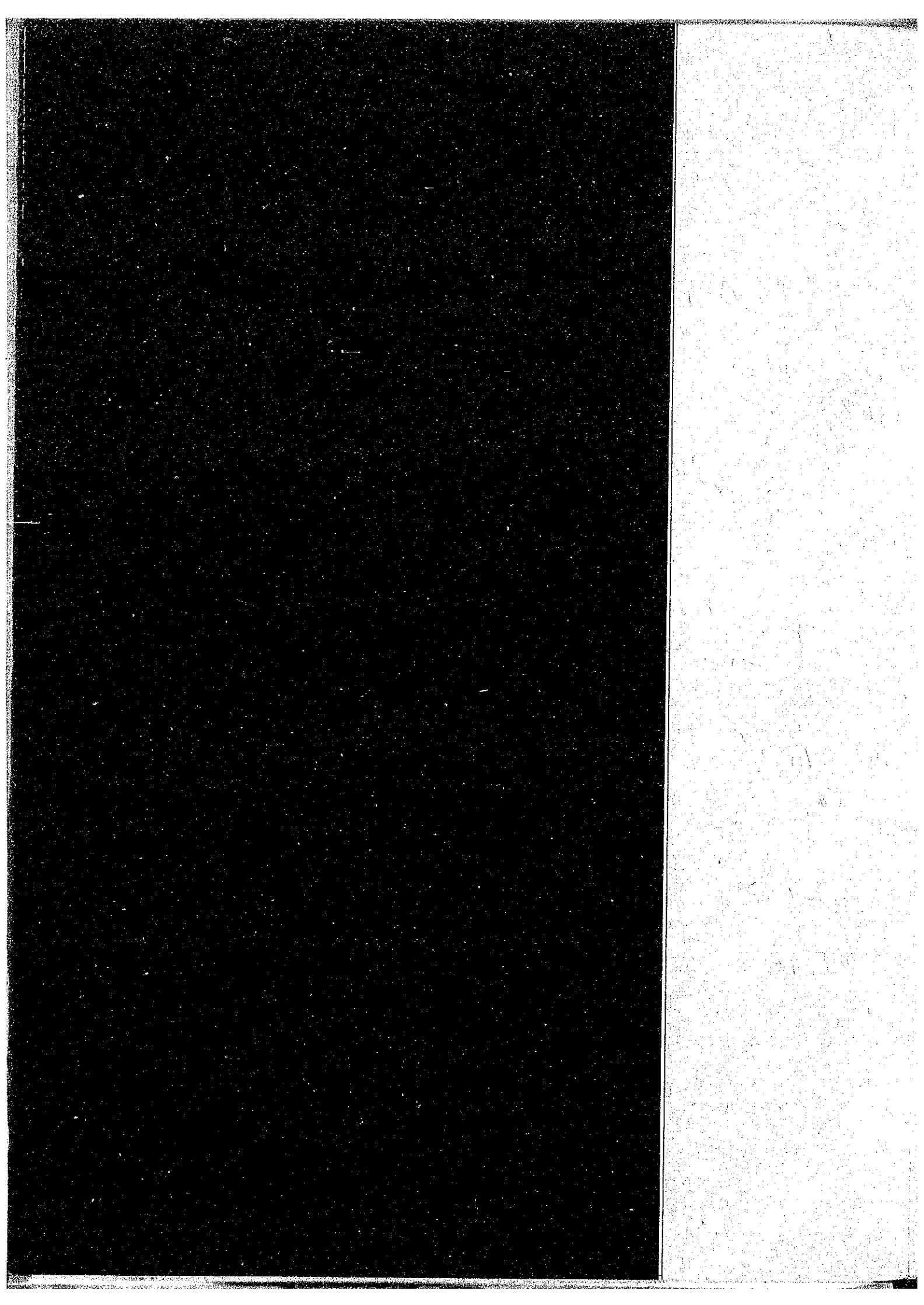


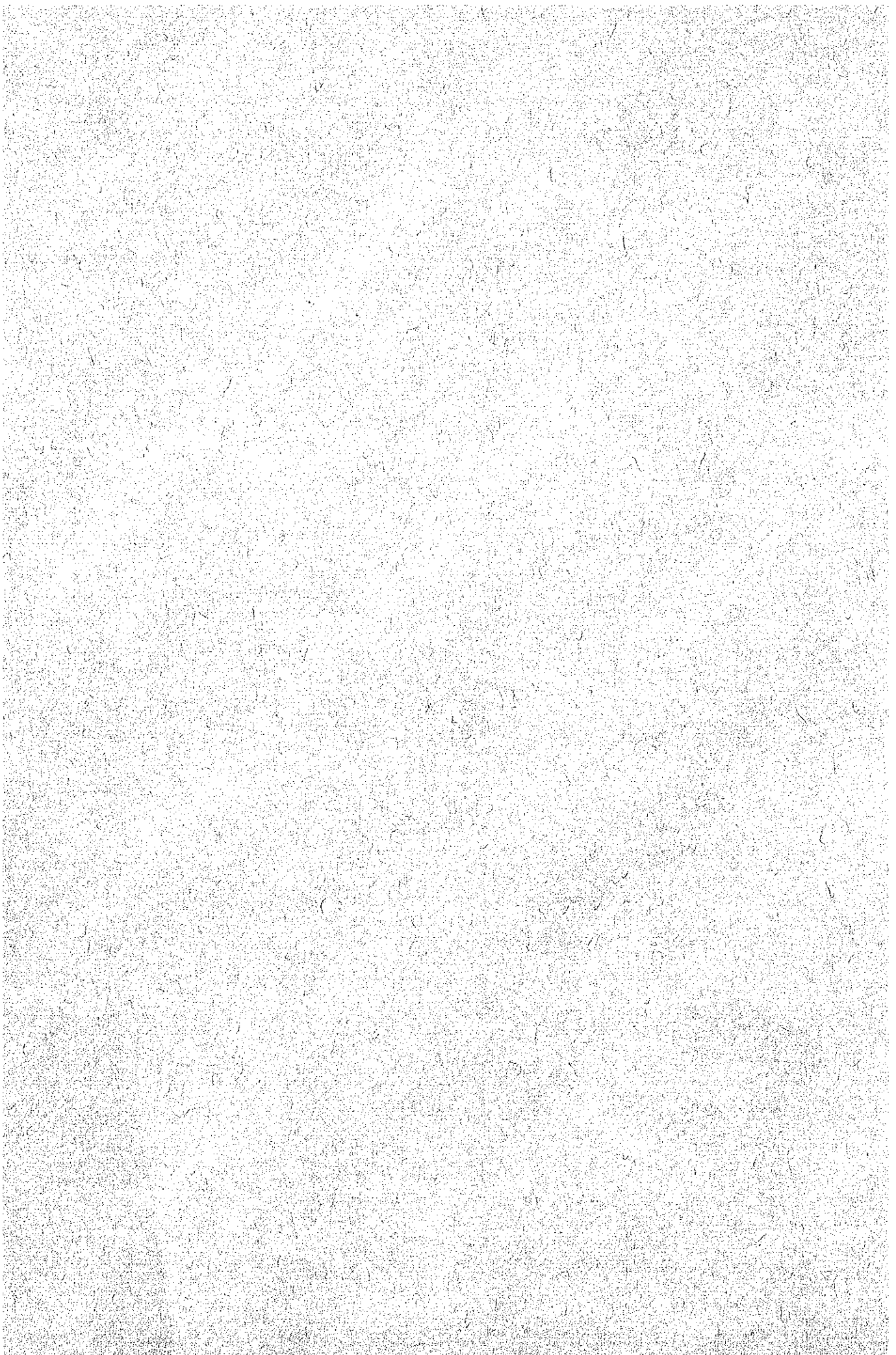
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GOVERNMENT OF MALAYSIA

