JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF FISHERIES, SOCIALIST REPUBLIC OF VIET NAM



# THE MARINE RESOURCES STUDY IN VIET NAM

## Main Report

FEBRUARY 1998



FUYO OCEAN DEVELOPMENT & ENGINEERING Co., Ltd.

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MINISTRY OF FISHERIES, SOCIALIST REPUBLIC OF VIET NAM

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# PREFACE

In response to the request from the Government of the Socialist Republic of Viet Nam, the Government of Japan decided to conduct the Marine Resources Survey in Viet Nam and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to Viet Nam a study team headed by Mr. Kenji TAKAGI, Fuyo Ocean Development & Engineering Co.,Ltd. six times during the period from March 1995 to December 1997.

The team held discussions with the officials concerned of the Government of the Socialist Republic of Viet Nam, and conducted field studies at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between two countries.

I wish to express my sincere appreciation to the officials concerned of the Socialist Republic of Viet Nam for their close cooperation extended to the team.

February, 1998

Kimio Fujita
President
Japan International Cooperation Agency

February 1998

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Kimio Fujita:

Letter of Transmittal

We are pleased to submit to you the report on the Study on "the Marine Resources in Viet Nam". The report contains the advice and suggestions of the relevant authorities of the Government of Japan and the Government of Viet Nam as well as the results of the above mentioned Study.

This study was conducted by Fuyo Ocean Development & Engineering Co., Ltd., based on a contract with JICA, from February 23, 1995 to February 28, 1998. In this study, we conducted the sea-borne survey to investigate the relative stock abundance of pelagic fishery resources in the Viet Nam Exclusive Economic Zone and land site surveys at selected major fish landing sites and fishing villages so as to clarify coastal fishery conditions.

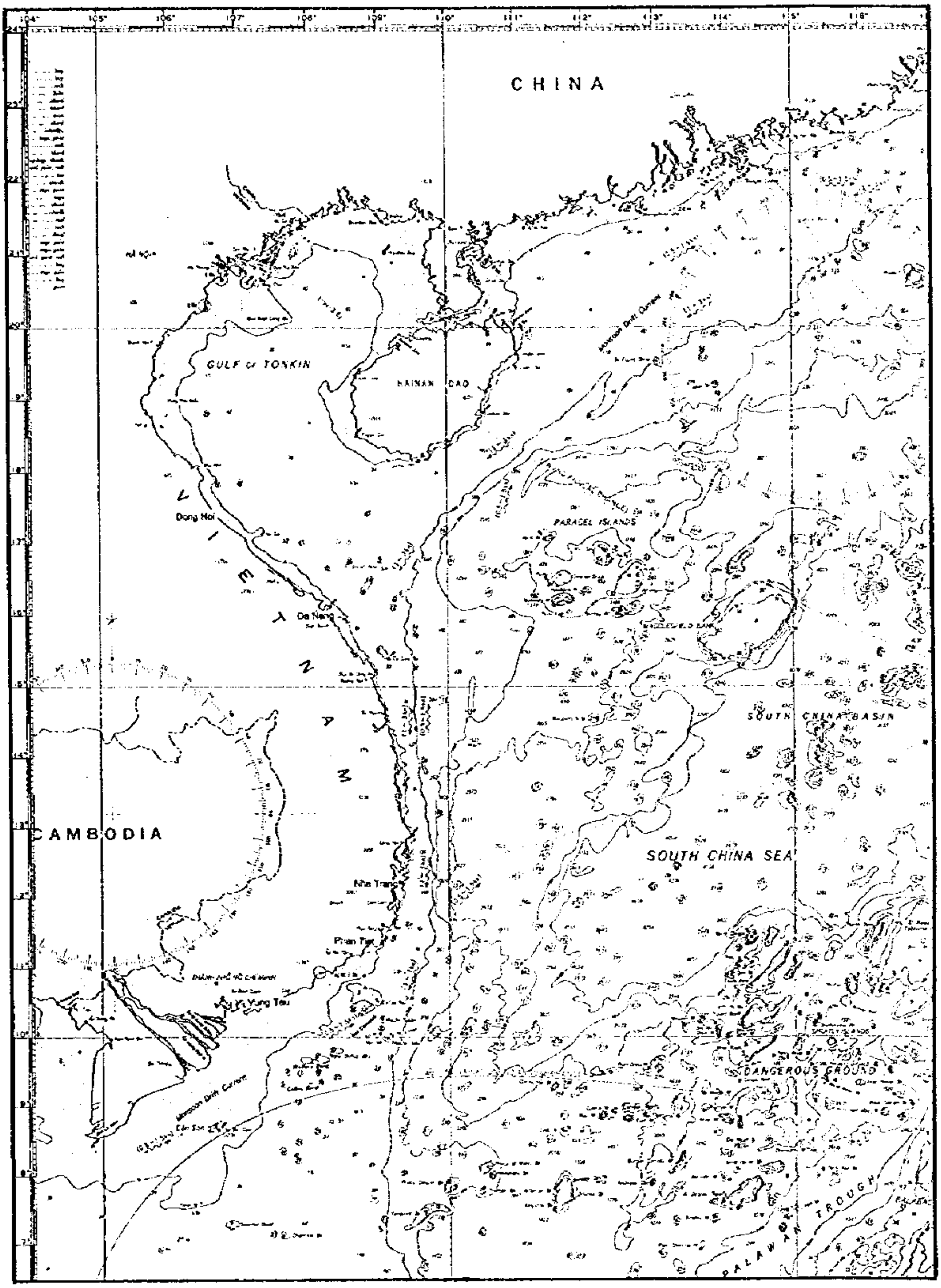
Based on the results of these surveys, we prepared guide-lines for a marine resources management plan and offered policy considerations and recommendations for the promotion of fisheries in Viet Nam.

We wish to take this opportunity to express our sincere gratitude to the relevant officials of JICA, the Ministry of Foreign Affairs and the Ministry of Agriculture, Forestry and Fisheries in Japan. We also wish to express our deep gratitude to the concerned officials of the Ministry of Fisheries (MOF), Ministry of Planning and Investment (MPI), other relevant agencies, and the JICA Viet Nam Office and the Embassy of Japan in Viet Nam for their close cooperation and assistance extended to the Team during the Study.

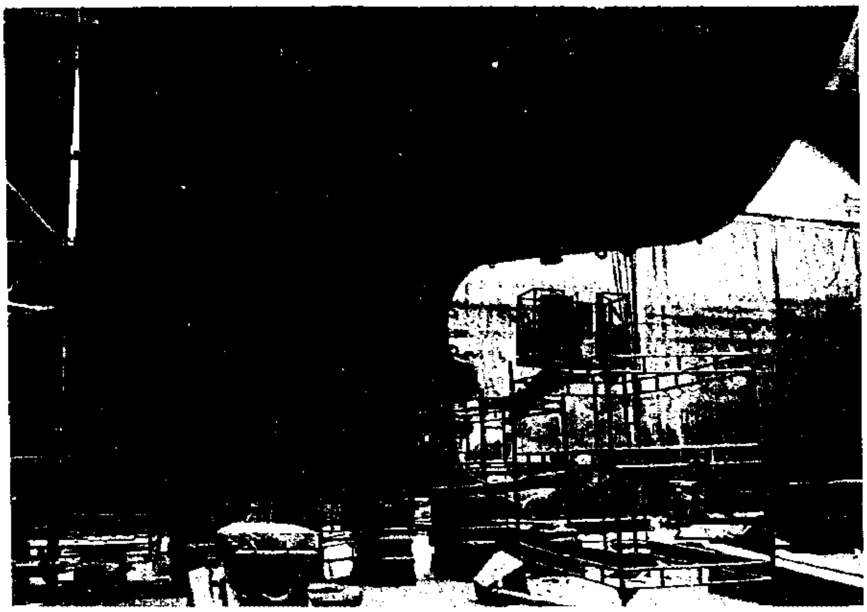
Very truly yours,

Kenji Takagi
Team Leader
The Study on the Marine Resources in Viet Nam
Fuyo Ocean Development & Engineering Co., Ltd.

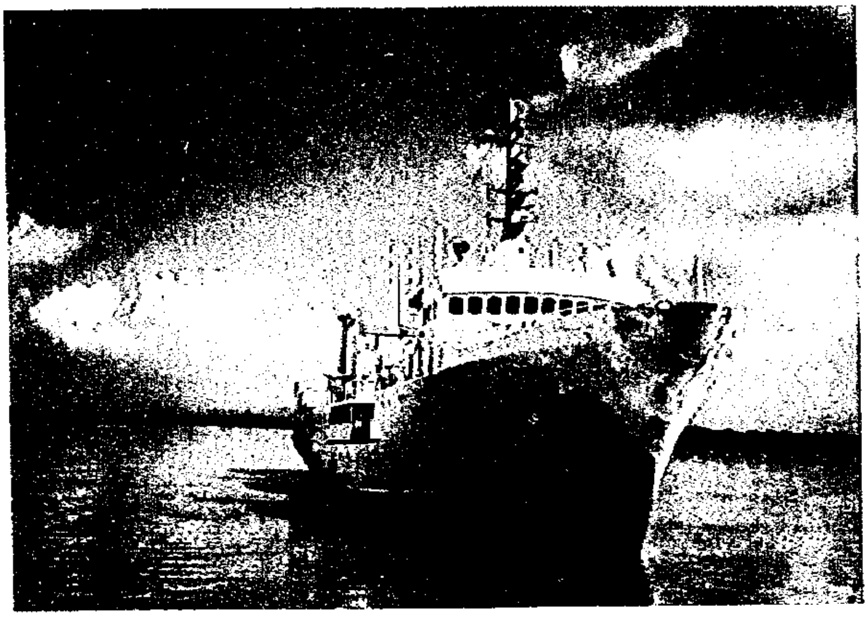
VIET NAM and SOUTH CHINA SEA



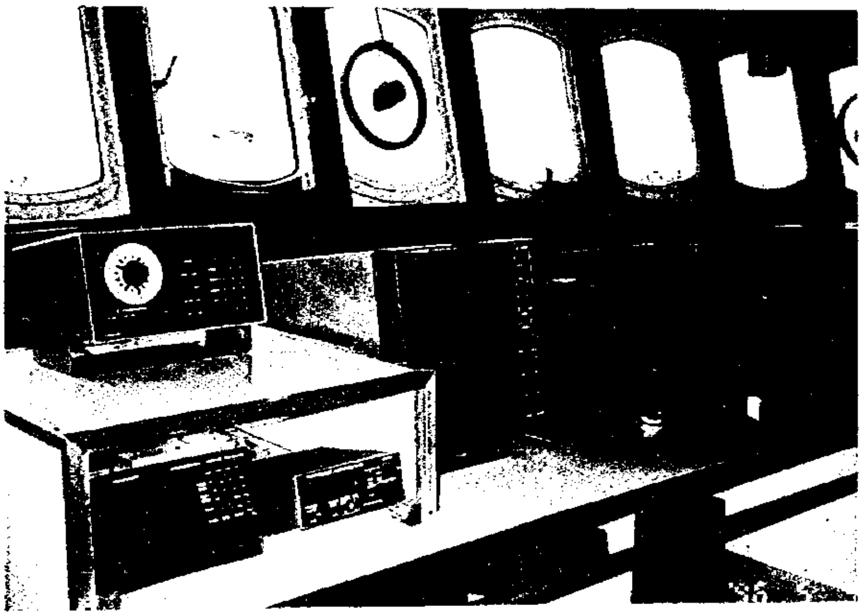

(source: International Chart Series 508)



R/V Bien Dong
in the dry-dock

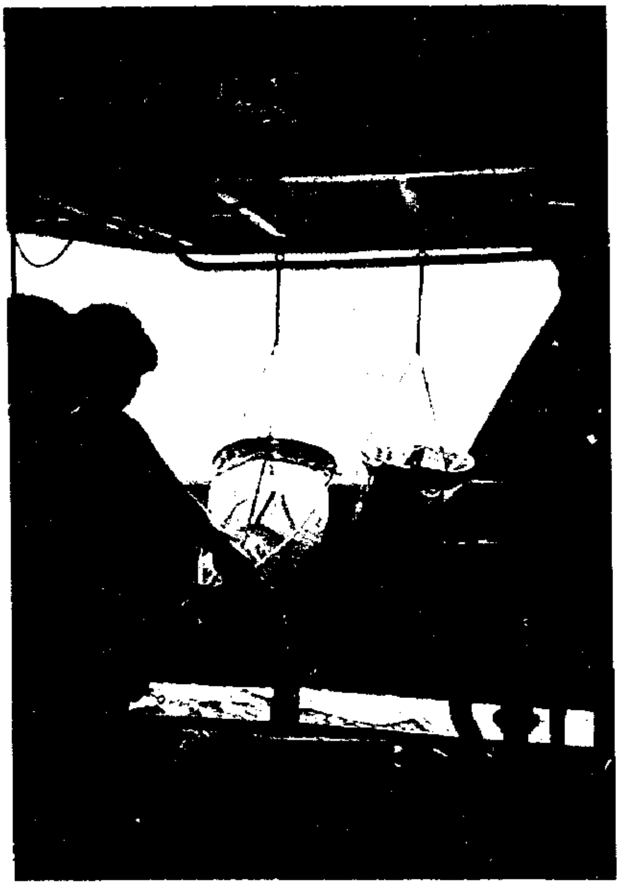


Departure of
R/V Bien Dong

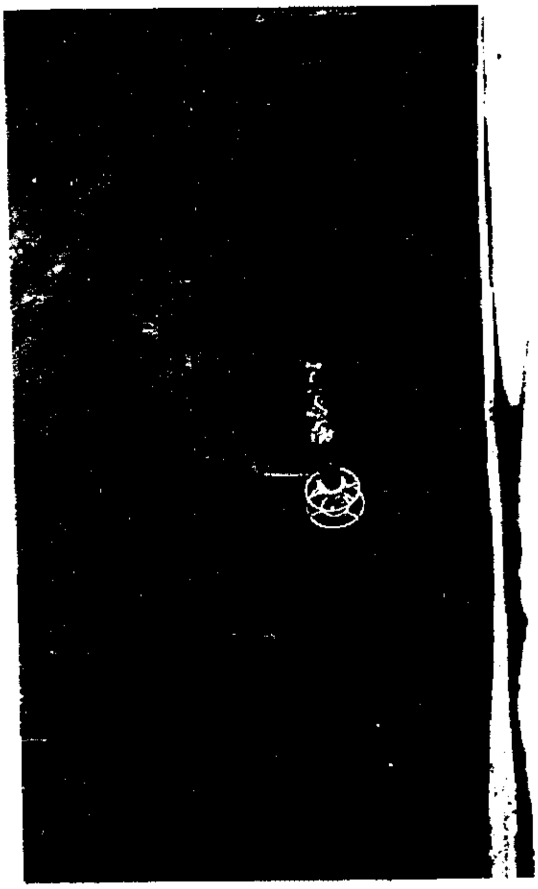


Display system of
newly installed
instruments

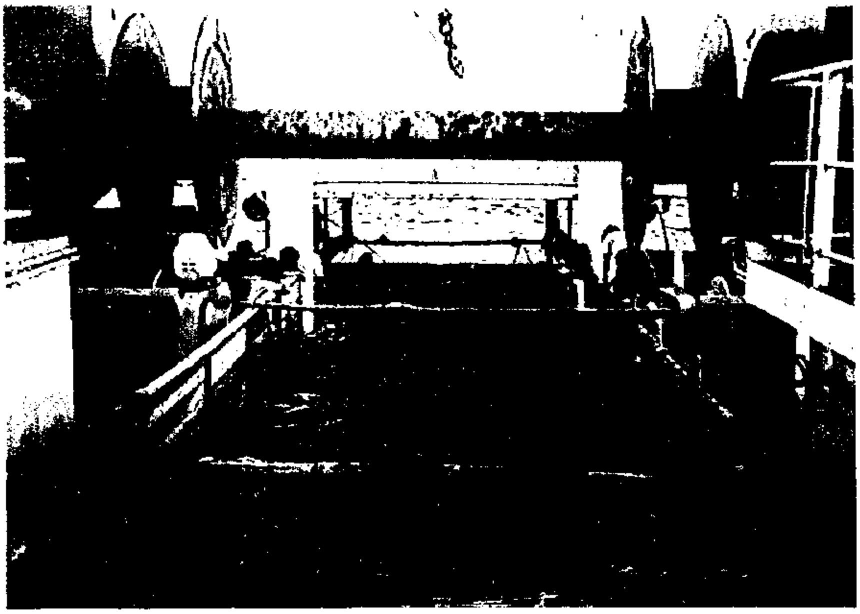
GPS system
Radar
Fish-finder
Current meter
Thermometer



