. A long-term plan should be formulated to gradually reduce the number of trawlers operating in the Gulf of Thailand to approximately half of the present total. Furthermore, in order to reduce the wastage in exploiting these valuable demersal resources a study should be made on the optimum cod-end mesh size for the trawl net used by commercial trawlers, and regulations on cod-end mesh size used in the fisheries in the Gulf of Thailand should be strictly enforced.

As far as the pelagic fishery resources are concerned, studies should be carried out without delay on the status of the stocks of pelagic fishery,and suitable management measures, including the limitation of entry to fisheries, should be formulated and implemented when necessary.

This study also indicates that there is a need to increase the knowledge of the biology and bionomics of several commercially important species. Furthermore,information pertaining to the socio-economic aspect of these fisheries is also needed. This information is essential in the formulation of effective conservation programs to enable Thailand to reap maximum economic benefit from her natural resources.

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