**NATIONAL WATER RESOURCES
STUDY, MALAYSIA**

SECTORAL REPORT

VOL. 12

INLAND FISHERY

OCTOBER 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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COMPOSITION OF THIS VOLUME

This Volume consists of two parts: Part 1 deals with the subject matters of Peninsular Malaysia and Part 2 is devoted to the States of Sabah and Sarawak.

ABBREVIATIONS

(1) Plan

FMP	:	First Malaysia Plan
SMP	:	Second Malaysia Plan
TMP	:	Third Malaysia Plan
4MP	:	Fourth Malaysia Plan
5MP	:	Fifth Malaysia Plan
6MP	:	Sixth Malaysia Plan
7MP	:	Seventh Malaysia Plan
NEP	:	New Economic Policy
OPP	:	Outline Perspective Plan
RESP	:	Rural Environmental Sanitation Program

(2) Domestic Organization

DID (JPT)	:	Drainage and Irrigation Department
DOA	:	Department of Agriculture
DOE	:	Division of Environment
DOF	:	Department of Forestry
DOFS	:	Department of Fishery
DOM	:	Department of Mines
DOS	:	Department of Statistics
EPU	:	Economic Planning Unit
FAMA	:	Federal Agricultural Marketing Authority
FELCRA	:	Federal Land Consolidation and Rehabilitation Authority
FELDA	:	Federal Land Development Authority
ICU	:	Implementation and Coordination Unit
MARDI	:	Malaysian Agricultural Research and Development Institute
MIDA	:	Malaysian Industrial Development Authority
MLRD	:	Ministry of Land and Regional Development
MMS	:	Malaysian Meteorological Service
MOA	:	Ministry of Agriculture
MOF	:	Ministry of Finance

MOH : Ministry of Health
 MOPI : Ministry of Primary Industries
 MRRDB : Malaysia Rubber Research and Development Board
 NDPC : National Development Planning Committee
 NEB (LLN) : National Electricity Board
 PORIM : Palm Oil Research Institute of Malaysia
 PWD (JKR) : Public Works Department
 RDA : Regional Development Authority
 RISDA : Rubber Industry Small-holders Development Authority
 RRIM : Rubber Research Institute of Malaysia
 SEB : Sabah Electricity Board
 SEBC : State Economic Development Corporation
 S(E)PU : State (Economic) Planning Unit
 SESCO : Sarawak Electricity Supply Corporation
 UDA : Urban Development Authority

(3) International or Foreign Organization

ADAA : Australian Development Assistance Agency
 ADB : Asian Development Bank
 ASCE : American Society of Civil Engineers
 FAO : Food and Agriculture Organization of the United Nations
 IBRD : International Bank for Reconstruction and Development
 ILO : International Labour Organization
 IMF : International Monetary Fund
 IRRI : International Rice Research Institute
 JICA : Japan International Cooperation Agency
 JSCE : Japan Society of Civil Engineers
 MOC : Ministry of Construction, Japan
 OECD : Organization for Economic Cooperation and Development
 OECF : Overseas Economic Cooperation Fund, Japan
 UK : United Kingdom
 UNDP : United Nations Development Program

UNSF : United Nations Special Fund
US or USA: United States of America
US/AID : United States Agency for International
Development
USBR : United States Bureau of Reclamation
WHO : World Health Organization
WMO : World Meteorological Organization

(4) Others

B : Benefit
BOD : Biochemical Oxygen Demand
C : Cost
CIF : Cost, Insurance and Freight
COD : Chemical Oxygen Demand
D&I : Domestic and Industrial
dia : Diameter
EIRR : Economic Internal Rate of Return
El. : Elevation above mean sea level
Eq. : Equation
Fig. : Figure
FOB : Free on Board
FSL : Full Supply Level
GDP : Gross Domestic Product
GNP : Gross National Product
H : Height, or Water Head
HWL : Reservoir High Water Level
LWL : Reservoir Low Water Level
O&M : Operation and Maintenance
Q : Discharge
Ref. : Reference
SITC : Standard International Trade Classification
SS : Suspended Solid
V : Volume
W : Width

ABBREVIATIONS OF MEASUREMENT

Length

mm = millimeter
cm = centimeter
m = meter
km = kilometer
ft = foot
yd = yard

Area

cm² = square centimeter
m² = square meter
ha = hectare
km² = square kilometer

Volume

cm³ = cubic centimeter
l = lit = liter
kl = kiloliter
m³ = cubic meter
gal. = gallon

Weight

mg = milligram
g = gram
kg = kilogram
ton = metric ton
lb = pound

Time

s = second
min = minute
h = hour
d = day
y = year

Electrical Measures

V = Volt
A = Ampere
Hz = Hertz (cycle)
W = Watt
kW = Kilowatt
MW = Megawatt
GW = Gigawatt

Other Measures

% = percent
PS = horsepower
° = degree
' = minute
" = second
°C = degree in centigrade
10³ = thousand
10⁶ = million
10⁹ = billion (milliard)

Derived Measures

m³/s = cubic meter per second
cusec = cubic feet per second
mgd = million gallon per day
kWh = kilowatt hour
MWh = Megawatt hour
GWh = Gigawatt hour
kWh/y = kilowatt hour per year
kVA = kilovolt ampere
BTU = British thermal unit
psi = pound per square inch