Sampling by
the plankton net



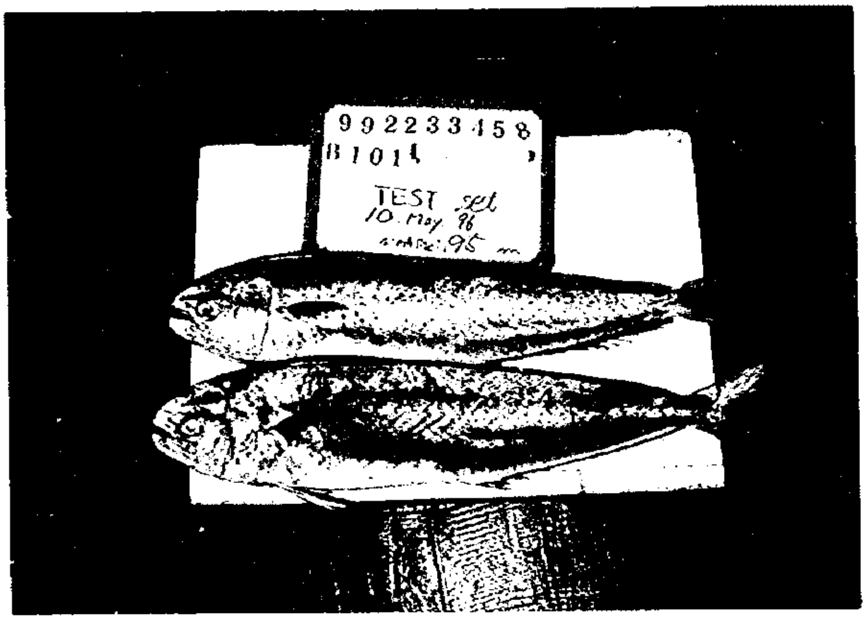
Conductivity
temperature
depth meter



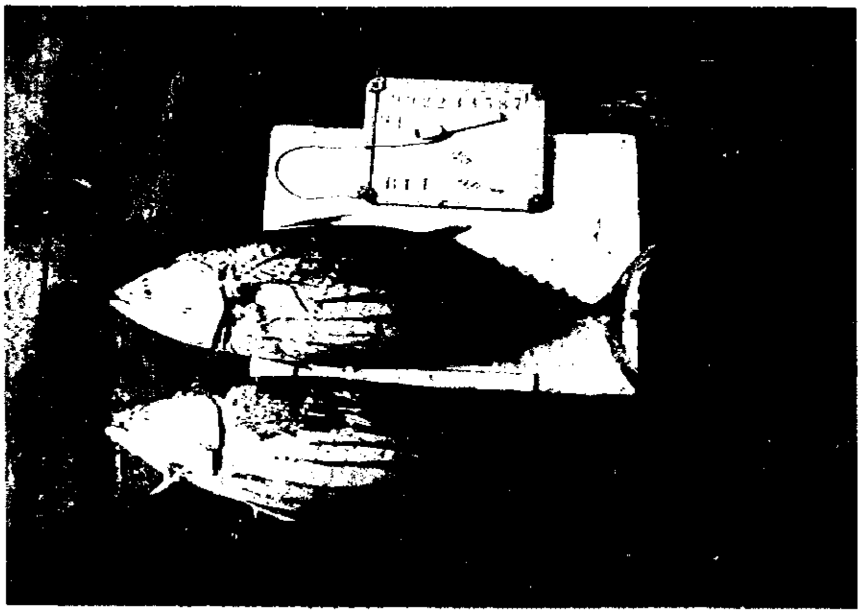
Setting of gillnets

Hauling of gillnets

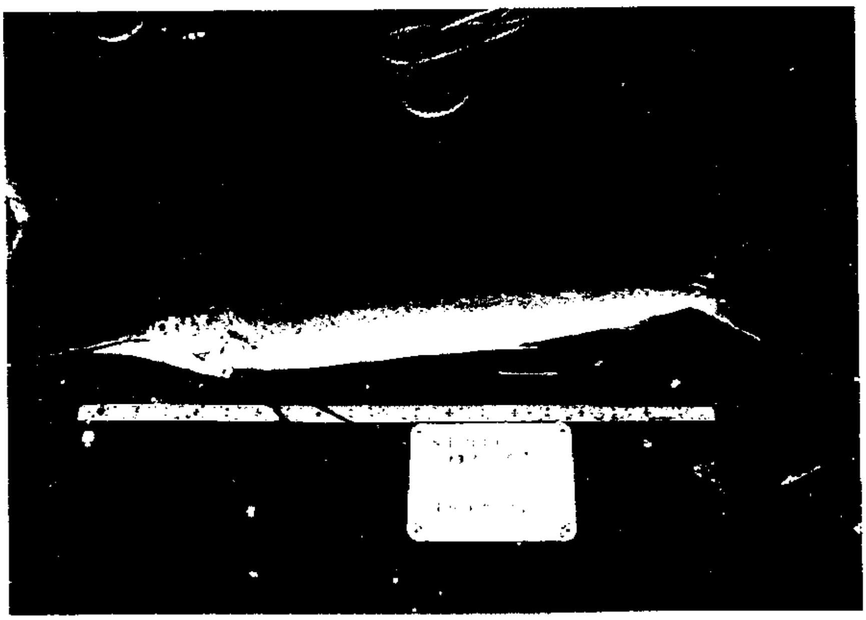
Measurements of fish




Common
dolfinfish
*Coryphaena*
*hippurus*



Skipjack tuna
*Katsuwonus*
*pelamis*



Indo-Pacific
sailfish
*Istophorus*
*platypterus*

Landing of small-scale fishery

Landing market

Sorting of fish landed

Presentation at the seminar

Participants to the workshop

Courtesy visit to the Ministry of Fisheries

# Summary

# Summary


## 1. Background of the Study

The fisheries industry plays the fourth most important role in Viet Nam's international trade based economy, following oil production, rice farming and textile manufacture. Furthermore, it supplies some 40 % of animal protein to the national diet. Advancement of fisheries industry must contribute to the development of the national economy by increasing the supply of high quality nutrients to the peoples and through the acquisition of foreign currency through export. Thus it offers chances for the promotion of related industries and the increase of employment.

The Vietnamese fishery suffers with problems needing to be solved for medium- and long-term development such as over-exploitation of living resources in the inshore waters, under-exploitation of offshore fishery resources, underdeveloped infrastructure, shortage of finance for modernization, lack of systems for managing the living resources, delay of privatization of national enterprises and lack of organization of fishermen.

To solve these problems, the Ministry of Fisheries of Viet Nam has attempted to establish plans for balanced development of the coastal and offshore fisheries. It is urgently requested to clarify distribution of, and to evaluate abundance of the living resources in the offshore waters, in order to determine plans for encouraging the offshore fisheries.

Under these circumstances, the Government of Viet Nam requested implementation of a fishery resources survey to the Government of Japan. In response to this request, JICA dispatched a preparatory study team to Viet Nam to confirm contents of the request and to discuss the cooperation in April 1994 and sent the Scope of Work Mission in September 1994 that concluded the Scope of Work (S/W).

## 2. Objectives of the Study

(1) To investigate relative stock abundance of pelagic fishery resources in the Viet Nam Exclusive Economic Zone;

(2) To clarify coastal fishery conditions through landing site survey at

selected major fish landing sites;

(3) To prepare guide-lines for a marine resources management plan which would include the proper fishing methods;

(4) To carry out technology transfer and training in the course of the Study to the counterpart personnel of the Government of Viet Nam, and thus to contribute to establishing sustainable utilization of marine resources in Viet Nam.

### 3. Study area

The sea-borne survey area was mainly the central region defined as the offshore area exceeding 40 m in depth within the Viet Nam EEZ, from 8° to 18° North and from the shoreline to 112° East, excepting internationally disputed areas as described in Minutes of Meeting of S/W.

The land site survey was carried out at the five selected provinces in the central region and closely adjacent parts of the northern and southern regions. The selected provinces (and fish landing sites) were Ba Ria - Vung Tau (Vung Tau), Binh Thuan (Phan Thiet), Khanh Hoa (Nha Trang), Quang Nam Da Nang (Da Nang), and Quang Binh (Dong Hoi).

### 4. Period, duration and major items of the research activities

| Field Survey | 1 st<br>95.3.12~95.5.27 | 2 nd<br>95.7.2~95.9.3 | 3 rd<br>95.10.1~96.2.8 | 4 th<br>96.5.1~96.10.14 | 5 th<br>96.9.2~96.10.31 | 6 th<br>97.5.5~97.7.3 | 7 th<br>97.12.9~97.12.18 |
|---|---|---|---|---|---|---|---|
| Improvement Work of R/V | 1 st<br>95.3.16~95.5.27 | | 2 nd<br>95.10.1~95.10.20 | | | | |
| Sea-borne Survey | | | 1 st<br>95.10.31~95.12.21 | 2 nd<br>96.5.8~96.8.23 | 3 rd<br>96.9.6~96.10.26 | 4 th<br>97.5.10~97.6.28 | |
| Landing Site Survey | 1 st<br>95.3.16~95.3.29 | 2 nd<br>95.7.2~95.9.3 | 3 rd<br>95.11.10~96.2.6 | 4 th<br>96.8.4~96.10.14 | | | |
| Report | Inception R. | | | | | Interim R. | Draft Final R. |
| Phase | First | First | First | First | First | Second | Second |

The research was executed for three years divided into two phases. The sea-borne survey was conducted twice a year considering the changes of the ocean current direction due to seasonal winds.

**5. Research vessel**

The sea-borne survey was conducted on board the R/V Bien Dong (493.35 gross tons and 47.5 m in total length, equipped with main engine of 1,500 Hp, registered at Haiphong Port). The ship is an oceanographic research vessel with stern trawl, built in Norway in 1975. Due to the vessel's age, refreshment of hull as well as apparatus for navigation and scientific operations was necessary. Prior to the survey, improvement works were conducted so as to permit drift gillnet operation, and renew apparatus.

**6. Fishing gear**

Surface drift gillnets were employed for collecting basic data to estimate relative abundance of large-sized pelagic fishes throughout the surveys. In order to capture these fishes which vary widely in size and body shape, the gear consisted of five mesh sizes, 73 mm, 95 mm, 123 mm, 150 mm and 160 mm in stretched length.

During the surveys in the Second Phase, Vietnamese gillnets with mesh of 100 mm were adopted to catch fish swimming at subsurface layers, together with the surface nets of the same mesh size so as the contrast for comparing the efficiency.

**7. Improvement Work of the Research Vessel**

As the research vessel "Bien Dong" had been equipped with stern-trawling and purse seine fishing systems, modification for gillnet system working was planned. This ship has a long forecastle but many pieces of equipment, such as winches, windlass, mooring facilities etc. occupying the deck. As it appeared not possible to handle gillnet on the forecastle deck, a location just behind the forecastle deck house on the starboard side, 1st deck was chosen for a gillnet lifting and handling location.

Survey equipment (a scanning sonar, a fish finder, a Doppler current meter and an electrical water temperature meter) and nautical instruments (a GPS navigation system, INMARSAT communication system and a radar system) were newly installed.

Dry docking was undertaken at the inspection dock from Mar.15 to Mar.19, 1995 with the first docking from Apr. 3 to May 11, 1995 and the second docking from Sept. 15 to Oct. 7, 1995. During these periods, maintenance works for the hull - deck system, machinery system and electrical system were carried out. Upon completion of the modification and maintenance work, an inclination test for the vessel was conducted just after leaving the second dry-docking so as to determine the change of center of gravity and ship's displacement caused by alterations for gillnet handling and the new instrumentation. The result of these tests confirmed the safety of the vessel at sea. A sea trial was carried out under the supervision of VIRES inspectors.

## 8. Methodology of the Survey

### 8-1. Sea-borne Survey

The sea-borne survey was divided into 35 latitudinal and longitudinal one-degree quadrangles. The test fishing for evaluating relative abundance of large-sized pelagic fishes and oceanographic observation for investigating the environment of fishing grounds were conducted in each one-degree quadrangle during each survey cruise. Survey items were as follows:

- ✧ Oceanographic observation : air temperature, wind direction & velocity, wave & swell, water color & transparency, water temperature & salinity, current direction & velocity, zooplankton, phytoplankton
- ✧ Test fishing of drift gillnets : Nets were set before the sunset and hauled at sunrise of the next day. Records were kept as to position and time of fishing, water/sea depth, duration of operation, number of fishing gears used, amount of fish caught, and other findings and matters of interest
- ✧ During each cruise : Collection of records on the fish shoals by using echo sounder and scanning sonar.
- ✧ Determination of species & sex, measurement of body length & weight, sampling of scales, otoliths, gonads & stomachs, photograph & preservation of typical specimens

### 8-2. Definition of Relative Abundance (CPUE) and Abundance Index

Since the number of actually used nets in the test fishing often varied between stations, the catch of each operation was converted to that for 100 tans for the sake of even comparison. Likewise, the soaking time of nets in the sea often varied, and so each soaking time, from end of casting nets to start of hauling, were standardized by mean time of all operations. Catch-per-unit effort of each operations were converted to the values of 100 tans standardized by soaking time. Hereafter in this Report, the **relative abundance** (in terms of number of individuals and of weight) is defined as CPUE standardized according these procedures. The CPUE in number and CPUE in weight are synonyms of the relative abundance defined as such.

Additionally the **abundance index** was calculated by multiplying above-mentioned CPUE and extent of area of latitudinal and longitudinal one degree.

### 8-3. Land Site Survey

By using a field survey handbook together with survey questionnaires which were translated into Vietnamese, the survey was conducted in two broad fields, namely fisheries production and fisheries socio-economics.

"Mini-workshops" were conducted at the beginning of visit to each provincial fisheries department, with the objective of familiarizing collaborating fisheries officers with the purposes of the survey and the methodology for collecting and organizing data. A total of 13 provincial fisheries officers were trained through mini-workshops and the succeeding field surveys.

The fisheries production survey covered the modalities of marine fisheries operations and associated topics such as target species, fishing grounds, and developmental perspectives of fishers. To structure the interviews, a calendar year was divided into three seasons, "good", "intermediate" and "poor", and fishers were queried on their production per fishing trip in each of these three seasons. The annual total volume and value of production for a particular fishery are calculated from based on such figures per trip.

The socio-economic survey , on the other hand, covered subjects such as population, labor, technology, capital, management, fish distribution and information, among others.

## 9. Oceanographic characteristics

### 9-1. Temperature and salinity profiles

The oceanographic conditions in the early phase of the northeast monsoon season (September - October) were featured by a north-south change of mixing layers between Line-C and Line-D located at 12° N, thin in the north and thick in the south. Other features were the large north-south thermocline gradient between Line-C and D, shown by difference of depth of about 45 m. It was also noted that low salinity water was present in the sub-surface layer in the waters north of Da Nang and B-20 off Nha Trang.

Oceanographic conditions in the late phase of the northeast monsoon season (November -December) were featured by a thick mixing layer of about 100 m in the coastal waters and thin mixing layer in the offshore waters. North-south thermal gradient was steep in a deep layer about 100 m from the sea surface at both northern and southern parts in the coastal waters. In the offshore waters, the thermal gradient was gentle. Low salinity water occurred near the sea surface off Qui Nhon and Nha Trang. Throughout the northeastern monsoon season, the mixing layer developed quickly, especially in the waters near the continent.

Wide extension of low salinity water in the surface layer of the coastal waters from Da Nang to Nha Trang, indicates the influence of rainfall in the central and southern Vietnam. As a matter of fact, average precipitation for five years from 1991 to 1995 shows a rise of rain fall in October and November in the vicinity of Da Nang, Qui Nhon and Nha Trang. In other words, the area under survey is featured by decline of salinity in the surface layer due to heavy rain fall in the Central and South Regions, accompanied with wide horizontal variation of salinity.

During the southwest monsoon season, vertical profiles of temperature and salinity closely resembled each other. Horizontal change was significant for temperature, but of only slightly effected on salinity. Both vertical profile and horizontal distribution of temperature and salinity indicated features inherent to the up-welling. Such features appeared at both 2nd and 4th surveys in the waters north of Da Nang and off Nha Trang.

### 9-2. Zooplankton and phytoplankton

Copepods constituted the major portion of zooplankton samples. In addition, Ostracoda, Chaetognatha and Tunicata appeared significantly in the waters north of Lat. 14° N. There occurred 47 species of phytoplankton and they were classified into two major groups of Bacillariacea and Dinoflagellata.

In the southwest monsoon season, zooplankton were found less in the South Region than in the Central and North Regions, especially in vicinity of the mouth of the Mekong River, and in the shallow waters along Qui Nhon to Nha Trang. Two surveys executed in the southwest monsoon seasons indicated change of phytoplankton species composition between years. Dinoflagellata was comparatively the least at all stations in the second cruise, but the portion of Dinoflagellata rose at some stations in the fourth cruise.

In the early phase of the northeastern monsoon season, zooplankoton appeared most frequently in the Central Region, also in vicinity of the mouth of the Mekong River, and in the shallow waters along Qui Nhon to Nha Trang. In phytoplankton samples taken during the early phase of the northeast monsoon season, Bacillariacea constituted the major portion in the North Region, but Dinoflagellata often exceeded the other in abundance in the shallow waters of the North Region and in the offshore waters of the South Region.

## 10. New findings on distribution of fishes and other important marine animals

The catch of 95 test fishing operations of drift gillnets during the four research cruises consisted of fishes of 102 species of 33 families, and cephalopods of 3 species, each coming from different families. In addition, five species of dolphins (mammals) and three species of turtles were captured incidentally. A brown boody is the only sea bird taken during the research cruises.

One of the significant biological findings is new records of many species in the Vietnamese waters, compared to the Check List of Marine Fishes on the Southeast Asian Region issued by the Southeast Asian Fisheries Development Center (hereinafter referred to as SEAFDEC) in 1996. New records count 21 species in the whole Southeast Asian waters, and 21 additional species in the Vietnamese waters. In other words, the existence of 42 species or slightly over two fifth of the 99 identified species were confirmed for the first time in the Vietnamese waters. Taxonomy is not of primary interest to the present research, and further study is desirable in regard to assure the identification and scientific names.

**11. Definition of major species**

Figures 1 & 2 indicate the catch composition of families of fishes and cephalopods in decreasing order of either, in terms of number of individual animals (Figure 1), or in terms of weight (Figure 2). The dominating five families in number are Scombridae, Coryphaenidae, Bramidae, Ommastrephidae and Carangidae, comprising 86 % of the total catch. In term of weight, the heaviest catches are from Scombridae, Myliobatidae, Istiophoridae, Coryphaenidae and Bramidae, covering 89 % of the total. Large-sized species were upper rank in weight, though only few individuals appeared in the catch and only occasionally. Three families, Scombridae, Coryphanidae and Bramidae, appeared in the most abundant five in both number and weight, comprising 74 % of total catch in number, and 48 % in weight.

Similarly, species of fishes and cephalopods were ranked in decreasing order of number and weight of catch (Tables 1 & 2). In total 14 species entered into the most abundant 25 in both terms, and are listed in the order of classification code as follows: Coryphaena hippurus, C. equiselis, Brama orchini, Lobotes surinamensis, Auxis thazard, A. rochei, Euthynnus affinis, Katsuwonus pelamis, Thunnus tonggol, T. albacares, T. obesus, Istiophorus platypterus, Aluterus monoceros and Sthenoteuthis oualaniensis. In addition, four billfishes of Makaira indica, M. mazara, Tetrapterus audas and Xiphias gladius represent major catch in weight if not in number, and are added to the 18 major species.