Money

M\$ = Malaysian ringgit
US\$ = US dollar
¥ = Japanese Yen

CONVERSION FACTORS

	<u>From Metric System</u>	<u>To Metric System</u>
<u>Length</u>	1 cm = 0.394 inch 1 m = 3.28 ft = 1.094 yd 1 km = 0.621 mile	1 inch = 2.54 cm 1 ft = 30.48 cm 1 yd = 91.44 cm 1 mile = 1.609 km
<u>Area</u>	1 cm ² = 0.155 sq.in 1 m ² = 10.76 sq.ft 1 ha = 2.471 acres 1 km ² = 0.386 sq.mile	1 sq.ft = 0.0929 m ² 1 sq.yd = 0.835 m ² 1 acre = 0.4047 ha 1 sq.mile = 2.59 km ²
<u>Volume</u>	1 cm ³ = 0.0610 cu.in 1 lit = 0.220 gal.(imp.) 1 kl = 6.29 barrels 1 m ³ = 35.3 cu.ft 10 ⁶ m ³ = 811 acre-ft	1 cu.ft = 28.32 lit 1 cu.yd = 0.765 m ³ 1 gal.(imp.) = 4.55 lit 1 gal.(US) = 3.79 lit 1 acre-ft = 1,233.5 m ³
<u>Weight</u>	1 g = 0.0353 ounce 1 kg = 2.20 lb 1 ton = 0.984 long ton = 1.102 short ton	1 ounce = 28.35 g 1 lb = 0.4536 kg 1 long ton = 1.016 ton 1 short ton = 0.907 ton
<u>Energy</u>	1 kWh = 3,413 BTU	1 BTU = 0.293 Wh
<u>Temperature</u>	°C = (°F - 32) · 5/9	°F = 1.8°C + 32
<u>Derived Measures</u>	1 m ³ /s = 35.3 cusec 1 kg/cm ² = 14.2 psi 1 ton/ha = 891 lb/acre 10 ⁶ m ³ = 810.7 acre-ft 1 m ³ /s = 19.0 mgd	1 cusec = 0.0283 m ³ /s 1 psi = 0.703 kg/cm ² 1 lb/acre = 1.12 kg/ha 1 acre-ft = 1,233.5 m ³ 1 mgd = 0.0526 m ³ /s
<u>Local Measures</u>	1 lit = 0.220 gantang 1 kg = 1.65 kati 1 ton = 16.5 pikul	1 gantang = 4.55 lit 1 kati = 0.606 kg 1 pikul = 60.6 kg

Exchange Rate
(as average between July and December 1980)

\$1 = M\$2.22
¥100 = M\$1.03

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PENINSULAR
MALAYSIA

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SPECIAL ABBREVIATIONS

MAJUIKAN: Fisheries Development Authority

A.F.P.S.: Available fish for protein source

1. INTRODUCTION

Fishery activities of Malaysia consist of 2 categories, marine fishery and inland fishery. In this Study, brackish water area is included in the category of inland fishery.

The main objectives of the inland fishery study are as follows:

- (1) to clarify the present condition of fishery activities in Peninsular Malaysia, and to estimate the present water use of the inland fishery activities;
- (2) to project the future direction and production of inland fishery taking the Government policies into consideration;
- (3) to estimate the future freshwater demand; and
- (4) to identify the problems and needs required for the development of inland fishery.

2. PRESENT CONDITION OF INLAND FISHERY

2.1 Production and Consumption of Fish

2.1.1 Fish production

According to the fishery statistics of Malaysia, total marine landing to fish markets in Peninsular Malaysia increased from 198,000 to 565,000 tons during 1965 - 1978 period due to the introduction of trawl fishing method in 1965 as shown in Fig. 1 (Ref. 10). Landing of marine fish by state during 1972 - 78 period is also given in Table 1.

On the contrary, total freshwater landing at major markets decreased from 3,276 to 1,232 tons during 1972 - 1979 period as shown in Table 2 and in Fig. 2. It means the contribution of inland fisheries to the total production also decreased from 1.6% to 0.2%.

According to the Freshwater Section of DOFS, it is suggested that landing of freshwater fish shows only a part of its actual production because most of the cultured fish is not passed through market channels but directly delivered to consumers by pond owners or fish sellers.

It should also be remembered that the statistical values of inland fish production do not include the amount of self-consumption of the people who live and catch fish along the rivers. Some reports give a figure of 25,000 to 29,000 tons as estimated self-consumption but the sources are not given (Refs. 1 to 3).

2.1.2 Number of fishermen

The number of marine fishermen operating licensed boats increased from 69,200 to 83,700 during 1965 - 1978 as shown in Table 3. On the other hand, no data is available on the total number of inland fishermen but the number of farmers who engaged in pond operations of freshwater fish culture increased from 7,000 to 8,000 during 1976 - 1978, which is equal to about 10% of that of marine fishermen in 1978 as shown in Table 3.

2.1.3 Fish consumption

Fish consumption in this study signifies the demand for available fish for protein source (A.F.P.S.) which is defined by the following formula:

$$\text{A.F.P.S.} = (\text{Total fish production} - \text{Trash fish production}) \\ + (\text{Imported fish} - \text{Exported fish})$$

In Peninsular Malaysia, only the data for fish landing is available. The figures of fish landing was, therefore, used instead of those of fish production to estimate A.F.P.S. As shown in Table 4 and Fig. 3, total

fish consumption increased rapidly due to the increase of marine fish landing. The balance of import and export turned into surplus in 1975. In consequence, total fish consumption showed sharp increase at an average rate of 15.6% per annum. Accordingly, per capita fish consumption in Peninsular Malaysia increased almost double during 1972 - 1978 period (Sectoral Report Vol. 1). Considering that considerable amount of fish is directly delivered to consumers without passing through markets or self-consumed, actual figure of per capita consumption may be much higher.

2.2 Marine Fish Resources

The marine fish landing from the west coast during 1972 - 1978 increased from 227,000 to 411,000 tons, which has always been more than 70% of the total landings as is shown in Table 1. In addition, annual production per marine fisherman of the west coast during the same period has increased from 5.1 to 7.6 tons, compared with that of the east coast from 3.2 to 5.2 tons as shown in Table 5.

These facts indicate that the marine fisheries have been developing rapidly in both coasts, but those of the west coast have been leading the fisheries development in Peninsular Malaysia.

As mentioned in Section 2.1.1, rapid development of marine fisheries in Peninsular Malaysia has been realized by the introduction of trawling methods in 1965.

Since just after starting the trawl fishing, several researches on the resources for trawling fishing were carried out. According to one of the latest reviews issued in 1976 on the demersal fish resources surveys which were carried out during 1970 - 1972, the quantity of sustainable yield of fish within 9.3 km (5 nautical miles) zone is estimated to be at least 124,000 tons, consisting of fish and prawns in the water off the west coast of Peninsular Malaysia, whilst at least 368,000 tons of that in the water off the east coast of Peninsular Malaysia (Ref. 4).

According to the latest trend of fish catch by trawling as shown in Fig. 4, however, total landing by trawling on the west coast already reached almost double of the estimated quantity of catchable fish in 1978.

As of 1979, no other data is available to discuss maximum sustainable yield of trawl fishing. At present, the amount of resources available for marine fishery of Peninsular Malaysia, which has been playing the major role in fishery activities, remain vague.

2.3 Inland Fishery Activities

Inland fishery activities are categorized mainly in two types, fishing and culturing including fry production. These activities are operated in various waters such as rivers, lakes and reservoirs, tin mining pools, paddy fields, constructed ponds and mangrove areas. Inland fishery activities by water type are as shown in Table 6.

At present, fishing is popular in rivers and paddy fields, culturing in tin mining pools and constructed ponds.

From the administrative point of view, the control and development of the inland fishery in Malaysia is the responsibility of DOFS and MAJUIKAN. The latter is a statutory body formed to complement DOFS through active involvement in fishery enterprises.

Recent trend of freshwater fish landing at major markets is as shown in Table 7 and in Fig. 2. From these, the following characteristics can be absorbed:

- (1) The trend of annual landings in Peninsular showed sharp decrease during 1972 - 1979 as described in Section 2.1.1.
- (2) Almost 100% of the total landings in each year was that of the west coast during the years.
- (3) The landing in the State of Perak was always the largest among all the States and ranged from 58.9% to 78.5% of the total landings. The landings in the States of Selangor, Johor and Negeri Sembilan followed in this order, but their contributions fluctured during the period.
- (4) The average total landings of the above mentioned 4 States during the period accounted for 93.5% of the total landings in Peninsular.
- (5) The landing in the States of Kedah and Pulau Penang have not been recorded since 1977. It seems the trade of freshwater fish will not be done any more in these States.
- (6) The landings in the States of Melaka and Pahang are small but seem to be comparatively stable.

2.3.1 Fishing in inland waters

Data which are readily available on fishing in inland waters are quite limited. Interview surveys were carried out along 14 representative rivers, therefore, to grasp the present condition of inland waters fishing. The 14 rivers are as follows:

- | | | | |
|-----------------|---------------|--------------|---------------|
| (1) Kedah, | (2) Muda, | (3) Kerian, | (4) Kurau, |
| (5) Perak, | (6) Melaka, | (7) Muar, | (8) Johor, |
| (9) Endau, | (10) Rompin, | (11) Pahang, | (12) Kuantan, |
| (13) Trengganu, | (14) Kelantan | | |

The informations obtained through the surveys are given in Tables 8 to 10. Findings by the information are given hereunder:

- (1) During recent 10 years, fish catch has been decreasing along almost all the parts of river basins except a part of the Kedah, Perak and Johor rivers where fish catch was reported to have remained unchanged, and a part of the Kurau, Endau, Pahang and Kelantan rivers where fish catch was reported to have increased recently.
- (2) It is confirmed that the full-time fishermen of riverine fishing still exist in many places along the Perak and Johor rivers, and in some lower parts of the Kerian, Kurau, Melaka, Pahang, and Muar rivers. On the contrary, along the Melaka, Muar, Endau and Kelantan rivers, full-time fishermen seem to have changed their jobs recently, considering the recent fish catch decrease.
- (3) Main source of animal protein is fish, especially sea fish, even for the people who are living along the rivers. But, in 55 places interviewed out of 60, people are taking at least some amount of freshwater fish. Some people prefer freshwater fish because of its sweeter taste and cheaper price, who are mostly living in such places where full-time fishermen are still catching fish.
- (4) It seems that fish demand is stronger than its supply in many places.
- (5) In case of fish marketing, people of 25 places buy fish from fish sellers, 21 places from markets, 12 places from local stores and 10 places from mixed sources. Fish marketing system in Peninsular has still room to improve by making fish prices cheaper than those of fish sellers and local stores.

2.3.2 Fish culture in inland waters

Fish culture in Peninsular Malaysia is categorized into 5 types as shown in Table 11. As of 1980, most popular fish culture types are tin mining pools and constructed ponds.

About 10 species are currently under culture. Kap Kelapa Besar (*Aristichthys nobilis*) and Kap Rumpit (*Ctenopharngodon idellus*) are most popular. Lampan Jawa (*Puntius gonionotus*), Tilapia (*Tilapia mossambica*), Lee Koh (*Cyprinus carpio*) and Udang galah (*Macrobrachium resenbergi*) are the second and others are not popular yet as shown in Table 12.

All the popular species mentioned above are herbivore or omnivore (herbivorous dominant). Accordingly, pond condition depends on the water control how to keep the pond water suitably rich for the growth of phyto- and animal-plankton by the supply of organic or/and inorganic fertilizer.

Basically, pond water is not changed during the culture period (mostly 9 months) but some water is added to make up the loss of evaporation and percolation.

No separate statistical data are available on the production of cultured fish and only the data for fish landing are available. By using the fish composition of the annual landing, the trends of annual landings from pond culture, paddy field culture and fishing were estimated as shown in Table 13 and Fig. 5. It shows that the landing of cultured fish decreased from 1,150 to 610 tons during 1972 - 1979 period, together with that of paddy field culture from 540 to 50 tons.

On the contrary, the trends of the area of culture ponds as well as the number of culture farmers showed a steady increase as shown in Table 14. In addition, DOFS has been proceeding with the subsidy policy to promote freshwater fish culture since 1976, the first year of 3MP. This policy seems to have induced totally 3,239 farmers and land of 354 ha were under its influence during 1976 - 1979 as shown in Table 15 and Fig. 7.

From these facts, it is likely that the actual production of cultured fish increased during 1972 - 1979, but its landing declined due to some change to marketing system as shown in Fig. 5.

The actual production of culture ponds was estimated in this study as shown in Table 16, using the above mentioned area of culture ponds and the average productivity of culture ponds based on the results of production survey of culture ponds in Peninsular Malaysia in 1979 as shown in Table 17.

According to the estimation, the annual fish production in cultured ponds increased from 4,560 to 6,820 tons during 1972 - 1979.

The distribution of culture ponds in 1975 by district level which is given in Fig. 8 shows the following characteristics of freshwater fish culture in Malaysia:

- (1) Almost all culture ponds concentrate in the west coast.
- (2) Most active areas are adjacent to big cities such as Ipoh, Kuala Lumpur, Melaka and Johor Bahru.