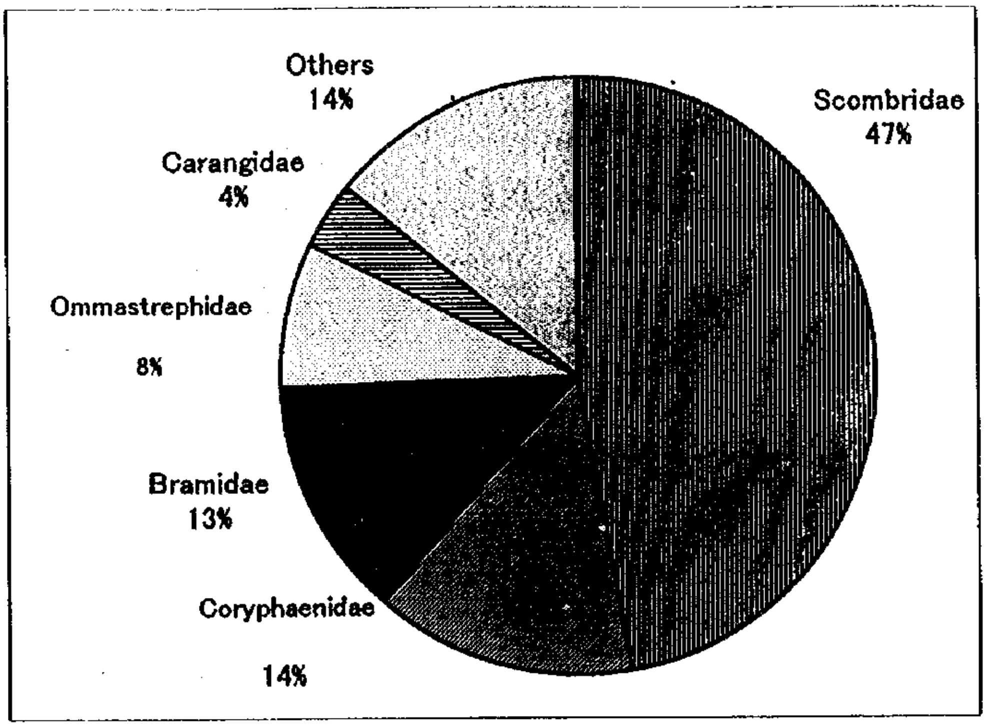



Figure 1. Composition of catch number of fish and cephalopod classified by families.

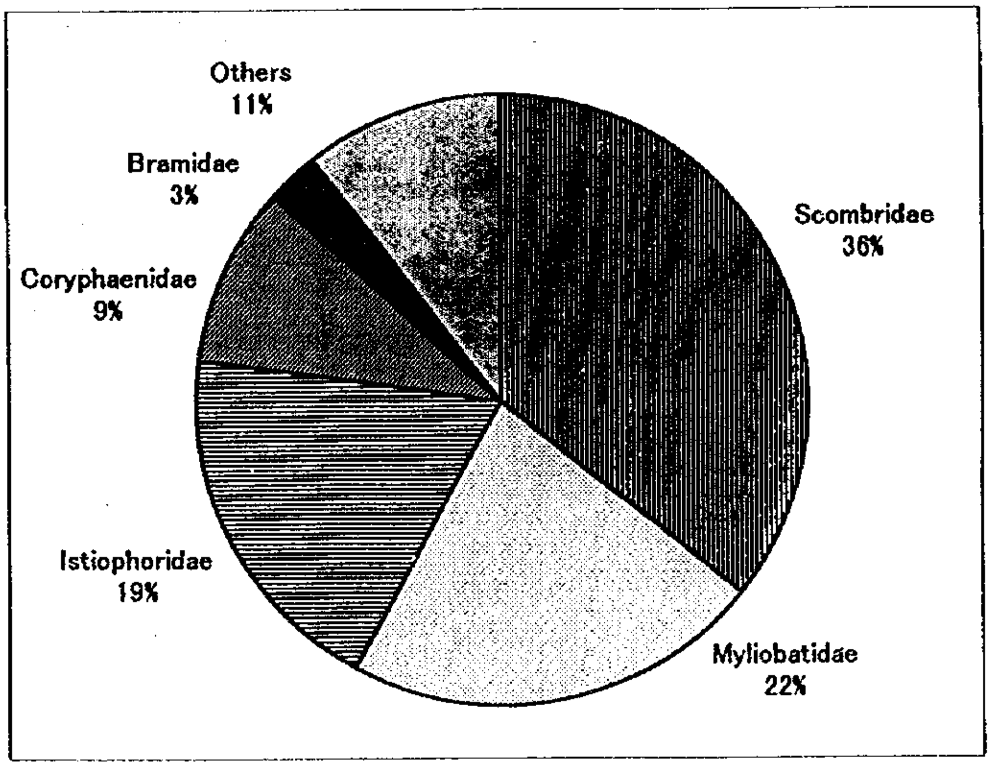



Figure 2. Composition of catch weight of fish and cephalopod classified by families.

Table 1. Species order of catch in number during sea-borne survey, 1995 - 1997.

| Order | Species Name | Code | 1st cruise 95.11-12 | 2nd cruise 96.5-6 | 3rd cruise 96.9-10 | 4th cruise 97.5-6 | Total |
|---|---|---|---|---|---|---|---|
| 1 | *Auxis rochei* | 11444 | | 189 | 58 | 591 | 838 |
| 2 | *Brama orcini* | 07122 | 5 | 122 | 397 | 157 | 681 |
| 3 | *Auxis thazard* | 11443 | 2 | 127 | 242 | 289 | 660 |
| 4 | *Katsuwonus pelamis* | 11454 | 10 | 144 | 197 | 301 | 652 |
| 5 | *Coryphaena hippurus* | 07061 | 2 | 179 | 235 | 218 | 634 |
| 6 | *Sthenoteuthis oualaniensis* | 21198 | 9 | 76 | 144 | 163 | 392 |
| 7 | *Aluterus monoceros* | 12071 | 1 | 4 | 131 | 2 | 138 |
| 8 | *Lobotes surinamensis* | 07311 | 1 | 48 | 56 | 28 | 133 |
| 9 | *Thunnus tonggol* | 11463 | | | 40 | 71 | 111 |
| 10 | *Coryphaena equiselis* | 07062 | | 13 | 33 | 63 | 109 |
| 11 | *Thunnus obesus* | 11472 | 1 | 15 | 4 | 59 | 79 |
| 12 | *Euthynnus affinis* | 11453 | | 6 | 30 | 26 | 62 |
| 13 | *Priacanthus macracanthus* | 06533 | | 12 | 5 | 29 | 46 |
| 14 | *Istiophorus platypterus* | 11491 | | 10 | 26 | 8 | 44 |
| 15 | *Carangoides orthogrammus* | 07032 | | 4 | 13 | 24 | 41 |
| 16 | *Cubiceps squamiceps* | 11542 | | | 34 | | 34 |
| 17 | *Selar crumenophthalmus* | 06963 | | 5 | 11 | 10 | 26 |
| 18 | *Scomber australasicus* | 11442 | | 3 | | 23 | 26 |
| 19 | *Cubiceps pauciradiatus* | 11543 | | 3 | | 22 | 25 |
| 20 | *Seriola rivoliana* | 06921 | | 13 | 4 | 6 | 23 |
| 21 | *Psenes cyanophrys* | 11541 | | 8 | 4 | 8 | 20 |
| 22 | *Thunnus albacares* | 11471 | | 1 | 11 | 7 | 19 |
| 23 | *Diodon hystrix* | 12354 | | 1 | | 18 | 19 |
| 24 | *Canthidermis maculata* | 12041 | | 2 | 10 | 5 | 17 |
| 25 | *Diodon eydouxii* | 12353 | | 3 | 7 | 7 | 17 |

Table 2. Species order of catch in weight during sea-borne survey, 1995 - 1997.

| Order | Species Name | Code | 1st cruise 95.11-12 | 2nd cruise 96.5-6 | 3rd cruise 96.9-10 | 4th cruise 97.5-6 | Total |
|---|---|---|---|---|---|---|---|
| 1 | *Katsuwonus pelamis* | 11454 | 12.20 | 518.76 | 537.25 | 709.70 | 1777.91 |
| 2 | *Mobula japonica* | 01522 | | 593.00 | 371.00 | 225.00 | 1189.00 |
| 3 | *Coryphaena hippurus* | 07061 | 4.10 | 218.60 | 294.87 | 207.47 | 725.04 |
| 4 | *Manta birostris* | 01521 | | 178.00 | 450.00 | | 628.00 |
| 5 | *Auxis thazard* | 11443 | 1.35 | 154.01 | 240.40 | 227.45 | 623.21 |
| 6 | *Makaira mazara* | 11493 | | 365.00 | 177.80 | | 542.80 |
| 7 | *Istiophorus platypterus* | 11491 | | 249.50 | 130.10 | 126.75 | 506.35 |
| 8 | *Makaira indica* | 11492 | | 85.00 | 266.00 | | 351.00 |
| 9 | *Auxis rochei* | 11444 | | 58.08 | 14.28 | 166.89 | 239.25 |
| 10 | *Brama orcini* | 07122 | 1.70 | 45.48 | 128.68 | 38.18 | 214.04 |
| 11 | *Lobotes surinamensis* | 07311 | 0.55 | 83.10 | 67.60 | 41.50 | 192.75 |
| 12 | *Tetrapterus audax* | 11494 | | | | 171.00 | 171.00 |
| 13 | *Sthenoteuthis oualaniensis* | 21198 | 3.95 | 36.91 | 56.00 | 70.53 | 167.39 |
| 14 | *Thunnus albacares* | 11471 | | 12.60 | 67.45 | 5.30 | 85.35 |
| 15 | *Prionace glauca* | 01052 | | 73.00 | | | 73.00 |
| 16 | *Thunnus tonggol* | 11463 | | | 36.40 | 30.15 | 66.55 |
| 17 | *Euthynnus affinis* | 11453 | | 15.24 | 31.00 | 17.42 | 63.66 |
| 18 | *Carcharhinus falciformis* | 01092 | | 16.08 | 21.90 | 14.85 | 52.83 |
| 19 | *Coryphaena equiselis* | 07062 | | 6.33 | 18.15 | 23.65 | 48.13 |
| 20 | *Sphyrna lewini* | 01102 | | | | 45.00 | 45.00 |
| 21 | *Thunnus obesus* | 11472 | 1.80 | 6.00 | 9.00 | 25.75 | 42.55 |
| 22 | *Carcharhinus brevipinna* | 01083 | | 0.80 | 32.00 | | 32.80 |
| 23 | *Aluterus monoceros* | 12071 | 0.40 | 1.90 | 29.04 | 0.23 | 31.57 |
| 24 | *Xiphias gladius* | 11502 | | | | 24.00 | 24.00 |
| 25 | *Galeocerdo cuvier* | 01051 | | 23.00 | | | 23.00 |

## 12. Distribution and relative abundance of major species

### 12-1. Distribution and abundance of common dolphinfish (*Coryphaena hippurus*)

The fish were distributed widely over the whole survey area throughout survey period. In the southwestern monsoon season, it tended to aggregate in the coastal waters, especially in quadrangles of Lat. 15 degrees N to 18 degree N in the North Region. Other areas of concentration are found off the Mekong Delta in the South Region, as well as coastal waters of the Central Region. CPUE in number of fish were illustrated for each cruise and for each quadrangle in Figure 12. Comparison of CPUE by quadrangle for each of three cruises suggested that the distribution pattern resembles between the 3rd and 4th surveys, but not the 2nd survey. The 2nd and 4th surveys in both southwestern monsoon seasons showed a wide fluctuation in CPUE (Figure 3).

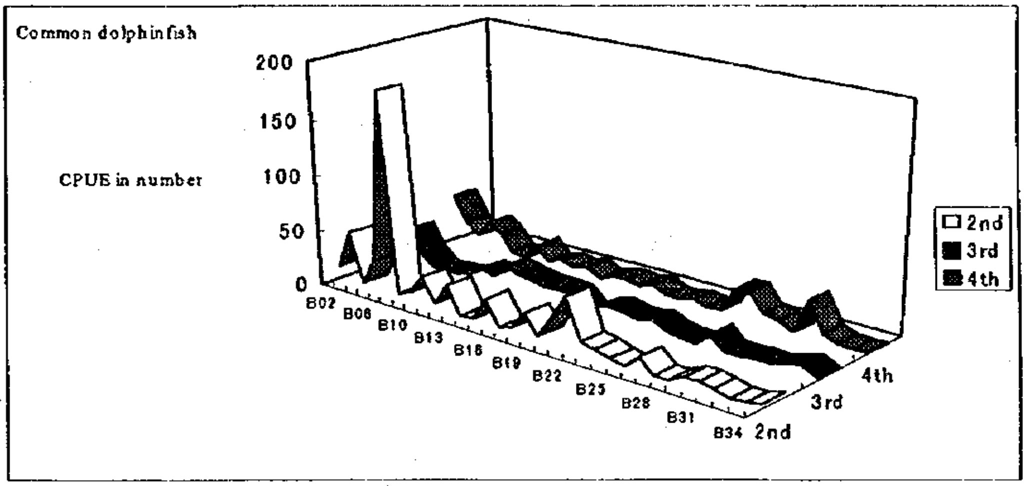



Figure 3. Distribution of CPUE in number of common dolphinfish by quadrangle in each of the three surveys of 1996 and 1997

### 12-2. Distribution and abundance of pompano dolphinfish (*Coryphaena equiselis*)

In general, pompano dolphinfish were found less than common dolphinfish in both CPUE and distribution range within the survey area. CPUE in number of the fish were illustrated for each cruise and for each quadrangle in Figure 4. Comparison of CPUE by quadrangle for each of three cruises suggests that the distribution pattern has a resemblance between the 3rd and 4th surveys, but not with the 2nd survey. Season-to-season change appears to be wider than year-to-year fluctuations.

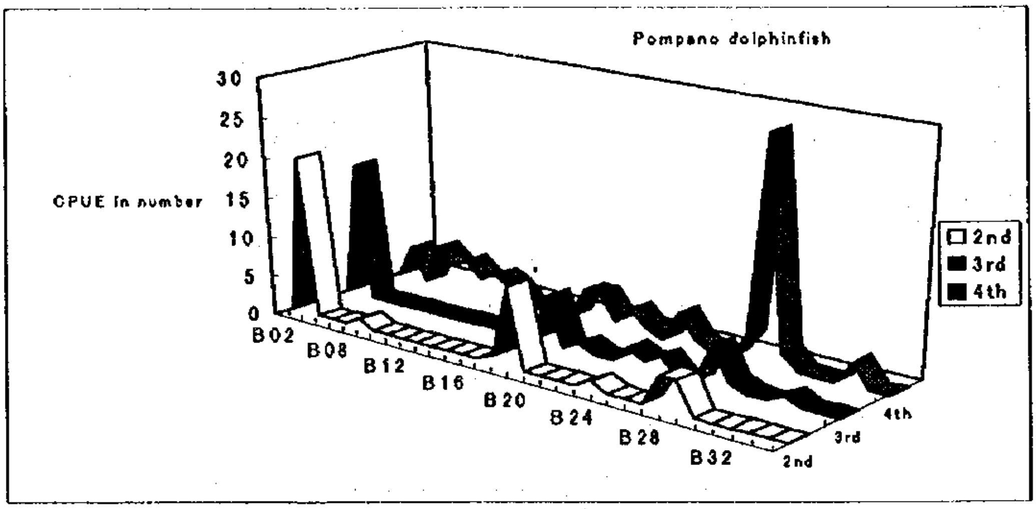


Figure 4. Distribution of CPUE in number of Pompano dolphinfish
by quadrangle in each of the three surveys from 1996 to 1997.

### 12-3. Distribution and abundance of bigtooth pomfret (*Brama orcini*)

In the southwestern monsoon season, the sum of CPUE was 185 for 1996 and 116 for 1997. The fish appeared mainly in quadrangles, 12 degree N - 15 degree N, of the Central Region and 8 degree N - 11 degree N, of the South Region. The fish did not appear near the Gulf of Tonkin in the North Region / or near the Mekong Delta in the South Region. It seems probable to assume that the fish avoid low saline waters derived from large rivers.

In the northeastern monsoon season, CPUE of bigtooth pomfret totaled 422, as high as about three times of the figures in the southwestern monsoon season. The geographical range expanded widely the Central and South Regions excluding coastal part of the latter (Figure 5).

### 12-4. Distribution and abundance of tripletail (*Lobotes surinamensis*)

In the southwestern monsoon season, the sum of CPUE was 54 for 1996 and 34 for 1997. The fish was widely distributed in the survey area excluding coastal waters facing the Gulf of Tonkin of the North Region and coastal waters of the South Region (Figure 6).

Data taken during the northeastern monsoon season indicates CPUE 58 of in number. The fish appeared more frequently in the South Region.

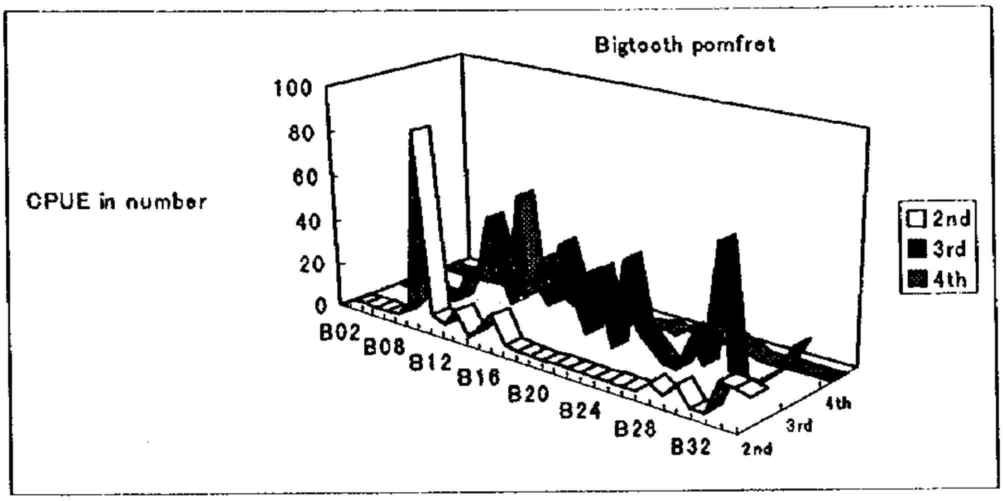



Figure5. Distribution of CPUE in number of bigtooth Pomfret
by quadrangle in each of the three surveys from 1996 to 1997.