From these facts, it is clear that the main markets of cultured fish are in urban areas and not in rural areas, as of 1975. But, as shown in Table 15, even the states in east coast such as the States of Kelantan and Trengganu, fish culture has been getting popular, activated by the subsidy policy of DOFS which started in 1976.

3. PRESENT WATER USE OF INLAND FISHERY

3.1 Recent Change of River Flow Pattern

The production of riverine fishing in Peninsular Malaysia decreased during these 10 years. According to the information obtained by interview surveys, this was caused by the recent change of river flow pattern as follows:

- (1) In some rivers, flood occurs more often but reduces more swiftly after the rain. And after the flood, the water level becomes low compared with before. Accordingly, fish does not have enough time to grow during flood time and cannot find enough food after the flood. Those rivers does not have any big scale dams but have lost those virginity by the development of logging and agricultural plantation.
- (2) In other rivers, flood does not occur any more or so often compared with before because of the construction of dams upstream. Accordingly, fishes has lost their spawning places and time and enough food during flood time. The above information suggests that the maximum production of riverine fishing can be obtained under the natural river flow pattern which is not affected by the human activities.

3.2 Water Use of Freshwater Fish Culture

As of 1979, the total area of constructed pond is 1,519 ha as shown in Table 14.

Followings are the basic pond operation according to the information from DOFS:

- (1) Water is kept stagnant with the depth of about 1 m.
- (2) Culture period is about 9 months.
- (3) Water is changed totally once a year and not changed afterwards during the culture period to keep the effect of fertilizer.
- (4) Water is supplied daily for supplementing evaporation and percolation which was estimated at 13.2 m³/ha/d in the Sectoral Report Vol. 11). Based on these conditions, the annual water use of culture ponds (WD) was estimated as follows:

$$\begin{aligned} WD &= \text{Initial water for filling up ponds} \\ &+ \text{Daily additional water for supplementing} \\ &\quad \text{evaporation and percolation of pond water} \\ &= (\text{Area of Pond}) \times (\text{Pond Depth} + \text{Culture Period} \\ &\quad \times \text{Daily Additional Water}) \end{aligned}$$

Water use for freshwater fish culture by State in 1979 was shown in Table 18. The total water use in Peninsular Malaysia was estimated at 20.6×10^6 m³/year as of 1979.

It is not necessary to compute other types of fish culture such as cage culture in lakes and reservoirs, cage and pen culture in tin mining pools, paddy field culture and brackish pond culture in mangrove areas. Because fish culture of these types is operated only under the water environment to which freshwater is not necessary to be supplied.

4. PROSPECTIVE DIRECTION OF INLAND FISHERY

4.1 Government Policies

The fishery development policy in Malaysia is geared to the three-fold objectives of the New Economic Policy of eradicating poverty, restructuring society and providing employment for the increasing population. In line with this policy, total of M\$262 x 10⁶ was allocated for fishery development under TMP, sharp increase compared with the sum of M\$34 x 10⁶ provided under the SMP as shown in Table 19.

DOFS was allocated M\$111 x 10⁶ during the TMP period. The biggest fund of M\$72.7 x 10⁶ was utilized for the Program of the Financial Assistance to the fishermen and fish culture farmers, which was 65.6% of the total allocations of DOFS as shown in Table 20. It is clear that the main policy of DOFS for the fishery development under TMP was to assist financially fishermen and to encourage them to promote their activities.

Speaking of inland fisheries, the same policy was reflected in the form of subsidy program to the culture farmers of freshwater fish. About M\$7 x 10⁶ to M\$8 x 10⁶ was estimated to have utilized for the subsidy to the culture farmers to start freshwater fish culture under TMP as shown in Fig. 8. This amount accounts for about 10% of the total fund of the Program of the Financial Assistance. It is quite big amount compared with the contribution of freshwater fish landing which was below 2% out of total fish landing as described in Section 2.1.1.

The aquaculture projects of MAJUIKAN was allocated about M\$5 x 10⁶, which was 3% of its total budget under TMP as shown in Table 21. The amount allocated for freshwater fish culture was not available. Judging from the area of the freshwater ponds operated by MAJUIKAN of 53 ha in 1980, however, at least M\$1.3 x 10⁶ was presumably spent (Ref. 5). Though this amount is comparatively small, it has a significant meaning considering that the sum was spent for 2 high-scaled culture projects.

According to the information from MOA, a high priority is to be given for the development of aquaculture and inland fishery.

Considering these, it is clear that the freshwater fish culture including mangrove area will be strongly promoted in Peninsular Malaysia under the 4MP by the Government of Malaysia.

4.2 Existing Future Development Plans

From the Government basis, the constructed ponds of 1,257 ha for freshwater fish culture are planned to be constructed by the subsidy program of DOFS and 649 ha by culture projects of MAJUIKAN during the 4MP period as shown in Table 22. The total area of constructed ponds will reach, at least, 3,708 ha by the end of 1985 without counting the constructed ponds constructed solely by private sector.

The State land offices have recently changed their policies on the utilization of old tin mining pools for fish culture and requires the yearly extension permission to the investors. Fish culture in tin mining pools, therefore, is most likely not to be developed any more.

Other culture plans by the Government are freshwater cage culture of 5.6 ha (1,500 rafts) in lakes and reservoirs by DOFS and brackish cage culture (including marine cage culture) of 1.9 ha (500 rafts) by DOFS as shown in Table 23. These are not directly relating to quantitative matters to be discussed in this Study but relating to qualitative matters including water quality, eutrophication, pollution in river mouths.

As for the future plans other than those under 4MP, following 3 freshwater culture plans have been conceived:

- (a) Sepat Siam (*Trichogaster pectoralis*) culture of 203 ha in the Tumbok Block at Tembusu Angin in the State of Perak (Ref. 6);
- (b) combination of freshwater fish culture of 535 ha and freshwater prawn culture of 150 ha in Kemasin and Semerak in the State of Kelantan (Ref. 7); and
- (c) freshwater fish culture in swamp area of 243 ha in the State of Trengganu (Ref. 8).

The culture area totals 1,131 ha. In this Study, these plans were assumed to be implemented after the 4MP because definite schedules for them have yet to be formulated.

4.3 Prospective Direction of Inland Fishery

As described in Chapter 2, the fish consumption in Peninsular Malaysia has been rapidly increasing during 1972 - 1978 period. The domestic fish supply can not fully meet the fish demand. Although marine fishery keep larger share in the total domestic fish production, maximum sustainable yield is not clear as described in Section 2.2. The Government is seeking for various kinds of possibilities to improve the present fish deficit by utilizing its own natural resources. To activate the inland fishery is one of its main targets.