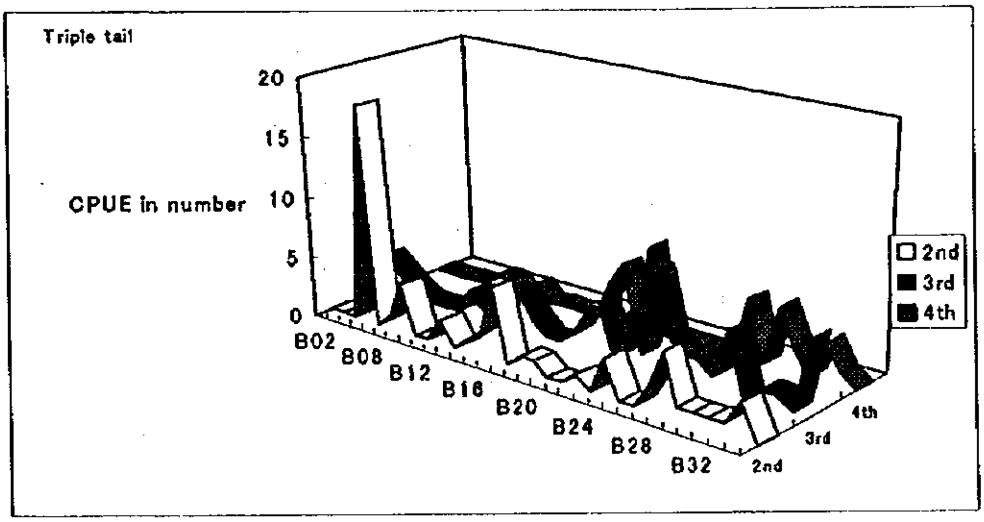



Figure 6. Distribution of CPUE in number of Triple tail
by quadrangle in each of the three surveys from 1996 to 1997.

## 12-5. Distribution and abundance of frigate mackerel (*Auxis thazard*)

In the southwestern monsoon season, the sum of total CPUE in number for 1997 was 385, three times higher than 116 for 1996, suggesting remarkable year to year variation of the abundance. The highest concentration was found in the coastal waters of the North and South Regions. The figure in the most prolific quadrangle in the South Region comprised 90 % of the total in 1997 (Figures 7).

In the northeastern monsoon season, the CPUE in number was 234 in total and

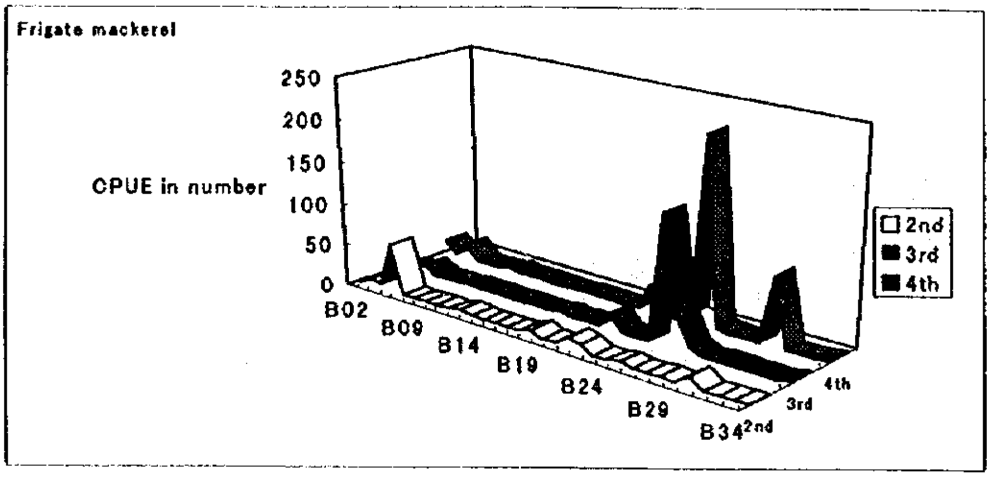



Figure 7. Distribution of CPUE in number of Frigate mackerel
by quadrangle in each three surveys from 1996 to 1997.

222 of them occurred in the South Region.

## 12-6. Distribution and abundance of bullet mackerel (*Auxis rochei*)

In the southwestern monsoon season, the sum of CPUE for 1997 was 775, over 3 times higher than the value for 1996. CPUE in number varied widely from year to year, especially in the North and Central Regions. The fish were mainly distributed in the waters near the coast, and less to the north of Lat. 16 degree N off Da Nang.

The fish were more frequently taken in the southwestern monsoon seasons than in the other season, but the CPUE showed fairly wide variation between years (Figure 8).

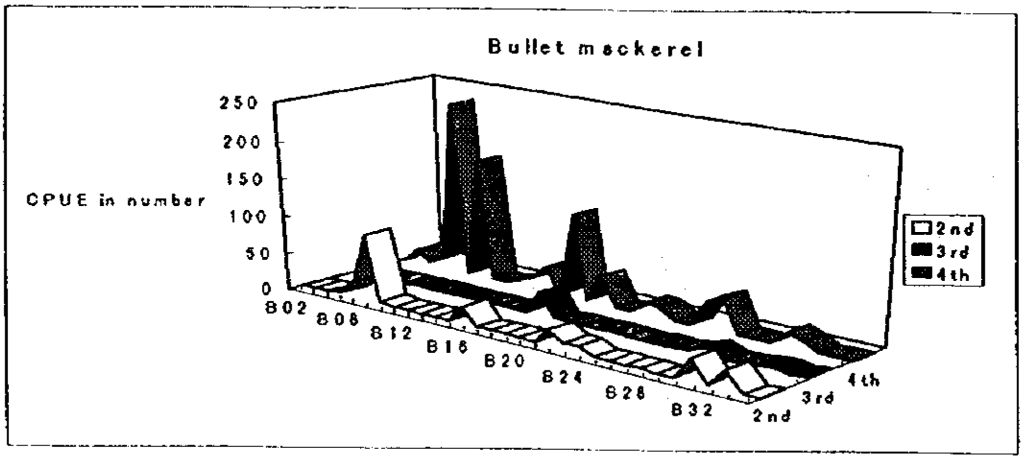



Figure 8. Distribution of CPUE in number of Bullet mackerel
by quadrangle in each of the three surveys from 1996 to 1997.

### 12-7. Distribution and abundance of eastern little tuna (*Euthynnus affinis*)

In the southwestern monsoon season, the fish was distributed in two general areas of offshore waters in the North Region and the coastal waters in the South Region, more highly in the latter than in the former (Figure 9).

In the northeastern monsoon season, the fish was dispersed over wide ranges including the waters around the Gulf of Tonkin of the North Region, in the offshore waters of the Central Region and in both coastal and offshore waters of the South Region.

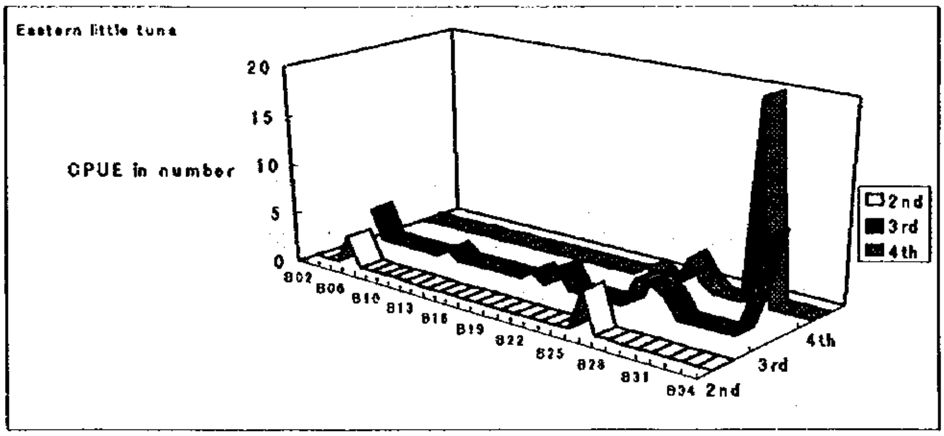



Figure 9 Distribution of CPUE in number of Eastern little tuna by quadrangle in each of the three surveys from 1996 to 1997.

### 12-8. Distribution and abundance of skipjack tuna (*Katsuwonus pelamis*)

In the southwestern monsoon season, the sum of CPUE in number differed between the two years, 135 in 1996 and 312 in 1997. The year-to-year variation was more remarkable in the two prolific South and Central Regions than in the North Region. The fish occurred mainly in the offshore waters throughout the cruises and was scarce in the entrance to the Gulf of Tonkin, in waters off Nha Trang, and in the coastal quadrangle near the Mekong Delta.

In the northeastern monsoon season, features of the distribution were high values in the Central Region, and low values in the offshore waters of the South Region (Figure 10). Unfortunately, occurrence of the fish in the North Region was not fully examined due to lack of test fishing in three quadrangles therein.

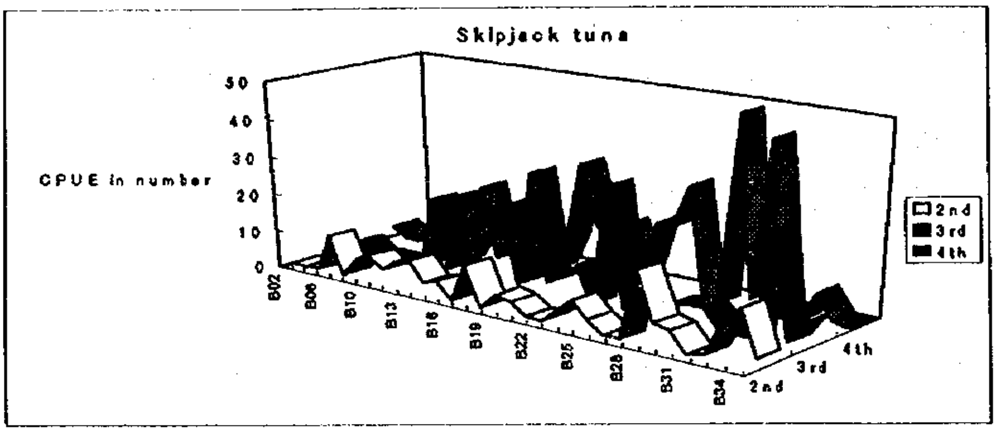



Figure 10. Distribution of CPUE in number of Skipjack tuna
by quadrangle in each of the three surveys from 1996 to 1997.

### 12-9. Distribution and abundance of tunas (*Thunnus*)

Test operations caught long tail tuna (*Thunnus tonggol*) in the 3rd and 4th surveys, but not in the 2nd survey. The fish appeared only in the coastal waters near the Mekong Delta of the South Region. CPUE in number was higher, 112 in the southwestern monsoon season of 1997, than that of 36 in the northeastern monsoon season of 1996 (Figure 11).

Only a small number of yellowfin tuna (Thunnus albacares) were collected by the test fishing, a single individual during the 2nd survey, and 11 individuals during in each of the 3rd and 4th surveys. The fish occurred more frequently in the North Region during the southwestern monsoon season, while in the South Region during the northeastern monsoon season, rather than in the other regions.

Bigeye tuna (*Thunnus obesus*) was infrequent catch for the test fishing and the data failed to show specific features of distribution.

### 12-10. Distribution and abundance of billfishes

The sum of CPUE in number for sail fish (*Istiophorus platypterus*) was 10, 17 and 10 in the 2nd, 3rd and 4th cruise, respectively. In the southwestern monsoon season, the fish was distributed on the continental shelf, as well as shallow waters around the Spratly Islands. In the northeastern monsoon season, the fish was not taken in the North Region, but occurred frequently in the offshore waters of the Central and South

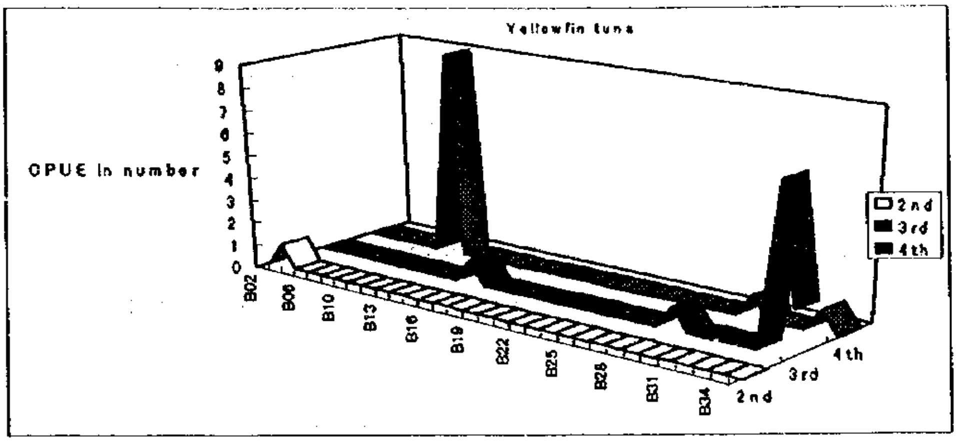



Figure 11. Distribution of CPUE in number of longtail tuna by quadrangle in each of the three surveys from 1996 to 1997.

Regions.

Black marlin (*Makaira indica)* occurred in the North and South Regions during the 2nd and 3rd surveys, but not during the 4th survey, nor in the Central Region. The fish appeared in the shallow coastal waters including those around the Mekong Delta and the Gulf of Tonkin.

In total, 6 and 10 of blue marlin (*Makaira mazara*) were taken during the 2nd and 3rd surveys, respectively. Positive quadrangles scatter along the whole coastal waters during the southwestern monsoon season, but were confined to the southern waters during the northeastern monsoon season.

Blue marlin appeared more frequently in the waters around the Mekong Delta, where the concentration of fish appeared near the Delta in the northeastern monsoon season, and seemed to have shifted offshore in the southwestern monsoon season. Blue marlin, as well as sailfish and black marlin, may migrate to the coastal waters where outflow of river waters might have attracted small-sized forage fishes.

Test fishing of the 4th survey incidentally caught 4 striped marlins (*Tetrapterus audax*) in a quadrangle and a single swordfish (*Xiphias gladius*) in another.

### 12-13. Distribution and abundance of unicorn leatherjacket (*Aluterus monoceros*)

Test fishing in the southwestern monsoon season showed only 4 and 2, values of CPUE in number, in offshore waters of the Central Region during the 2nd and 4th surveys, respectively. On the other hand, 133 of CPUE, were taken during the 3rd survey, where the fish were found to be widely distributed. High concentrations appeared in the water near the Gulf of Tonkin of the North Region and in the waters around the Spratly Islands, but not near the Mekong Delta in the South Region.

### 12-14. Distribution and abundance of flying squid (*Sthenoteuthis oualaniensis*)

In the southwestern monsoon season, CPUE in number totaled to 268 and 209 , for the 2nd and 4th surveys, respectively. The squid did not appear in the vicinity of the Gulf of Tonkin nor of the Mekong Delta. Positive quadrangles were located in the offshore areas in the North and South Regions, but extended from the coast to offshore in the Central Region.

In the northeastern monsoon season, the sum of CPUE in number at all the operation sites was 153. There was no recorded collection of the squid in the vicinity of the Mekong Delta. In the Central Region, on the contrary, the squid were more frequently recorded in the northwestern monsoon season than in the other season (Figure 12).

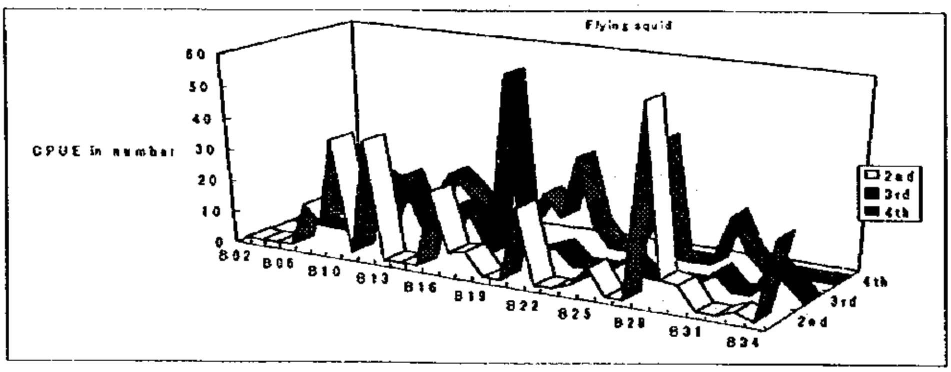



Figure 12. Distribution of CPUE in number of flying squid by quadrangle in each of the three surveys from 1996 to 1997

### 13. Biological findings of the major species

Among 18 major species, 95% of individuals were from 12 species including bullet mackerel, pompanos, frigate mackerel, skipjack tuna, common dolphinfish and flying squid. Only pomfret is a mid-layer species. The others are pelagic oceanic species, common in the warm waters including southern Japan stretching to the Ryukyu Archipelago (Matsubara,Ochiai and Iwai 1979, Ochiai and Tanaka 1986, Nakabo 1993).

Flying squid is a typical oceanic cephalopod (Okutani 1995).

### 13-1. Common dolphinfish (*Coryphaena hippurus*)

Sampled fish ranged between 225 and 1,125 mm in fork length with mode of 425 mm and mean of 448.5 mm, or between 0.5 kg and 12.25 kg in body weight with mode of 0.75 kg and mean of 1.15 kg.

In the southwestern monsoon season, medium sized fish of 375 to 425 mm in modal fork length dominated, while smaller fish of 275 mm were found distributed in the offshore waters of the Central and South Regions in the northeast monsoon season.

According to studies on material taken in Japanese waters, common dolphinfish reach 20～25 cm in June and July of their first year of life, and then grow up to 38 cm at one year after birth, 68 cm at two years, 90 cm at three years, 108 cm at four years and 122 cm at five years (Ochiai and Tanaka 1986). Assuming the growth rate applicable to the Vietnamese stocks, the major portion of samples taken in the southwest monsoon season are 1-age, and those in the northeast monsoon season are 0-age.

Stomach contents and gonads were investigated for feeding habits and spawning activity of the fish in the area under study. Among five fish taken in the northeast monsoon season of 1996, three fish had empty stomachs, and the other two were found to have eaten squid, in spite of the previous reports that fish are their major prey.

### 13-2. Pompano dolphinfish (*Coryphaena equiselis*)

Test fishing captured pompano dolphinfish which were as large as 225 to 425 mm in fork length, with a mode of 325 mm and mean of 309.0 mm in fork length and 0.25 to 1.25 kg in body weight, with mode of 0.25 kg and mean of 0.44 kg.