The production of fishing in inland waters, especially rivers, however, is not likely to be recovered because of the adverse effects of various kinds of development activities on the ecological condition of fish as is described in Section 3.1. The total area of lakes, reservoirs and other open water bodies is 15,500 ha in Peninsular Malaysia, but most of them need more time to become productive waters by eutrophication (Ref. 9).

From the viewpoint of area to be utilized for fish culture, 25,600 ha paddy field fish culture has much potentiality (Ref. 9). However, it also is not likely to be developed so much in the near future because its production is adversely influenced by the agricultural chemicals and shortening of growth period of fishes by the irrigation development.

On the other hand, fish culture both in fresh water and brackish-water excluding paddy field is hopeful because of the following reasons:

- (1) It has been steadily developing under the support of DOFS. This can be considered as the evidence that the technology of fish culture has been basically established and can induce profitable pond operations; and
- (2) The accumulation of culture technology will make possible the future development of a part of mangrove swampy area of 103,000 ha for fisheries aquaculture as shown in Table 24.

The Government is planning to develop more than 3,708 ha of fish culture area by 1985 through the implementation of the 4MP. To project the perspective development area of fish culture in 1990 and 2000 in Peninsular Malaysia, the following assumptions were made:

- (1) The area of freshwater culture ponds including tin mining pools including all the existing plans during 1981 - 2000 will increase at the average rate of 4% per annum which is equivalent to the rate during 1973 - 1980 as shown in Tables 14 and 25; and
- (2) The development area of cage culture and brackishwater culture will only be doubled in 2000 after the completion of the 4MP because fish farmers need several years to master newly introduced culture technique such as cage culture or brackishwater culture. For example, Japanese fish culture farmers were able to increase fish production from 41,800 to 82,100 tons during 1967 - 1977. But they had spent more or less 15 years to master the suitable and stable culture technique before they could reach the above-mentioned rate.

Based on these assumptions, the total prospective development areas of fish culture in 1990 and 2000 were estimated at 10,174 ha and 15,105 ha, respectively, of which detailed figures are given in Table 26 and Fig. 10.

In these culture areas, 29,584 tons of fish are expected to be produced in 1990 and 41,777 tons in 2000. In order to meet the domestic fish demand, 88.5×10^3 tons of inland fish is required in 2000. The expected production falls far short of the requirement.

4.4. Future Water Demand

Out of several culture types of inland fishery, only freshwater pond culture excluding tin mining pools needs seasonal and daily water supply.

Future water demand of freshwater pond by state is as shown in Tables 29 and 30. Total water demand of freshwater pond in Peninsular Malaysia were estimated at $59 \times 10^6 \text{ m}^3$ for 1990 and $111 \times 10^6 \text{ m}^3$ for 2000, respectively.

5. PROBLEMS AND NEEDS

Followings are the needs and problems to be solved for the development of inland fisheries in Peninsular Malaysia, which were recognized by this Study:

- (1) Inland fishing, especially riverine fishing, has been facing serious decline of production due to the adverse change of ecological river environment for fish. Studies on the causal relation between the fish resources and the ecological change are needed, especially for the Perak and Pahang rivers. Special attention should be paid to the effect of the construction of dams and weirs and to measures for the alleviation of the adverse effects of these structures.
- (2) In order to accomplish the fish culture development plans under the 4MP, the following actions need to be taken:
 - (a) Studies and experiments; mechanism of cost and benefit, biological differences between herbivorous, omnivorous and carnivorous fishes, role of sunlight, water and fertilizer concept of water change rate, survival ratio, feed conversion ratio, space factor, fish density, fish disease, weight loss, decomposition, fish process, weight loss, decomposition, fish processing;
 - (b) Strengthening of extension service; assignment of technicians experienced for fish culturing, detailed informations on production and problems encountered by fish farmers, technical advices and propagation of fish culture;
 - (c) Strengthening of seed supply system; quality, quantity and timing;
 - (d) Organization of fish farmers; fish distribution, price control, avoidance of possibility of a subordinate position controlled by fishsellers, joint ownership of transportation facilities; and
 - (e) Stable availability of clean and cheap water; adjustment of water use taking into consideration the competing water use by irrigation when fish culturing is scaled up.
- (3) Paddy field fishing and fish culture needs much more intensified studies as to how to avoid the negative influences of agricultural chemicals and shortening of culture period caused by irrigation development, and how to increase its production. It is necessary to get a close cooperation of farmers.
- (4) Future development plans need not only subsidy programs but also study on the necessity of Government loan for O&M cost specially in case of carnivorous and shrimp culture.

- (5) Development of mangrove areas needs sufficient discussion among government agencies, especially on its location, scale and the structure of water channels.
- (6) Systematic studies are needed on how to supply cheap and fresh fish to the east coast people during the monsoon season.
- (7) In case of brackish water pond culture, due care should be taken for preventing water pollution. Guideline of the water quality standard for these ponds will be needed in future.

6. CONSTRUCTION COST AND O&M COST FOR INLAND FISHERY SCHEMES

6.1 Constructed Pond Culture

Unit construction cost for constructed ponds excluding physical contingency was estimated at M\$15.9 x 10³/ha based on the required excavation volume and land acquisition cost obtained from the Inland Fishery Section of DOFS and Majuikan (Ref. 12). Total unit construction cost was, therefore, estimated at M\$20.7 x 10³/ha.

O&M cost for the constructed ponds was assumed at 1% of the construction cost or M\$0.2 x 10³/ha/y based on the data obtained from DOFS and Majuikan (Ref. 12).

6.2 Cage Culture in Dams Reservoirs

Based on the data obtained from DOFS and Majuikan, unit construction cost for cage culture fishery in dams reservoirs excluding physical contingency was estimated at M\$455.0 x 10³/ha. Total unit construction cost, therefore, estimated at M\$592.0 x 10³/ha.

O&M cost for cage culture fishery was assumed at 2% of the construction cost or M\$11.8 x 10³/ha/y based on the data obtained from DOFS and Majuikan (Ref. 12).

6.3 Estimated Cost

Estimated investment cost (construction cost) together with the area of constructed ponds to be developed during 1980 - 2000 period by state is given in Sectoral Report Public Expenditure and Beneficial and Adverse Effects. Investment cost together with the area of cage culture in reservoirs (inland fishery in reservoirs) by basin is given for various alternatives for water source development and these under lower economic growth in the same sectoral report. Recurrent expenditure (O&M cost) for the constructed pond culture and cage culture in reservoirs for Peninsular Malaysia is also shown in the same report.