### 13-3. Bigtooth Pomfret (*Brama orcini*)

Ranges of the fish taken during the four cruises were 110-390 mm in fork length and 0.05-1.15 kg in body weight. There was a tendency that the small sized fish were distributed in the continental slope and the large sized fish were in the offshore area.

According to stomach samples, bigtooth pomfret fed on fishes including Genus

Sardinella, squids and shrimps, even though half of the samples had already digested animals for identification of species composition of stomach contents.

### 13-4. Tripletail (*Lobotes surinamensis*)

Standard length of tripletail taken throughout the surveys ranged between 150 and 570 mm with a mean of 324.6 mm. Body weight of the fish varied from 0.1 kg to 4.5 kg, and averaged 1.46 kg. There was the possibility that size composition changes between seasons with large sized fish over 300 mm in standard length in the southwestern monsoon season and small fish below 200 mm in the northeastern monsoon season.

### 13-5. Frigate mackerel (*Auxis thazard*)

Sampled fish ranged from 230 to 450 mm in fork length and from 0.1 to 1.9 kg in body weight. The modes were 350 mm and 0.9 kg, and the means were 360.6 mm and 0.95 kg.

Growth rate of frigate mackerel was evaluated with specimens from Gulf of Thailand as 26 cm at one year of age, 38 cm at two year of age and 47 cm at three year of age (Klinmuang 1979). Refering to the findings of Chu Tien Vinh (1994), estimated age of the frigate mackerel exploited off Viet Nam were mostly at 1 to 2 year of age. His inference suggests that major catch consisted of 1 or 2 year of age fish in 1996 or simply one year in the southwest monsoon season of 1997.

### 13-6. Bullet mackerel (*Auxis rochei*)

The samples consisted of fish 150 to 310 mm in fork length or 0.025 to 0.575 kg in body weight, or 270 mm and 0.275 kg in modes and 260.7 mm and 0.28 kg in means.

Stomachs collected during May and June 1997 were found to contain shrimps most frequently, followed by Euphausia and squids. Ochiai and Tanaka (1986) reported that closely spaced gill rakers suggested that bullet mackerel prefer shrimps and other crustacea to fishes and squids.

**13-7. Eastern little tuna (*Euthynnus affinis*)**

The samples consisted of fish 150 to 160 mm in fork length with modes of 210 mm and 310 mm, averaging 359.8 mm, or of 0.2 to 4.3 kg in body weight with mode of 0.3 kg and average of 1.03 kg. The sample showed remarkable variation of size of fish, mostly large sized fish of 300 mm or above during the two cruises in 1996, but small sized fish of 150 to 230mm in the inshore area of South Region during the cruise in the southwest monsoon season of 1997.

**13-8. Skipjack tuna (*Katsuwonus pelamis*)**

Fork length and body weight ranged from 230 to 710 mm and 0.50 to 8.25 kg, respectively, and three modes were found at 290 mm, 430 mm and 550 to 570 mm, or at 0.5 kg, 1.75 kg and 4.25 kg. The averages were 476.8 mm and 2.75 kg.

There is substantial biological data on age and growth of skipjack tuna for its economic importance (Ochiai and Tanaka 1986). Reference to the previous reports indicates that two year of age fish might have dominated samples collected in the southwest monsoon season of 1996, that fish taken in the northeast monsoon season of 1996 might have consisted of one- and two-year olds, and that young fish of one year of age dominated those sampled in the southwest monsoon season of 1997.

Among stomach samples collected, 38 % were found with fishes and squids, 33 % with fishes only, 5 % with fishes, squids and shrimps and rest 10 % empty. Fishes and squids comprise 52 % and 35 % of forage organisms, respectively. Major fishes in stomachs were sardines, anchovies, carangids of Genus Caranx and Rastrelliger.

**13-9. Longtail tuna (*Thunnus tonggol*)**

Samples taken by the present survey were 230 to 430 mm in length, with mode of 250 mm and mean of 300.0 mm in fork length. These fish weighed 0.3～1.5 kg, and the mode was 0.3 kg. Fish taken in the northeast monsoon season of 1996 were 370 mm in modal length and 0.9 kg in modal weight. Taken in the southwest monsoon season of 1997 were smaller fish with modes of 250 mm and 0.3 kg. According to Mohsin (1996), there appear three age groups of longtail tuna, one year of age of 27 to

30 cm, two year of age of 35 cm and three year of age of 45 cm in the waters east of Malaysia and Gulf of Thailand. Applying this information, age of fish taken in the present survey is estimated as two years in the northeast monsoon season and one year in the southwest monsoon season.

### 13-10. Yellowfin tuna (*Thunnus albacares*)

The whole sample consisted of fish ranging between 225 mm and 1,425 mm in fork length or 1 kg and 45 kg in body weight, with modes of 275 mm and 1 kg and means of 461,2 mm and 4.5 kg. Dividing these materials into season of sampling, length frequencies showed two modes of 275 mm and 500 mm in the northeastern monsoon season of 1996, and only a single mode of 275 mm in the southwest monsoon season of 1997. A rearing experiment showed that the fish grow to 25 to 26 cm in six months after hatching and about 50 cm in one year. It is possible to consider that fish of the first year of life were taken in the survey area and one year old fish also appeared in the northeast monsoon season but only first year of life fish were taken in the southwest monsoon season.

### 13-11. Bigeye tuna (*Thunnus obesus*)

Size frequency of the whole sample showed ranges and modes of 210 to 590 mm and 250 mm in fork length, and 0.1 to 0.4 kg and 0.3 kg in body weight. The averages were 272.5 mm and 0.52 kg. Since the species is known to reach 44 cm at the end of first year of life, most of samples taken in the present survey were considered to have been of less than one year in age.

### 13-12. Sailfish (*Istiophorus platypterus*)

Samples of this species ranged between 550 mm and 2,450 mm in fork length, and 1.25 kg and 36.25 kg in body weight, with respective modes of 1,950 to 2,050 mm and 1.25 kg, and means of 1,458.3 mm and 11.51 kg. The fish taken in the southwest monsoon season were larger than those in the northeast monsoon season. It is known that the Atlantic species reach to 183 cm and 216 cm at the ends of first and second years of life representatively (Ochiai and Tanaka 1986). Taking this information into account, the fish found in the northeast monsoon season were 0-year of age and those in the southwest monsoon season were one year of age or two years of age.

### 13-13. Other billfishes

The samples of black marlin (*Makaira indica*) ranged between 1,550 mm and 2,350 mm in fork length and between 17.5 kg and 72.5 kg in body weight, with modes of 1,750 mm and 27.5 kg and means of 1,878mm and 33.3 kg.

Three specimens of striped marlin (*Tetrapterus audax*) ranged between 2,320 mm and 2,494 mm in fork length and between 52 and 65 kg in body weight.

A specimen of broadbill swordfish ( *Xiphias gladius*) measured 1,900 mm in fork length and 24 kg in body weight.

### 13-14. Unicorn leatherjacket (*Aluterus monocerus*)

The samples ranged between 130 mm and 350 mm in body length, and 75g g and 725 g in body weight, with modes of 190 to 210 mm and 175 g, and means of 248.0 mm and 290 g.

### 13-15. Flying squid (*Sthenoteuthis oualaniensis*)

Mantle length ranged between 120 mm and 330 mm with mode of 210 mm and mean of 206.3 mm. The comparable body weight figures were 125 g and 1,125 g, 475 g, and 440 g, respectively. During the southwestern monsoon season of 1996, modes were 230 mm in mantle length and 525 g in body weight. During the next northeastern monsoon season of 1996, modal length of 190 to 210 mm and modal weight of 425 g were found. During the southwest monsoon season of 1997, the samples were found as large as 190 to 210 mm in modal length and 475 g in modal weight.

## 14. Comparison of catch made by mid-layer and surface drift gillnets.

A set of gillnets of 100-mm mesh size was placed at depth of about 10 m below the sea surface connected with surface nets of the same mesh size, to concurrently allow test fishing by surface nets of five different mesh sizes during the second phase of the 4th cruise.

Surface gillnets (hereinafter referred to as "surface nets" ) captured a total of 364 CPUE in number and 207 of that in weight of 34 species, against 243 in number and 93 in weight of 20 species taken by mid-layer gillnets (hereinafter referred to as "mid-layer nets").

The surface nets resulted in a better catch in terms of CPUE in number and weight, as well as number of species when compared with the mid-layer nets.

The major stocks in the waters under study comprise pelagic species living near the sea surface. CPUE of two types of nets suggested that the surface operation was more efficient than the deeper operation.

In total 14 species of seven families were caught by both types of nets. They are two species of Carangidae, one species of Corphynidae, one species of Bramidae, six species of Scombridae, two species of Centrolophidae, one species of Echeneidae, and one species of Balistidae. Surface nets captured 19 species of 8 families which were not taken by mid-layer nets. They are six species of Exocoetidae, one species of Priacanthidae, 6 species of Carangidae, one species of Corphynidae, one species of Lobotidae, one species of Monacanth idae, one species of Diodontidae and one species of Ommastrephidae.

Inversely, five species of three families were found caught by mid-layer nets, but not by surface nets. They are one species of Teraponidae, three species of Carangidae and one species of Scombridae. The species composition of the catch implies a vertical difference of ichthyofauna in the area under discussion. Namely, the surface operation captured the pelagic species more frequently, while sub-surface inhabitants less efficiently than the mid-layer operation.

## 15. Abundance Index

As mentioned in chapter 8-2, abundance index was calculated by multiplying CPUE in a quadrangle by the relative area of a quadrangle. The following description covers abundance indices of major species in terms of weight.

**(1) Common dolphinfish, (*Coryphaena hippurus*)**

Total index for each period was the highest, 388 in the 2-nd survey, and the lowest, 245, in the 4th survey, both in the southwestern monsoon season. The average index was about 300. Lack of data in the offshore area of the North Region in the 3rd survey prevented comparison of the abundance indices with those in the other surveys. Taking the smaller area of the North Area into account, productivity of common dolphinfish seemed higher in that Region than in the others.

**(2) Pompano dolphinfish, (*Coryphaena equiselis*)**

Total abundance indices range from 13 to 27, and are averaged at 18, with only 1/15 of those being common dolphinfish.

**(3) Bigtooth pomfret, (*Brama orcini*)**

Total abundance indices ranged from 27 to 130. The values rose in the northeastern monsoon season, and declined to 1/3 to 1/2 in the southwestern monsoon season. The abundance indices were very low, only 1 or less in the North Region and coastal area of the South Region. High values above 50 occurred in the Central Region and offshore area of the South Region, where land water does not flow in. Abundance indices support the biological reasoning that bigtooth pomfret is an oceanic species.

**(4) Triple-tail, (*Lobotes surinamensis* )**

Total abundance indices are fairly stable during the three surveys, ranging between 52 and 67 around the mean of 62. Regional average showed the highest value of 28 in offshore area of the South Region, followed by 21 in the Central Region, and 7 in offshore area of the North Region.

**(5) Frigate mackerel, (*Auxis thazard*)**

Average of total abundance indices is the third highest after skipjack tuna and common dolphinfish. The range extends from 92 to 292. The variation between the two southwestern monsoon seasons exceeded 3 times, a much larger difference from values in the northeastern monsoon season. The coastal area of the South Region showed high values of 214 in the northeastern monsoon season and 250 in the southwestern monsoon of 1997, both comprised about 90 % of the seasonal total. Abundance of this species has been continuously high in the coastal area of the South Region.

**(6) Bullet mackerel, (*Auxis rochei*)**

Abundance indices varied quite extensively from 54 to 207, and were averaged at about 92. The regional averages were high, around 40 in the offshore area of the North Region and the Central Region, which covered about 80 % in the most prosperous season surveyed by the fourth cruise. Even though year-to-year variation is significant, the relative abundance tends to rise in the southwest monsoon season.

**(7) Skipjack tuna, (*Katsuwonus pelami*)**

Average abundance index, 585, was the highest among 18 major species. The range extended from 418 to 806. The indices in the southwestern monsoon seasons showed wide year-to-year variation, 418 in 1996 and 806 in 1997. Skipjack tuna was mostly distributed in the Central Region and the offshore area of the South Region, with averages and ranges of 265 and 175-316 and 285 and 203-402, respectively. The offshore fish did not appear in coastal waters of the North and South Regions.

**(8) Three species of Genus Thunnus, longtail tuna, (T. *tongogol*), bigeye tuna, (*T. obesus*), and yellowfin tuna, (*T. albacares*)**

Total abundance indices of three species combined changed drastically from 8 to 102, with an average of 24. There was no remarkable seasonal change, except significant year-to-year variation of the indices of longtail tuna and yellowfin tuna. Relatively high values for longtail tuna were found in the coastal area of the South Region and those for bigeye tuna in the Central Region. The values were low in the North Region.

**(9) Sailfish, (*Istiophorus platypterus*)**

Total abundance indices varied between 120 and 202, with an average of 162.

**(10) Unicorn leatherjacket, ( *Aluterus monoceros*)**

This is not an abundant species, with the average index of 10, ranging between 2 and 17. Relatively significant values exceeding the mean were sometimes found in the coastal area of the North and South Regions in the northeastern monsoon season.

**(11) Flying squid, (*Sthenoteuthis oualaniensis*)**

Abundance indices varied quite extensively from 58 to 119, and the average was 86. In the most prosperous Central Region, the value stayed at fairly constant value around 50. The indices in the offshore area of the South Region were also high, but fluctuated from 9 to 53 between cruises. The squid did not appear in the coastal areas of the North and South Regions. In the offshore area of the North Region, the abundance indices stayed at low level of 8 to 10.

**16. Basic Fishery Policy of Viet Nam**

At the beginning of this decade, the Vietnamese government indicated five principal policy objectives for the period 1991 - 2000 (MOF, 1992). These are:

(1) To increase the direct consumption of fishery products: The estimated average annual *per capita* fish consumption in Viet Nam is 14 kg in 1994, accounting for an estimated 40% of national animal protein intake.

(2) To increase export earning: It is intended to increase foreign exchange earning by ① increasing the volume and value of export-oriented species landed, and ② greatly increasing the amount of value added by improving the fish processing sector. In particular, it is intended to eliminate the need for reprocessing and repackaging of products in importing countries by processing in Viet Nam precisely to end-user requirements.

(3) To create employment within the sector: Somewhat over half a million persons are employed directly in the fisheries sector. In addition probably several million other persons are dependent on fisheries either for subsistence or in related commercial industries such as fish processing, a particularly important source of employment for women.

(4) To improve the infrastructural, equipment and technological base: Infrastructure development would include principally the upgrading of landing site, marketing and distribution facilities. Improvement of equipment and technological base is mainly aimed at reducing the number of small vessels operating in already overexploited inshore waters by building larger fishing boats for distant waters.

(5) To increase the contribution to the national budget: Although inshore warters with depth of less than 50 m are now regarded as fully exploited, it is estimated that an additional catches could eventually be landed from 1 million $km^2$ of continental shelf

water under the jurisdiction of Viet Nam. Much of this added production could be processed in Viet Nam to add to tax revenue for the government.

**17. Trend of Fisheries Production**

The new management system, based on the independent accountability of individual production units, was first introduced in 1981 into SEAPRODEX, a state-run fisheries enterprise. The growth in fishery production (the sum of capture fishery production and aquaculture production) in Viet Nam between 1981 and 1994 is shown in Table 3. From a total of 600,000 t of fishery production in 1981 has increased at an average annual rate of 6% to some 1,270,000 t in 1994.

Since 1981 the ratio of capture fishery to aquaculture production has remained at 7:3. The main gear types employed in capture fisheries are the lift net, purse seine, trawl, gill net, hand line, and long line. They are used mostly in coastal fishing grounds, and 90% of fishers are small-scale operators. Fishery production was enhanced by the motorization of fishing boats and the introduction of synthetic fiber nets. However, since fishing boats in Viet Nam are generally too small to operate in offshore areas, effort is concentrated in the narrow coastal water zones, thereby exacerbating the problem of overfishing in nearshore waters.

The bulk of aquaculture production in Viet Nam is derived from freshwaters. In contrast, brackishwater aquaculture is relatively underdeveloped. In 1991 freshwater aquaculture accounted for 82.5% of total production, whereas brackishwater production contributed only 17.5% (FAO, 1993). Although the percentage contribution of brackishwater aquaculture has increased from 7.3% (1984), this is still very low, compared with an average of 53.5% (1991) for the Asia- Pacific Region.

There are regional characteristics in fisheries production. The Southern Region is the center for both capture fisheries and aquaculture in Viet Nam. In the Central Region aquaculture production is stagnant. In contrast, the Northern Region makes only a small contribution to national fisheries production.

Table 5. Production of Fisheries in Viet Nam (1981 - 1994)

Unit : Ton

| Year | Total Production | Capture Fisheries | Aquaculture |
|---|---|---|---|
| 1981 | 596,356 | 416,356 | 180,000 |
| 1982 | 659,318 | 470,718 | 188,600 |
| 1983 | 724,399 | 519,869 | 204,530 |
| 1984 | 778,219 | 554,940 | 223,379 |
| 1985 | 857,998 | 626,848 | 231,150 |
| 1986 | 840,583 | 597,717 | 242,866 |
| 1987 | 890,509 | 640,569 | 249,940 |
| 1988 | 912,652 | 662,861 | 249,791 |
| 1989 | 913,495 | 661,365 | 252,130 |
| 1990 | 978,880 | 672,130 | 306,750 |
| 1991 | 1,062,163 | 714,253 | 347,910 |
| 1992 | 1,097,830 | 746,870 | 351,260 |
| 1993 | 1,172,529 | 798,057 | 374,472 |
| 1994 | 1,268,474 | 878,474 | 390,000 |

Source : MOF

**18. Working population and the number of fishing boats**

As shown in Table 4, the national fisheries working population increased 43% during the 7-year period 1985-92, from 740,000 persons in 1985 to 1,060,000 persons in 1992.