7. ECONOMIC BENEFIT AND COST FOR INLAND FISHERY

7.1 Economic Cost

Economic cost was obtained by deducting transfer payments including taxes and local contractors' profit from the financial cost. In this Study, economic cost was assumed at 80% of the financial cost. Unit economic construction cost and economic O&M cost is shown in Table 30 together with unit financial costs.

7.2 Economic Benefit

Economic benefit derived from the constructed pond culture and cage culture in the reservoirs was estimated at 80% of the net financial production value, taking into account the transfer payments.

Gross unit production value of cage culture was estimated at M\$672.8 x 10³/ha/y, while financial production cost was estimated at M\$476.1 x 10³/ha/y. Net unit production value (financial) was calculated at M\$196.7 x 10³/ha/y. Net unit production value (economic) for cage culture was, thus, estimated at M\$157.4 x 10³/ha/y. Similarly, net unit production value (economic) for pond culture was estimated at M\$2.0 x 10³/ha/y. Details are given in Table 31.

7.3 Estimated Economic Benefit and Cost

Estimated annual equivalents of economic benefit and cost at the discount rate of 8% for pond culture by state and these for cage culture in reservoirs by basin are given in Sectoral Report Public Expenditure and Beneficial and Adverse Effects.

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TABLES

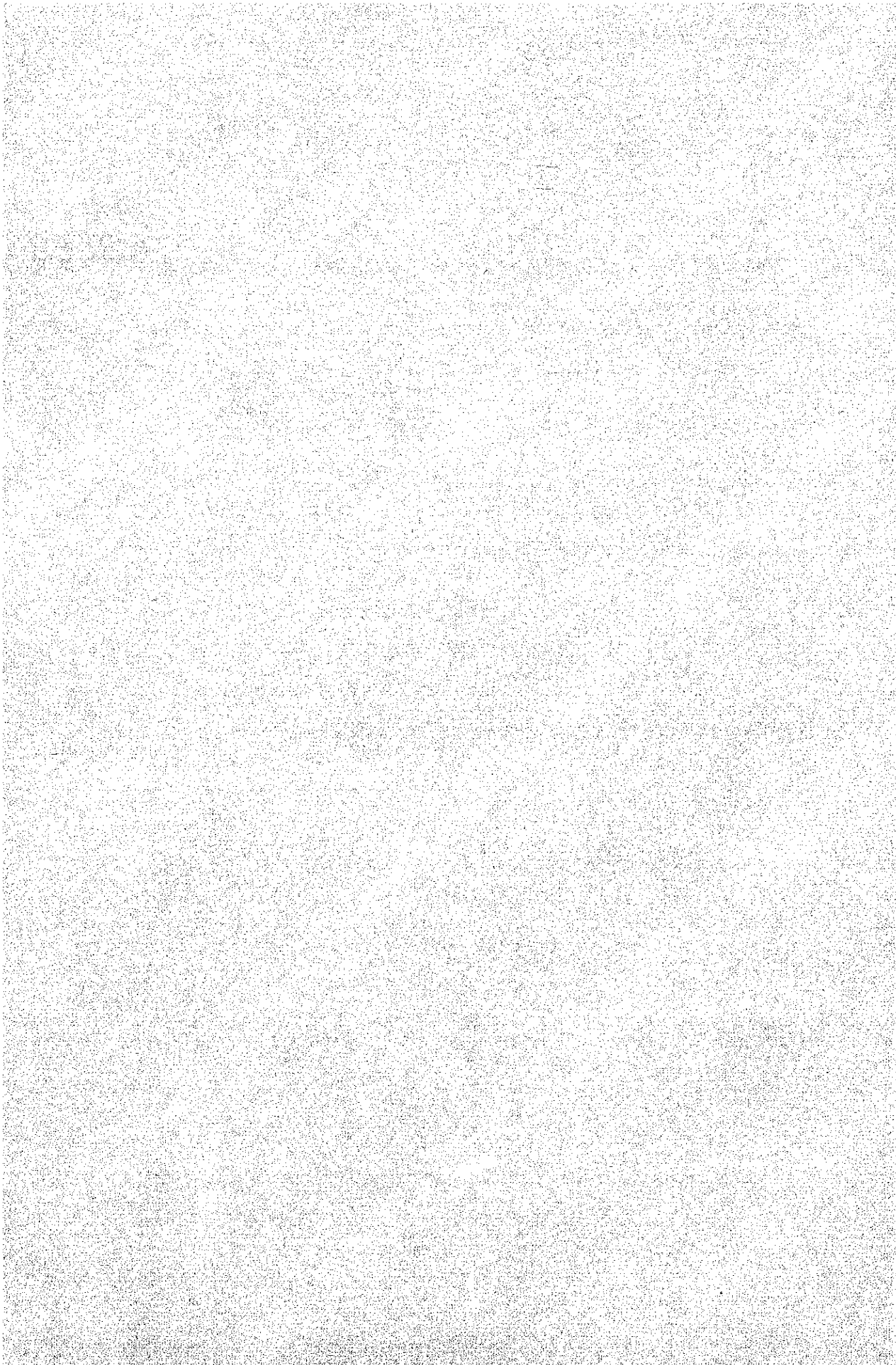


Table 1 LANDING OF MARINE FISH BY STATE (1972 - 1978)