Table 6. Fisheries Working Population in Viet Nam (1985 - 1992)

| Year | Total | Government Sector | Private/Cooperative Sector |
|---|---|---|---|
| 1985 | 740,240 | 38,050 | 720,190 |
| 1986 | 808,957 | 40,450 | 768,507 |
| 1987 | 772,589 | 41,337 | 731,172 |
| 1988 | 821,729 | 44,200 | 777,592 |
| 1989 | 934,433 | 45,200 | 894,233 |
| 1990 | Unknown | Unknown | Unknown |
| 1991 | Unknown | Unknown | Unknown |
| 1992 | 1,060,000 | 84,870 | 975,200 |

Source : MOF, 1993

Of the 383,000 adults (over 16 years-old) working in fisheries, 86% are men and 14% women. Their education level is generally low, with 68% not having completed primary school and just 0.6% having graduated from either vocational school or university. Per capita productivity in the Southern Region is higher than in either the Northern or Central Regions. This gap differential results from ① a regional difference in the means of production, i.e. fishing boats and gear, which are larger and better in the Southern Region, and ② a similar regional difference in the quality and size of fishing grounds, which are much richer and more productive in the Southern Region, with its large continental shelf.

In 1992, the fishing fleet of Viet Nam comprised 83,972 units, of which 54,612 were motorized. In recent years the number of motorized fishing boats has increased rapidly at an annual rate of 7.6 % (Table 5). However, the average engine capacity is approximately 22 h.p., and 80% of the motorized boats have engines of less than 45 h.p.. This important constraint has essentially confined fishing effort to coastal fishing grounds.

Table 7. Total Motorized Fishing Boats and Engine Capacity in Viet Nam

| Year | Total Motorized Fishing Boats (unit) | Total Engine Capacity (hp.) | Average Horsepower (hp. / boat) |
|---|---|---|---|
| 1983 | 29,117 | 475,832 | 16.3 |
| 1984 | 29,549 | 484,114 | 16.4 |
| 1985 | 29,323 | 494,507 | 16.9 |
| 1986 | 31,906 | 515,629 | 16.2 |
| 1987 | 35,744 | 582,992 | 16.3 |
| 1988 | 43,922 | 603,078 | 13.7 |
| 1989 | 37,100 | 693,722 | 18.7 |
| 1990 | 41,266 | 727,585 | 17.6 |
| 1991 | 43,940 | 824,436 | 18.8 |
| 1992 | 54,612 | 986,420 | 18.1 |
| 1993 | 61,717 | 1,188,804 | 19.3 |
| 1994 | 65,124 | 1,416,080 | 21.7 |

Source : MOF, 1993

**19. Distinctive features of five provinces surveyed**

The fishery sector in the Central Region surveyed area is characterized by an economically predominant position of marine capture fisheries within the fisheries sector but critical constraints in terms of fisheries infrastructure.

Ba Ria-Vung Tau Province has the larger and better equipped fishing boats among the five provinces. This province is also geographically favored by its proximity to the extensive area of shallow waters over the Sunda Shelf.

Binh Thuan Province is characterized by having many medium-sized fishing boats; its fisheries production in 1994 was the third largest marine fisheries production in Viet Nam. The province is also famous for fish sauce production. Fish landed in Binh Thuan Province are consumed largely in the domestic markets, and it is the tenth ranking province in the export of marine products.

The coastline of Khanh Hoa Province is fully varied. northward and southward currents flow into the offshore water of the province, and form productive fishing grounds. There is active international trading of fishery products in the province, making it ranked fifth in terms of exports. Fishermen are not interested in enlargement of size of their boat nor expansion of fishing grounds toward the offshore water. Instead, most are willing to convert the existing boats, especially from lift netting to purse seining vessels.

While Quang Nam Da Nang Province is in the ninth position in the value of fish landed and the eighth in export value, landing in this province shows a gradual decline from 50,000 t in 1976 to 37,500 t in 1994.

Compared with these four provinces, fisheries of which are active and in the high to middle levels of the national ranking, Quang Binh Province appears unimpressive, being twenty-fourth in landing value and twenty-fifth in export value.

**20. Fish Species by Gear Type**

The principal fishing gear used in Viet Nam are the trawl, gill net, purse seine, lift net, set net, casting net, long-line and hand line. The different gears used by fishers basically target different species.

Pair-trawlers target high value species for the export market, such as cuttlefish and swordtip squid, and they make considerable efforts to explore new fishing grounds in search of them. They also target other species, including purple-spotted bigeye, threadfin bream, golden threadfin bream, white croaker, banded barracuda and lizardfish.

Single-trawlers catch swimming crabs, hard clam, radiated scallop in addition to the species caught by the pair trawlers. Shrimp-trawlers target smooth shell prawn, green tail prawn, black tiger prawn, and western king prawn.

There are two types of drift net, one used on the surface and the other on the bottom. For the surface drift gillnetting, the main target species are skipjack tuna, eastern little tuna , frigate mackerel, and king mackerel, all of which are taken in night operations. For bottom gillnetting, this is operated in daytime, targeting skipjack tuna, king mackerel, hairtail, round scad, and Indian mackerel.

The target species of purse-seiners are yellow tail round scad, round scad, eye scad, slender scaled scad, Indian mackerel, frigate mackerel and eastern little tuna. Particularly, yellow tail and round scad are the most important.

The targets of lift-netters are Indian anchovy, big-eye herring, Indian mackerel, yellow tail round scad, round scad, slender scaled scad and swordtip squid. In particular, Indian anchovy, the preferred raw material for fish sauce is one of the most important targets. Three methods are employed in lift netting to attract fish : ①*payao*, ②light, ③ a combination of *payao* and light. The latter is said to increase productivity by about 20%. Many gear conflicts occur with trawlers which cross over *payao* at night. As a consequence, fewer *payao* are used these days. In the Southern Region lift-netting operations have now been replaced by purse-seining. In the Central Region this technology competes for the same target as purse-seining. It is likely that as the lift-net gear and other equipment wears out, operators will switch to purse-seining, as has occurred in the Southern Region.

Twelve set nets are operated off Nha Trang City in the Central Region. Target species are king mackerel, skipjack tuna, and yellowfin tuna. In the Northern Region a wide variety of small fixed nets are operated by family members to take advantage of the current in tidal creeks and small bays. Typical is the tidal stow net, which targets green tail prawn and small white prawn.

Long-lining is not conducted in the Southern Region. In the Central Region target species for demersal long-liners are grouper, snapper, and pike conger and for pelagic long-liners tunas and billfishes. There is a bottom long-line in this region to catch large shark to supply the shark fin trade. In the Northern Region smaller vessels powered by 10-25 h.p. engines are used targeting demersal species; pike conger, sea breams, snappers, and croakers.

There are squid cast net fisheries and shellfish diving fisheries in Viet Nam. The former efficient fishing method has led to a concern about over-fishing, leading the provincial authorities to consider imposing stricter restrictions on its use.

## 21. Fishing Ground and Fishing Season

Figure 13 shows the fishing grounds used by fishers interviewed in the five surveyed provinces. Except in the Paracel Islands and Spratly Islands, fishing grounds are located within the 100 fathom line. Because the 100 fathom line runs close to shore in the Central Region, the major fishing grounds are divided into the shallow waters of the Gulf of Tonkin to the north and Sunda Shelf to the south.

Single-trawlers use waters of less than 20 fathoms. Compared to single-trawlers, pair-trawlers have already advanced offshore. Where the continental shelf is narrow and the continental slope steep, neither type of trawlers operate. The fishing grounds for lift-netting lie within the 50 fathom isobath, and are concentrated mainly in waters shallower than 20 fathoms. Since lift nets cannot be operated in deep waters, lift netters who want to switch to offshore fishing grounds do so by becoming purse-seiners. Purse-seiners usually operate on a wide range of fishing grounds with water depths of less than 50 fathoms. Some large purse-seiners now exploit offshore waters 170 km southeast of Con Dao Island. Gill-nets are used over wider areas, from inshore to offshore. However, these fishing grounds are located largely in the Northern and Southern regions, whereas few occur in the Central Region. Long-line grounds are clearly divided to inshore and offshore areas.

The winter monsoon is from October to March, when seas are rough owing to a strong northeast wind. This forces many small fishing boats stay in port, especially during the period from November to January. What local fishers consider the "bad season" is caused by weather conditions than biological factors. In contrast, during the transition from the northeast monsoon to the southwest monsoon, during April to June,

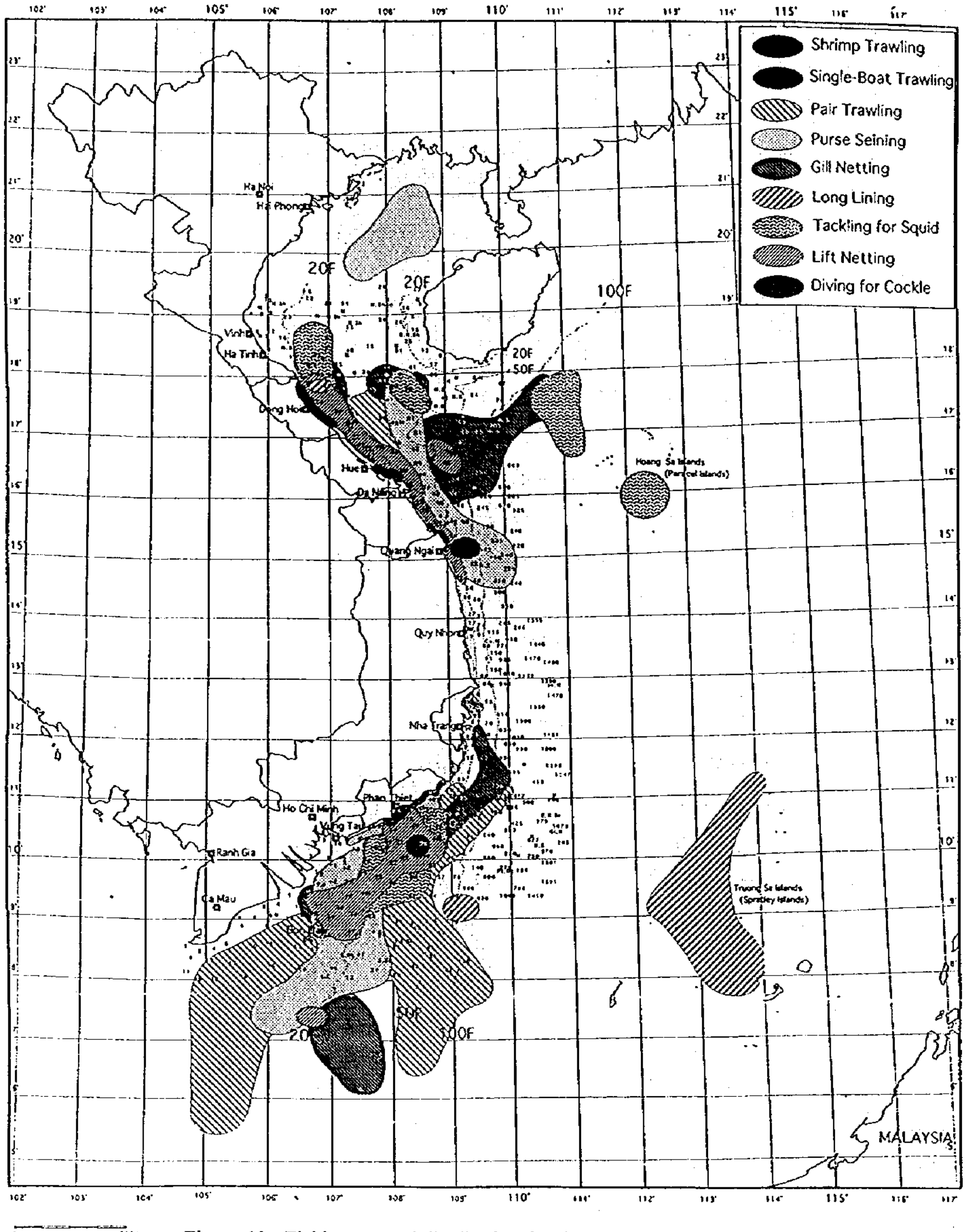



Figure 13. Fishing ground distribution for the Central Region in Viet Nam.

winds weaken, bringing calm seas. This is the best season for purse-seining and lift-netting operations which are difficult in rough seas. Typhoons strike Viet Nam mainly from September to December and tend to prevent fishing. Northern Viet Nam, particularly the Gulf of Tonkin coastal area, is affected the most. The two currents meet off the Central Region, creating good fishing grounds from May to June for the set net fishery around Nha Trang City, Khanh Hoa Province.

## 22. Fisheries Infrastructure

There are fish landing facilities for large-sized fishing boats in 32 fishing ports in Viet Nam, which can supply fuel, ice and water, and provide repair services and emergency refuge. However, little modern fishery infrastructure is available in small- to medium-sized fishing ports, where a large quantities of fish are landed directly onto sand beaches, owing to the lack of landing facility.

As of 1992, there were 120 ice plants nationwide, producing 2,000 tons of ice per day. There are also 126 cold storage facilities with a combined the total capacity of approximately 20,000 tons. Thirty five state-run boatyards build and repair fishing boats, and include yards capable to building large boats with engines of more than 100 h.p. and equipped with a freezer. In addition, there are many small local yards building smaller fishing boats based on traditional technology.

Only 30-60% of boats carry ice on fishing trips. Landed fish are frequently not handled quickly and properly in landing places. In many places small sampans move back and forth between a beach and fishing boats which remain at anchor off the beaches. The unloading work requires a long time, and in the climate of Viet Nam naturally lowers the freshness of fish. Often, people gut fish on beach and "clean" them with sea water. However, since a proper drainage system and toilets are lacking in many landing places, human and domestic waste flows across the beach or directly into the sea, where it mingles with waste oil and other discharge from fishing boats. Such a situation in many fish landing places raises concern about the sanitary conditions of landed fish.

## 23. Marketing and Fish Processing

Landed fish are purchased by fish traders. The fish are then sorted by species and size, cleaned with seawater and packed with crushed ice and sometimes salt in baskets made of bamboo, rattan or plastic. Finally they are trucked to consumers, mainly in urban areas, both within a province or in other provinces.

Financially powerful fish traders provide credit to fishers to finance fishing operations and boat maintenance. They are repaid by the right to exclusive sale of the catch. Small-time fish merchants buy fish at the beach and carry it fresh to local consumers on foot or by bicycle. Most do not use ice.

The fish processing industry in Vietnam has developed remarkably over the last 15 years. Frozen shrimp accounts for an overwhelming share of the exports of marine products, accounting for 67% of total export value. Squid and cuttlefish are also important export commodities. Squid caught by angling are dried on board, and cuttlefish are caught by trawlers and exported as a frozen product. Fish are frozen in the round or filleted before exporting. There is also a limited volume of canned fish. But only 10% of the fish production of Viet Nam is currently for export markets. In the domestic market, fish are consumed fresh, salted, dried, grilled, processed to fish meal and as fermented fish sauce and other products. As much as 120,000 t/year of fish is used to produce fermented fish sauce.

## 24. Domestic Consumption and International Trade in Fishery Products

The per capita annual fish consumption, which was 18-19 kg in the late-1960s, had declined to 12 kg by 1988. The decline has continued and estimated consumption in 1990 was 10.5 kg. More recent estimates of fish consumption range from 12 kg, of which 8.4 kg is derived from marine fish to 14 kg. The share of fishery products in the total animal protein intake was approximately 50% in the 1960s and 1970s but subsequently declined to 32% in 1991.

The export of fishery products from Viet Nam increased 20-fold from 3,241 t in 1980 to 64,366 t in 1990, making Viet Nam one of the major marine products exporting countries in Asia. Export earnings of US$ 11.2 million (1980) increased rapidly to US$

305 million (1992) and to US$ 458 million in 1994, a 40-times increase.

## 25. Fish Price

Vietnamese economy was under control of the Government prior to 1975. Then food stuffs, including fish, were supplied according to the national plan, and the price was determined by the Government. The country's economic systems transformed gradually, and free markets have been established for daily consumption since 1991. Currently the relation of demand and supply is the basic factor to determine the price of fish. Actual value of fish of a species may change for difference of season, area of production, quantity of landings, strength of demand, size, freshness, etc. It is difficult to clarify price of fish at landing sites, because the catch are usually delivered through negotiation transaction between fishermen and middle men, not through auction. Table 6 shows approximate figures of wholesale and retail prices of some fishes clarified through the inquiry. There appear the general tendencies of prices of different species of fishes in this country.

Table 8. Fish price in Viet Nam (US $ / kg)

| No. | Fish Name | Wholesale | | Retail | No. | Fish Name | Wholesale | | Retail |
|---|---|---|---|---|---|---|---|---|---|
| | | 1995 | 1997 | 1997 | | | 1995 | 1997 | 1997 |
| 1 | sharks | | 1.0 | 1.2 | 21 | white croaker | 0.8 | 0.6 | 1.7 |
| 2 | ray | | 0.6 | | 22 | large-yellow croaker | 0.8 | 1.7 | |
| 3 | bigeyed herring | | 0.3 | | 23 | sea bream | | 1.0 | 1.2 |
| 4 | Indian anchovy | | 0.3 | 0.5 | 24 | wahoo | 1.85 | 2.5 | 2.9 |
| 5 | lizardfishes | | 0.5 | 0.8 | 25 | Indo-pacific mackerel | | 1.2 | 2.0 |
| 6 | barracudas | | 1.0 | | 26 | skipjack tuna | | 0.8 | |
| 7 | flying fish | | 0.5 | 0.4 | 27 | eastern little tuna | | 0.8 | 1.2 |
| 8 | giant perch | | 3.0 | 4.0 | 28 | frigate tuna | | 0.4 | 1.2 |
| 9 | red grouper | | 5.0 | | 29 | hairtail | | 1.0 | 1.0 |
| 10 | purple-spotted bigeye | | 0.8 | 1.0 | 30 | Indian mackerel | | 0.4 | |
| 11 | needlefish | | 0.9 | | 31 | common dolphinfish | | 0.8 | |
| 12 | halfbeak | | 1.0 | | 32 | billfishes | | 2.0 | |
| 13 | black pomfret | 1.5 | 1.5 | | 33 | bartailed flathead | | 0.6 | |
| 14 | silver pomfret | 1.5 | 2.0 | 3.5 | 34 | goatfish | | 2.0 | |
| 15 | yellow tail round scad | 1 | 1.0 | 1.2 | 35 | grouper | | 4.2 | |
| 16 | round scad | 0.6 | 1.0 | 1.7 | 36 | snappers | | 1.5 | |
| 17 | jack mackerel | | 0.4 | | 37 | golden threadfin bream | | 1.2 | 1.8 |
| 18 | bigeye scad | | 2.0 | 1.0 | 38 | filefish | | 1.0 | |
| 19 | amberjack | | 3.0 | 2.0 | 39 | longtail tuna | | 2.0 | |
| 20 | rabbitfish | | 1.5 | | 40 | yellowfin tuna | 2.5 | 3.0 | |

## 26. Inputs Supply and Cost

Each province has at least one government-owned boatyard and an unknown number of small, scattered private yards. Although there are some large private boatyards operating from fixed locations, most are very small temporary facilities with no infrastructure mostly in the lower reaches of rivers or on lagoon shores.

The availability of lumber, its pricing and licensing requirements vary by province and depend mainly on the area and quality of provincial forest resources. Most boatyard officials interviewed have no interest in building anything but wooden boats. However, as the price of lumber increases with decreasing supplies, and as the price of fiberglass declines, it is felt that a technological switch will begin to occur.

The price of ships varies not only by sizes of hull and engines, but also by province and shipyard. Prices found during the present survey range from US$ 5,900 for a ship of 14 m with main engine of 33Hp to US$ 91,000 for another of 26 m with main engine of 300 Hp.

Mostly used but sometimes new engines are imported from Japan and China. The cost of Japanese new engines is about 200-250 US$ per unit h.p. and approximately US$ 80-100 per unit h.p. for used engines. Two small sizes of used Chinese-made engines are used: 15 h.p. (US$ 363-545) and 18 h.p. (US$ 727). One 12 h.p. Vietnamese-made engine is widely used; they have the merit of being relatively affordable, at US$ 181, but require frequent maintenance and have a relatively short serviceable life. In contrast, Japanese-made engines are prized for their reliability. Chinese-made units are reputed to breakdown quite frequently.

Propeller supply is done by small private workshops in all five landing sites. The purse-seiners that use light attraction have a generator set on deck. Such generators are generally rigged-up from an old truck engine fitted to an alternating current generator. In the Southern Region the larger gill-net boats are equipped with home-made net hauling gear, using automobile wheel rims, worn-out tires and powered by off-take from the boat engine. For radio, echosounder and navigation equipment, there are no official suppliers.

Fishers obtain gear-making materials on the open market from private suppliers and fabricate (and repair) nets at home, using household and crew labor.

There is wide variation of price among fishing gears of different types and sizes. Data collected by the present survey show the range of price from US$ 450 to 2,000 for trawl nets, US$ 4,550to 14,500 for purse seines, and US$ 540 to 17,500 for gill nets.

## 27. Credit

Credit and other financial services are obtained from a variety of formal and informal sources. Within the former, banks play the predominant role, whereas within the latter, the main credit suppliers are family members. However, most boat-owners raise credit by combining funds obtained from a bank with those raised from one or more sources in the informal sector. Despite recent striking advances in the provision of formal financial services in Viet Nam, informal sources remain pre-eminent in fishing communities.

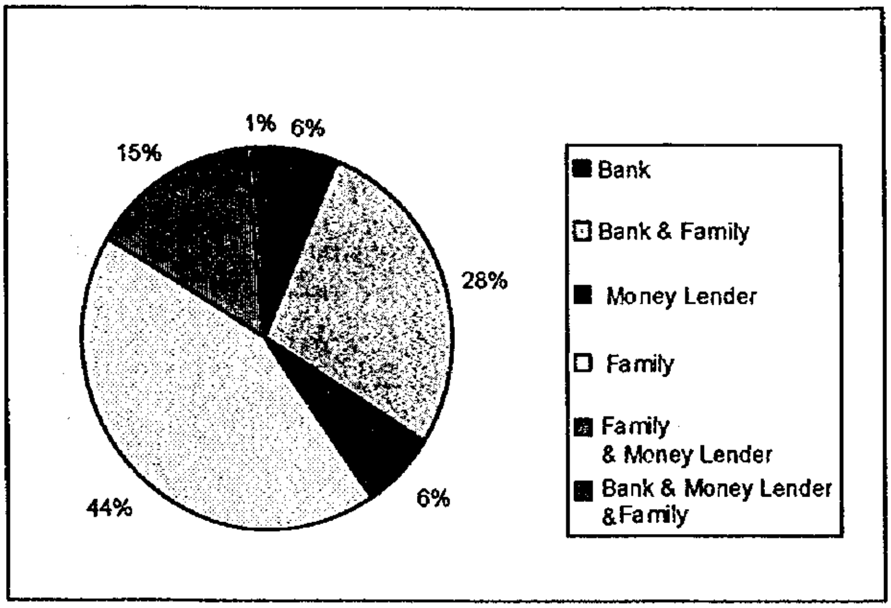



Figure 14. Source of capital of boat-owners surveyed

The sources of credit used by boat-owners to build new boats to purchase engines, gear and other essential equipment is shown in Fig. 14. First, the most popular way of raising funds is credit from family members and 44% (n=79) of respondents fall in this category. In addition to reflecting the general scarcity of collateral among boat-owners, especially those who are not already relatively well-off, this is a reflection of the high cost and short term of bank loans.

### 28. Standards of Living

Although fishing households frequently also own agricultural land, the amount owned is generally far less than for other categories of household. Fishery households possess a very small percentage of the total national stock of livestock and other agricultural assets. Average *per capita* annual incomes in fisheries households are 1.9 times higher than those for Viet Nam as a whole. The figures demonstrate an increase in fisheries household incomes from north to south, from USD 232 in Dong Hoi to USD 690 in Vung Tau. At the national level, fishing households ownership of the main consumer durable goods -- radio, television and motorcycle -- is below average. Fishery households are not well housed. Only 9.8% occupy "permanent" dwellings, compared with a national average of 11.9% (Source: GSO 1995)

### 29. Fisheries Management

In Viet Nam, there have been four major pieces of legislation, in the form of either declarations or decrees, which are of importance to the management of marine fisheries. At the national level fisheries operate under an open access system. The MOF limits the total effort permitted on each fishing ground and this limit is made known to the provinces as a principle. Each province allocates entry rights first to boats from its own province, then to those from other provinces. In addition to paying tax to their province of registration, outsider boats must pay tax to the province in which they fish.

The government of Viet Nam faces a major problem in trying to enforce existing marine capture fisheries legislation, since fishers are apparently unaware of national fisheries laws and regulations, and base their operations mostly on local rules. An ADB/FAO report notes "given the length of the coastline, the marked differences among regions and the difficulties of monitoring, surveillance and enforcement, delegation of resource management functions - within the umbrella of an appropriately flexible national framework - to local institutions, including fishermen organizations, appears to be the only workable solution to these problems".

**30. Voices of Fishermen**

The interview survey was conducted to fishers about the problems and issues they confront Their comments are grouped into four categories as follows in unranked order:

(a) expectations and aspirations for the future

1 construction of a larger fishing boat

2 exploit offshore fishing grounds

3 capital, including long-term credit

4 install modern devices like echosounder, radio, GPS

5 conversion to other fishing techniques

(b) constraints

1 taxes too high

2 inadequate equipment and/or funds

3 resources depletion

4 gear conflict with other fisheries

5 increasing number of fishing boats

(c) positive development perspectives

1 Larger boats and engines will enable fisheries development.

2 Advanced equipment will enable fisheries development.

3 Offshore areas have under-exploited fish resources.

(d) negative development perspectives

1 declining catch owing to reduced resources

2 depleted coastal fishing grounds

3 an increase in the number of fishing boats

4 foreign vessels intruding into local fishing grounds

These positive and negative views are not necessarily mutually exclusive; many consider that advance to further offshore fishing grounds by building a larger and powerful boat is the only solution to the ever-deteriorating situation of coastal fisheries.

## 31. Pelagic fish resources in offshore waters and possibility of exploitation

### 31-1. Conditions of stock assessment

The target species for the Study Team are mostly large-sized pelagic fishes inhabiting the offshore waters of the Exclusive Economic Zone of Viet Nam, which come to the sea surface and adjacent layer in night time. In order to convert the relative abundance indices to the biomass of stocks based on test fishing of surface drift gillnets with different mesh sizes from 73 mm to 160 mm, it is indispensable to clarify the behavior of subject fishes such as diurnal migration, vertical movement, swimming speed, seasonal migration, response to fishing gears, and so forth, together with catchability coefficient of the fishing gears used for the tests (Ishida 1986, Ishida et al. 1985). Furthermore, it is required to check the estimated values of abundance with those of different sources, such as analysis of catch and effort statistics, or direct measurements of standing crops. Without these items of information, we examine data obtained by the current surveys.

### 31-2. Summary of abundance indices and utilization of fish aggregating device

Total abundance indices of all fishes and cephalopods obtained in each of three sea-borne surveys from the 2nd to 4th cruises range between 2,507 and 2,981, and the average is 2,742 (Table 7). The indices include two large-sized rays of *Manta* and *Mobula*, but excludes dolphins and porpoises, turtles and sea birds. The indices excluding the two large-sized rays are 1,971 in the 2nd cruise, 2,170 in the 3rd cruise and 2,411 in the 4th cruise, and average as 2,194.

Thus, combined abundance indices of all the species stay at a fairly stable level. However, the indices of individual species of commercial value show wide variation between the three cruises. In other words, total pelagic resources retained by the surface drift nets with mesh sizes of 73 mm to 160 mm showed fairly stable abundance throughout the three survey periods. But the figures seem to be lower than those in other major fishing areas.

Table 7. Summary of abundance indices in terms of weight during three cruises in 1996 and 1997

| Code | Species | 2nd cruise | 3rd cruise | 4th cruise | Average |
|---|---|---|---|---|---|
| 72 | *Katsuwonus pelamis* | 418 | 531 | 806 | 585 |
| 54 | *Coryphaena hippurus* | 388 | 280 | 245 | 304 |
| 68 | *Auxis thazard* | 92 | 228 | 292 | 204 |
| 78 | *Istiophorus platypterus* | 202 | 120 | 163 | 162 |
| 80 | *Makaira mazara* | 292 | 167 | 0 | 153 |
| 79 | *Makaira indica* | 67 | 262 | 0 | 110 |
| 69 | *Auxis rochei* | 54 | 14 | 207 | 92 |
| 103 | *Sthenoteuthis oualaniensis* | 119 | 58 | 81 | 86 |
| 81 | *Tetrapterus audax* | 0 | 0 | 232 | 77 |
| 57 | *Brama orcini* | 56 | 130 | 27 | 71 |
| 58 | *Lobotes surinamensis* | 66 | 67 | 52 | 62 |
| 73 | *Thunnus tonggol* | 0 | 35 | 47 | 27 |
| 74 | *Thunnus albacares* | 4 | 69 | 7 | 27 |
| 71 | *Euthynnus affinis* | 10 | 30 | 17 | 19 |
| 75 | *Thunnus obesus* | 4 | 8 | 42 | 18 |
| 55 | *Coryphaena equiselis* | 13 | 14 | 27 | 18 |
| 82 | *Xiphias gladius* | 0 | 0 | 33 | 11 |
| 96 | *Aluterus monoceros* | 2 | 27 | 0 | 10 |
| | Others | 184 | 130 | 161 | 158 |
| | Subtotal | 1, 971 | 2, 170 | 2, 441 | 2, 194 |
| 10 & 11 | *Manta & Mobula* | 536 | 811 | 298 | 548 |
| | Total | 2, 507 | 2, 961 | 2, 738 | 2, 742 |

The Japan Marine Fishery Resource Research Center (JAMARC) conducted trial fishing with surface gillnets in different parts of the Pacific Ocean during 1978 through 1990. The figures of CPUE of catch in weight ranged between 3.8 kg and 20.0 kg. The figure obtained in the present survey is 1.1 kg, and lower than any of indices found by the JAMARC surveys. Namely, the present value is only 1/20 of the highest of the JAMARC's figures, and only 1/3 of even the lowest.

All the species listed in Table 7 have commercial value, but were not found aggregating so densely as to form profitable fishing grounds. Exploitation of scattered fish schools requires use of fish aggregation techniques to raise efficiency of fishing operation. For exploitation of yellow fin and skipjack tuna in the equatorial Pacific Ocean, the schools are captured after being aggregated densely either by porpoises in the eastern areas, or by fish aggregating devices, FAD, introduced later in the western areas. Efficiency of payao's and other surface FAD's are proved for catching dolphin fishes and others. Fish lumps play an important role for some fisheries in the western Pacific ocean.

Systems for retaining order of the sea area is indispensable for assuring efficiency of FAD's, which are accidentally broken by other fishing boats, or which cruising ships erroneously destroy, or willingly steal already retained fishes.

**31-3. Approximate evaluation of yields required to investments**

As the first step for the resources survey aiming at fishery development in the offshore waters without sufficient basic information, the scientific activity intended to clarify the names of existing species, identification of commercial importance and level of catch rate expressed by yields per unit effort as a measure of profitability of exploitation.

The next step is the determination of promising species and size of offshore operations. To answer the second step question, it is requested to evaluate biologically allowable catch (ABC) and optimum fishing effort in number of boats or fleet size, and also performance of fishing boats, type of fishing gear, optimum size of investment, operating cost, expected revenue, season for operation, stability of supply and others.

The land site survey provides information on requested economic factors, even though it is sporadic. In case of a wooden boat of 26 m in length, total investment reaches to about US$ 131,000 for the hull, second-hand Japanese engine of 300 Hp and gillnets of 7 km in length. The depreciation per annum is expected at about US$ 24,000 on the assumption that the decreciation period is six years for the ship and three years for the fishing gear.

In the case of a certain fishery, the operation including fuel, ice and food for crews costs about US $ 245 per day. If this running cost applies to a newly built boat, the annual sum would reach US $ 49,000 in the case that the ship cruises ten times a year, each lasting 20 days. It must be noted that the estimates does not include labor expense for the crew members. According to the landing site survey result, per capita annual income is US $ 252 in average for marine fisheries households. If this figure applys to a fishing vessel of 20 crew members, annual labor expense will be about US $

50,000. Assuming that the owner's share equals to the total crew's share, he also obtains US $ 50,000. The other expenses that the owner must cover includes rents of such facilities as offices and warehouses, utilization of vehicles, personnel, communications and transportation, fuel and light, taxes, interests, insurance etc.

On this basis the sum of depreciation, running coasts, wages and owner's share makes up approximately US $ 173,000 in total. This is the minimum requirement not including the expense for maintaining the fishery operation as well as the above expenses for land operations. This does not include maintaining fishery operation equipment which covers radar, wireless communication devices, fish finders, FADs etc. The total expense is anticipated to significantly exceed the minimum requirement of US $ 173.000.

The catch required to yield the minimum financial requirement amounts about 216 tons of skipjack tuna with a whole sale price of US $ 0.8 per kg. Assuming that 300 boats will be operated, it is necessary to land 65,000 tons of this species to pay back the minimum requirement.

The figure of 65,000 tons of skipjack tuna is compared with production of the species in the southeast Asian countries during the latest three years from 1993 to 1995. The figure is significantly less than the Indonesian catch of 138,000 tons from the central western Pacific Ocean but reaches 75 % of the Philippines catch of 87,000 tons, and exceeds twice of total catch from the eastern Indian Ocean, 29,000 tons. It is unrealistic to expect this as the initial production from the newly introduced fishery aiming at large-sized pelagic fishes in the Vietnamese offshore waters. In other words, large-sized fishing boats of 300 tons and a large fleet of 300 boats appear to be an extreme over-investment. It may be difficult to pay back the large investment through the yields of the fleet and to develop sound fishings. It should be added, however, that the present consideration does not cover the possible development of newly utilized demersal fishes in the water deeper than 40 m, small-sized pelagic fishes in the offshore waters, and migratory fishes the mid or deeper layers.

**31-4. Biological features of major species**

**(1) Skipjack tuna**

The world catch of skipjack tuna has shown dramatic increase from 250,000 tons in 1980 to 1,250,000 tons in 1994, indicating possible high productivity of the resources. The fisheries have expanded in many parts of the world in addition to traditionally stable fishing grounds.

The present surveys obtained three size groups of this species including small (less than 37 cm), medium (between 37 cm and 49 cm) and large (over 49 cm), which appear to be aged as 1-, 2- and 3-year and older. It is noted that the present surveys include smaller fish than those reported in the previous literature. On-going commercial fishery exploits mostly 3-year and older fish.

Length (L) - weight (W) relationship was $W=0.0134\ L^{3.2931}$ by basing on skipjack samples obtained in the present surveys and parameters of Von Bertalanffy's growth equation were $L_{\infty} = 87.26$ and $K = 0.3075$.

Skipjack tuna is the most prolific large-sized pelagic species found in the world oceans. Thus, it is one of the most promising stocks in the Vietnamese waters. It should be kept in mind that the fishery may not capture significant amounts of 1- and 2-age fish before sexual maturation.

**(2) Common dolphinfish**

According to the FAO Yearbook of Fisheries Statistics, the world catch of this species is reported to range between 20,000 tons and 40,000 tons. The northwestern Pacific Ocean produces 60 to 70 %, mostly by Japanese and Taiwanese fisheries. Recently the production has been on the decrease in Japan, and on the increase in Taiwan. Szyper and Lutinesy (1991) point to importance of dolphinfish not only for capture fisheries but also mariculture in the tropical areas. Bannister (1976) also notes the importance of this species in the Mediterranean Sea. According to Norton and Crooke (1994), dolphinfish comprises nearly 10 % of the harvest of sport fishing boats in southern California.

Samples taken by the present survey were about 45 cm in mean fork length, mostly 0- and 1-age individuals, thus smaller than those reported in the previous literature. Length (L) - weight (W) relationship was $W=0.0182\ L^{2.6123}$ and parameters of Von Bertalanffy's growth equation were $L_\infty = 86.6$ and $K = 0.2456$. This species is expected to be harvested by offshore fisheries, because of the possible high growth rate and low maturation age, both indicating high turn over rate of the biomass. Nevertheless, management of the stocks immigrating to coastal waters should be executed for both coastal and offshore fisheries.

**(3) Frigate and bullet tunas**

Average body length of samples taken during the present surveys were 36 cm for frigate tuna and 26 cm for bullet tuna, both smaller than the corresponding figures given in the previous literature. For frigate tuna, length (L) - weight (W) relationship was $W=0.0151\ L^{3.1787}$ and parameters of Von Bertalanffy's growth equation were $L_\infty =$ 48.43 and $K = 0.4201$. Length (L) - weight (W) relationship for bullet tuna was $W=0.0154\ L^{3.0206}$. Low maturation age of these two species implies high turn over rate and biotic productivity of the biomass. Since these fish immigrate the coastal waters, appropriate stock management will be needed in both coastal and offshore fisheries.

**(4) Flying squid**

The reported catch of flying squid amount only 40 tons in Okinawa with the use of jigging and 100 tons in Taiwan. Nevertheless, the resources of the large-sized oceanic mollusc appears substantial. It is reported to be dominant in the waters around Hawaii, and comprised a major portion of miscellaneous squids incidentally caught by experimental fishing aiming at jumbo flying squid *Dosdias gigas* in the eastern Pacific Ocean from California to Peru. During the FAO Indian Ocean Development Programme, the R/V Shoyo Maru sampled substantial numbers of flying squid of 18 to 50 cm in mantle length. Pinochukov (1989) estimated potential allowable production of cephalopods including flying squid in the Indian Ocean to be as large as about 500,000 tons. Yatsu (1996) includes flying squid in the most promising underdeveloped biotic resources in the open ocean.

During the present surveys, flying squid were taken only by the nets of smallest mesh size of 73 mm. Frequency distribution of mantle length shows a single mode at around 190 to 230 mm. Lack of nets with small mesh below 73 mm does not permit one to be certain of the composition of population in the sea. Nevertheless, the present samples seem to represent the gradually maturing group. Mantle length (L) - body weight (W) relationship was $W=0.0962\ L^{2.066}$. Biomass of the species seems significant, but variable widely because of short life span of one year. It is required to establish a system to predict and manage the stock through accumulating information on growth and maturation.

**(5) Bigtooth pomfret**

Samples taken during the present survey were about 25 cm in mean fork length. Length (L) - weight (W) relationship was $W=0.0211\ L^{2.8692}$. Pomfrets seem to be abundant in the Pacific Ocean. Insufficient biological information on the species under discussion dictates gradual expansion of fishing activity through control of allowable catch for safety.

**(6) Tripletail**

The present surveys captured specimens of 32.5 cm in mean body length, smaller than those reported by Froese and Pauly. Length (L) - weight (W) relationship was $W=0.0187\ L^{3.0146}$. Only fragmental biological data of this species is available, and exploitation needs regulation through gradual increase of allowable catch for safety.

**(7) Billfishes**

Mean body length of specimens taken by the present surveys were at around 146 cm for sailfish, 188 cm for black marlin and 172 cm for blue marlin, all smaller than than those reported in the previous literature. Especially, samples of sailfish and blue marlin comprised young fishes of less than 10 kg in body weight.

There is concern regarding the decline of billfishes, together with bigeye tuna, due to exploitation (CITES). International cooperation is required for managing these stocks. Even though no international organization exists in the sea area around Viet Nam, it is necessary to pay attention on investigation and other activities on these stocks conducted by SEAFDEC and ICLARM.

**(8) Longtail tuna**

Specimens collected during the present surveys appeared mostly 1- and 2-year old, about 30 cm for the average in fork length, smaller than those reported in the previous literature. Low age of maturation implies high turn over rate of the biomass, and there is the possibility of exploitation in offshore fisheries. The fish inhabits the coastal waters at young stages and stock management should be designed so as to regulate fisheries in both coastal waters and offshore waters.

**(9) Eastern little tuna**

The mean fork length of specimens taken in the present surveys was about 36 cm, being significantly smaller than those reported in the previous literature. Low maturation age implies high turn over rate of the resources, and possibility of substantial harvest for offshore fisheries aiming at the resources. Because of occurrence in the coastal waters, management of the resources requires regulation of exploitation by both coastal and offshore fisheries.

**(10) Yellowfin tuna**

The present surveys caught small sized fish, 46 cm in mean fork length, mostly 0- and 1-year olds, compared to the data reported in the previous literature. The resources already showed very large productivity in the world's oceans. It is possible to develop offshore fisheries aiming at this species in Vietnamese waters. It is important to regulate the fisheries so as to avoid over harvesting of young fish before maturation.

**(11) Bigeye tuna**

Mori et. al. (1996) note that optimum temperature for bigeye tuna in the Indian Ocean ranges between 10℃ and 16℃, almost identical to the record of 10℃ and 15℃

in the Pacific Ocean. Habitable depth by bigeye tuna extends beyond 300 mm, deeper than distribution range of other tuna species.

Specimens taken during the present surveys consisted of mostly 0-age fish, of about 27 cm in mean fork length. Sea surface temperature in the survey area was significantly higher than the optimum temperature of bigeye tuna. Thus, the experimental operation failed to catch grown fish that might have stayed in far deeper layers from the surface even at night. Longline is required to catch the grown fish from the deep layers.

It should be noted that bigeye tuna, together with billfishes, as mentioned earlier, are considered to have been heavily exploited (CITES), and international organizations are requested to undertake management of the resources.

## 32. Basic Concept of Fisheries Management

The proposition for the management of fishery resources is to find effective means for the utilization of the living resources in Asian countries where efficient utilization of food is most important. The object is the achievement of the maximum utilization by harvesting of the optimum number of individuals at the most suitable size.

Generally speaking, the regulation of fishing activities is the only practical and efficient means for management of a nation's offshore living resources. Three major principles for fishing regulation are; the avoidance of over-fishing, the protection of larvae, juveniles and under-sized fishes, and the protection of spawning sites and spawners.

Actual enforcement of fishing regulations are conducted through measures either in advance of operation or in the process of fishing. The former includes the limitation of fishing gears, of the amount of fishing effort, of the size of fish to be landed, of the mesh size of nets; and the establishment of closed seasons and closed grounds. The establishment of quotas represents one aspect of the latter type of regulation.

Typically fishery management aims primarily at the economic effect to maximize profits from fishing operations. It is to be noted that the resource is one of the concepts of economics, thereby resources management is a subject within fishery management.

Real components of fishery management are divided into economic elements and social elements. The economic elements consist of price of catch (appraisal of price of products on balance of demand and supply), the processing and distribution of fishery products, the running of the business, profits from associated business and so forth. There are social elements such as management regime including policies, allocation of quota, control etc. and the management system covering size, operation, self-regulation, consent formation etc.

## 33. Guide Line for Fisheries Resources Management

In the case of demersal stocks, apparent figures of standing stocks are obtained by experimental operation of trawl nets that provide average density of fish and extent of distribution range. In the newly exploited fishing grounds, the size of standing stock is considered as the carrying capacity, $B_0$. Since the fishing mortality coefficient for the maximum sustainable yield (MSY) is known to be near the natural mortality coefficient, M, in some fishing grounds, Gulland (1970) expressed the first approximation of MSY by $0.5MB_0$. It is recommended to select the total allowable catch at a level far less than the first approximation of MSY, and then set the number of boats sufficient to harvest the defined catch. After commencement of commercial operation, the fishermen are asked to submit records of their fishing operations, in order to estimate more reliable relative abundance or catch-per-unit of effort than that based on data of one or a few research vessels. It is realistic to undertake such management schemes and to increase number of fishing boats gradually after confirmation of stability of CPUE based on the catch records of the fishing fleet.

The above principles are applicable to the management of pelagic fishes. As a matter of fact, total allowable catch of yellowfin tuna increased substantially by the expansion of fishing operations increased gradually with careful examination of the relative abundance or CPUE (IATTC 1975).

The present report excludes significant demersal fish resources on the offshore area of the continental shelf and the continental slope, deeper than 40 m, which are extensively surveyed under the DANIDA Programme. The target species for the present Study are mostly large-sized pelagic fishes inhabiting the offshore waters of the Exclusive Economic Zone of Viet Nam, which come to the sea surface and adjacent layer at nighttime. Pelagic fishes swimming in deep layer even in nighttime, like bigeye tuna and yellowfin tuna, were not caught in surface drift gillnets. Also no information was obtained on small-sized pelagic fishes of the genera Rastrelliger, Decapterus, Sardinella and Stolephorus, due to large mesh size, 73 mm or wider, of drift gillnets,.

Many fishes may decrease significantly with the progress of exploitation. Apparent high figures of abundance at the initial stage of exploitation may attract investments and the resultant increase of fishing boats could cause over-exploitation. Taking into account the considerable difficulty to reduce number of boats from an over-capitalized fleet, it is recommended to introduce planning of the rational harvest.

The drastic reduction of the number of fishing vessels must assert a very strong impact on society in countries essentially depending food and income from fisheries. In these countries, any license system based on both size of stocks and social features must be more realistic than the free access and simple TAC system.

Yamamoto (1996) reported that catch limit system is logical but it is so difficult and costly in its implementation in developing countries therefore recommended that "open access policy" be terminated as early as possible and a community based fisheries management system (CBFMS) be adopted under a form of "limited entry policy".

### 34. Policy Considerations and Recommendations

The promotion of fisheries needs a comprehensive support service providing various elements of both hard- and soft-ware. They are, preservation of environmental conditions, construction of fishing ports, improvement of facilities for fisheries villages, the establishment of distribution and processing systems, the expansion of financial systems, technical renovation including production techniques, organization and education of fishery workers, the improvement of legislative systems, the reinforcement of administrative systems including the adoption, execution and enforcement of policy, establishment of information collection systems including fishery statistics and finally the encouragement of scientific investigation.

In regard to fisheries development in Viet Nam, it is realized that the master plan has been already completed, and the present activity has proceeded to the stage for examining action plans in individual fields. Taking it into consideration, here are given related plans for development of large-sized pelagic fish resources in the offshore waters, as well as some other related aspects, namely several proposals for development of fisheries covering experimental operation in offshore waters by semi-commercial fleet, fisheries statistics, continuation / expansion of scientific research on the living resources, reconsideration of fishery regulation, organization of fishermen, expansion of distribution of fishery products by means of improvement of preservation and processing, technical innovation, expansion of activities of patrol-, guard-, guiding- and research- vessels and fisheries infrastructure development.

### 34-1. Test fishing in offshore areas by semi-commercial fleet

Feasibility of target offshore area should be identified by test fishing of a sizable fleet. It is desirable to employ several fishing boats with national license to explore commercially feasible fishing grounds of large sized pelagic species such as skipjack tuna, common dolphinfish, etc. These vessels should operate in the whole fishable area as evenly as possible, not concentrating on specific spots.

Total fishing should be conducted throughout the year, so as to obtain information on distribution and migration of fish as well as expected revenue from the operations. The data of such test fishing provides us with information of practicability of commercial operations in these areas.

The fleet is prohibited to operate in the coastal waters. Promising fishing gears may include trawl nets, purse seines, gill nets, longline and hand lines. It is required to operate the fleet throughout a year in the offshore waters by utilization of any possible method such as *payao* for aggregating pelagic species, and use of offshore longline for pelagic fish living in deep layers.

### 34-2. Fisheries statistics

Compilation of fishery statistics covering amount of catch, amount of fishing effort, and some other item is necessary in forming the initial requirements for establishing management schemes of fishery resources. Fishery management starts with the collection of statistics and ends at the re-examination of statistics. It is believed that a considerable portion of the marine catch goes unrecorded in Viet Nam. There is an urgent need in Viet Nam to establish a comprehensive fisheries statistics and information system.

In the long-term, the Fisheries Information System should be computerized, on-line, and accessible to all national and provincial level scientists, managers, policy-makers, and commercial entities. In the beginning, however, this must be established as a database, recording catch and effort data - including distribution and length frequency of species - at all main fishing ports. A national Geographical Information System (GIS) specifically for fisheries is desirable in the future.

### 34-3. Continuation and expansion of scientific survey on fisheries resources

It is required to obtain basic scientific information useful for rational fishery development and stock management by continuing and expanding scientific investigation of major fisheries resources. Stocks or subpopulation will be identified for executing resources management by each of the subunits of a species population, if possible. Research must cover biological parameters such as spawning grounds, spawning seasons, migratory routes, growth, maturation, mortality etc., taking subpopulation into account. Knowledge of behaviour of fishes play important role for development of effective fisheries. For this purpose, effective fishing gear for survey must be selected based on data of selectivity inherent to different fishing gear against different fishes. It is desirable to introduce split-type fish finders with excellent ability to investigate fish shoals.

### 34-4. Reconsideration of fisheries regulation

Development and management of fisheries resources are based on consistent regulatory systems related to the activities. Impoverishment of coastal resources due to over-exploitation is apparent. To offset poor catches in coastal waters, fishermen have ventured into offshore areas using larger and better-equipped boats. It is not difficult to foresee further enlargement of Vietnamese fishing boats in the future, but since the resources of fishing grounds are finite, such expansionist strategy will eventually meet its limits. Fisheries management plans for the rational use of offshore resources must be formulated, and the up-grading of the fishing fleet properly managed.

There has emerged a successful fisheries management programme by collaborating provinces in the Southern Region; Kien Gian Province, Minh Hai Province and small neighboring provinces have jointly set up a local management regime to enforce regulation in a coordinated manner. The experience of these provinces should be examined thoroughly for application to the rest of Viet Nam.

Wide-spread complaints from legitimate local fishermen themselves is a result of the lax attitude of provincial authorities towards fishermen using illegal fishing methods such as dynamite and toxic materials. The government of Viet Nam should begin a determined programme to prevent these illegal activities.

**34-5. Fishermen's organizations**

After the "Doi Moi" reforms were initiated, old cooperatives were either abolished or ceased functioning. In fisheries sector, the situation of farmers' organisations resembles to that in the agricultural sector, though much less attention is paid to this issue. An overwhelming majority of fishermen who express clear resentment to the former government-controlled cooperatives are not actually informed of fundamental difference of service cooperatives from those failed cooperatives. It seems that local fishermen are not pressed with the needs for their own organisation at least at this time, but the lack of such organisations would not only undermine their benefits but also hamper sound fisheries management and development planning.

In Nghe An Province, there used to be 60 fishery cooperatives in the 1980s, and now only five of them are still operational. However, amid such a sharp decline in the cooperative sector, there is a spontaneous development of an unique service cooperative. For instance, 160 fishermen of 9 fishing boats belonging to Hai Don Cooperative have transformed their cooperative to company-like modality to strengthen its services of supplying ice, fuel and fishing gear in a favourable condition and marketing their catch. One of the most recommendable policy for the government is to study on this and other spontaneous developments of similar fishermen's organisation in order not only to support their institutional evolution but also to disseminate information to fishing communities throughout the country.

It is recommended that fishermen's organisation should not be interpreted as having negative reactions towards various fish marketing systems operating in Viet Nam, including market intermediaries. Fair attention should be given to market intermediaries and in particular to fully elucidating their credit, employment generation, investment and other roles in fisheries as well as other rural economic sectors beyond just fish marketing.

It is essential to educate workers to run the infrastructure and facilities efficiently, and also to operate their own organizations. The Japanese system for fisheries extension service (SUISAN KAIRYOU FUKYUUIN*) is stationed in prefectural governments and seems to be helpful for planning official support to the fishermen's activities in regard to extension services for information, improvement of fishing gears, collection of catch data, renovation of the running of industry, and the establishment of orderly fishing operations. (*: This service cooperates with its administration department and research department. The personnel of the department are stationed in the field and perform the above-mentioned activities in close relation with fishermen.)

The training center for new fishing technology and for fishery management techniques are useful tools in fisheries education.

### 34-6. Retention of catch freshness and expansion of markets through processing

Most fishery product prices fall extremely quickly due to the rapid deterioration of product quality after harvest. The retention of freshness of catch is considered very important in every process from catching the fish through to receipt by the final consumer. It is desirable to construct cold-chain systems at every step of the distribution chain including fishing vessels, landing sites, markets, carrier-vehicles, retail shops and home kitchens.

Processing is another major field related to the distribution of the catch. Processed goods are distributed over far wider markets than the fresh fish. The processing industry often creates many job-opportunities for female workers in local community.

**34-7. Technological improvement**

Almost all fishing boats in Viet Nam are lacking in electronic equipment, such as location devices, echo-sounders and communications equipment which is particularly imperative for ensuring crew safety. Technological improvement of fishing gear is also required to use it in offshore waters at relatively low investment costs to fishing boat-owners.

The initial and limited trials to assess the technological and economic feasibility of using fiberglass composite fishing boats should be expanded. This should include scraping measures of unusable FRP boats as well as the need for technical training of boatyard managers, craftsmen and general workers.

It is recommended that an urgent feasibility study linked with pilot projects be conducted on the use of standard fish boxes at sea for marketing, distribution and storage on land. This should be linked with other infrastructure changes recommended for fish landing sites, and with the provision of a reliable, adequate and sanitary ice supply. The use of standard fish boxes is also effective to accumulate statistical catch data.

**34-8. Expansion of activities of patrol-, guard-, guiding- and research- vessels**

The steady and continuous development of offshore fisheries needs the establishment of the Exclusive Economic Zone and the enforcement of the rights of jurisdiction therein. Orderly fishing activities are required not only from domestic fishing vessels, but also from foreign vessels. It is often problematic to keep foreign operators from illegal operations and poaching. A fleet of patrol and enforcement ships must be intensified in order to cope with such difficulties.

One requisite for efficient development of the marine fishery is the enthusiasm and active participation of fishermen to the test fishing, data collection, technical renovation and so forth. In addition, systematic monitoring must cover the oceanographic factors, distribution and abundance of the living resources, and key biological parameters. Results of studies based on research activities must be supplied to fishermen to keep them aware and supportive of the current situation and of forecasts for fishing grounds, composition of available stocks and other information for catching operations. These activities are executed only with the benefit of sufficient guiding and research vessels.

### 34-9. Fisheries infrastructure development

Poor fisheries infrastructure is the most crucial issue in the fisheries sector of Viet Nam. The government and donor communities have focused on the improvement of obsolete infrastructure or the lack of it. Poor post-harvest fish handling on Vietnamese fishing boats is compounded by improper and often insanitary handling after landing, leading to rapid deterioration in the quality of the catch. The contamination of fish, consequent loss of value and potential hazards to human health are real threats to the fishing industry, in particular to the fish exporting business, as well as to the general public.

In terms of social infrastructure for fishing communities, very poor conditions are similarly observed ubiquitously. The accelerated development of the fisheries sector has been accompanied by the rapid expansion of the population engaging in fishing and fishery-related occupations. People in the communities can not generally afford either tapped water or a toilet in their houses. It is critical for the government to tackle this issue early whilst inexpensive to remedy.