Unit: 10³ tons

State	Year	1972	1973	1974	1975	1976	1977	1978
Perlis		5.4 (1.8)	8.0 (2.2)	13.5 (3.1)	13.6 (3.7)	9.9 (2.4)	14.3 (2.9)	14.5 (2.6)
Kedah		37.6 (12.3)	45.2 (12.4)	42.6 (9.7)	42.9 (11.4)	51.9 (12.6)	71.6 (14.4)	66.5 (11.8)
Penang		31.8 (10.4)	33.3 (9.1)	26.7 (6.1)	21.0 (5.6)	17.2 (4.2)	28.0 (5.6)	22.5 (4.0)
Perak		78.0 (25.5)	98.1 (26.9)	131.9 (30.0)	95.0 (25.3)	108.6 (26.4)	143.2 (28.7)	186.6 (33.0)
Selangor		58.2 (19.0)	78.6 (21.5)	88.2 (20.1)	82.2 (21.9)	91.7 (22.3)	105.9 (21.3)	104.7 (18.5)
N. Sembilan		0.3 (0.1)	0.5 (0.1)	0.3 (0.1)	0.4 (0.1)	0.5 (0.1)	0.4 (0.1)	0.4 (0.1)
Malacca		1.5 (0.5)	1.5 (0.4)	1.3 (0.3)	1.3 (0.4)	1.3 (0.3)	1.5 (0.3)	2.4 (0.4)
Johor (West)		14.2 (4.6)	11.1 (3.0)	13.4 (3.1)	13.9 (3.7)	13.5 (3.3)	13.0 (2.6)	13.0 (2.3)
Sub-Total (West Coast)		227.0 (74.1)	276.3 (75.6)	317.8 (72.3)	270.3 (72.1)	294.6 (71.7)	377.9 (75.9)	410.6 (72.7)
Johor (East)		29.8 (9.7)	27.5 (7.5)	30.3 (6.9)	25.0 (6.7)	33.6 (8.2)	21.8 (4.4)	48.0 (8.5)
Pahang		8.1 (2.7)	11.6 (3.2)	19.0 (4.3)	13.5 (3.6)	14.2 (3.5)	14.0 (2.8)	16.3 (2.9)
Trengganu		30.2 (9.9)	37.4 (10.2)	59.7 (13.6)	53.4 (14.2)	55.3 (13.5)	77.8 (15.6)	75.3 (13.3)
Kelantan		11.2 (3.6)	12.7 (3.5)	12.7 (2.9)	12.7 (3.4)	13.3 (3.3)	6.5 (1.3)	14.5 (2.6)
Sub-Total (East Coast)		79.3 (25.9)	89.2 (24.4)	121.6 (27.7)	104.6 (27.9)	116.4 (28.7)	120.1 (24.1)	154.1 (27.3)
Total		306.3 (100)	365.5 (100)	439.4 (100)	374.9 (100)	411.0 (100)	498.0 (100)	564.7 (100)

Source; Ref. 10

Table 2 LANDING OF FRESHWATER FISH AT MAJOR
MARKETS BY STATE (1972 - 1979)

State	Year	Unit: tons							
		1972	1973	1974	1975	1976	1977	1978	1979
Perlis		61 (1.9)	10 (0.3)	13 (0.7)	2 (0.1)	- (-)	- (-)	1 (0.1)	12 (1.0)
Kedah		66 (2.0)	337 (11.0)	19 (0.9)	8 (0.6)	3 (0.3)	- (-)	- (-)	20 (0.2)
Penang		4 (0.1)	3 (0.1)	5 (0.2)	3 (0.2)	3 (0.2)	- (-)	- (-)	- (-)
Perak		2,209 (67.4)	1,722 (56.4)	1,576 (78.5)	969 (70.2)	841 (65.3)	830 (69.4)	612 (65.5)	726 (58.9)
Selangor		674 (20.6)	716 (23.4)	130 (6.5)	15 (1.1)	14 (1.1)	46 (3.8)	70 (7.5)	297 (24.1)
N. Sembilan		125 (3.8)	115 (3.7)	117 (5.8)	92 (6.7)	139 (10.8)	68 (5.7)	91 (9.8)	91 (7.4)
Malacca		6 (0.2)	6 (0.2)	14 (0.7)	20 (1.4)	26 (2.0)	25 (2.1)	41 (4.4)	27 (2.2)
Johor (West)		98 (3.0)	129 (4.2)	119 (5.9)	245 (17.7)	243 (18.8)	202 (16.9)	81 (8.6)	40 (3.2)
Sub-Total (West Coast)		3,243 (99.0)	3,038 (99.4)	1,993 (99.3)	1,354 (98.1)	1,269 (98.4)	1,171 (97.8)	900 (96.3)	1,195 (97.0)
Pahang		31 (0.9)	15 (0.5)	13 (0.6)	24 (1.7)	20 (1.6)	25 (2.1)	31 (3.3)	26 (2.1)
Trengganu		- (-)	2 (-)	1 (-)	- (-)	- (-)	- (0.1)	2 (0.2)	8 (0.6)
Kelantan		2 (0.1)	1 (-)	- (-)	3 (0.2)	- (-)	1 (0.1)	2 (0.2)	3 (0.2)
Sub-Total (East Coast)		33 (1.0)	18 (0.6)	14 (0.7)	27 (1.9)	20 (1.6)	26 (2.2)	34 (3.7)	37 (3.0)
Total		3,276 (100)	3,056 (100)	2,007 (100)	1,381 (100)	1,289 (100)	1,197 (100)	934 (100)	1,232 (100)

Remarks; Figures in parentheses signify landing in percentage

Source; Ref. 10

Table 3 NUMBER OF MARINE FISHERMEN BY STATE (1972 - 1978)

Unit: 10³ persons

State	Year	1972	1973	1974	1975	1976	1977	1978
Perlis		1.4 (-)	1.3 (-)	1.5 (-)	1.4 (-)	1.7 (0.02)	1.9 (0.03)	2.4 (0.04)
Kedah		6.6 (-)	6.1 (-)	6.3 (-)	7.6 (-)	9.0 (0.15)	7.8 (0.14)	9.6 (0.23)
Penang		6.3 (-)	6.0 (-)	6.3 (-)	5.8 (-)	5.9 (0.07)	6.0 (0.07)	6.8 (0.07)
Perak		14.0 (-)	19.2 (-)	16.4 (-)	17.8 (-)	14.5 (2.58)	14.8 (2.70)	15.3 (2.87)
Selangor		7.0 (-)	7.8 (-)	6.4 (-)	6.9 (-)	6.9 (0.46)	7.0 (0.50)	7.3 (0.51)
N. Sembilan		0.4 (-)	0.3 (-)	0.3 (-)	0.4 (-)	0.5 (1.56)	0.5 (1.84)	0.5 (1.73)
Melaka		1.4 (-)	1.3 (-)	1.5 (-)	1.3 (-)	1.6 (0.18)	1.8 (0.20)	2.0 (0.26)
Johor (West)		7.1 (-)	7.1 (-)	6.8 (-)	7.2 (-)	7.9 (0.63)	8.8 (0.67)	10.2 (0.70)
Sub-Total (West Coast)		44.2 (-)	48.8 (-)	45.5 (-)	48.4 (-)	48.0 (5.65)	48.6 (6.20)	54.1 (6.41)
Johor (East)		5.2 (-)	4.7 (-)	5.8 (-)	5.0 (-)	5.4 (-)	5.4 (-)	6.0 (-)
Pahang		3.0 (-)	2.8 (-)	3.2 (-)	3.6 (-)	3.7 (1.02)	3.6 (1.09)	4.0 (1.13)
Trengganu		10.9 (-)	14.0 (-)	11.4 (-)	11.4 (-)	11.9 (0.11)	12.6 (0.13)	13.1 (0.21)
Kelantan		5.9 (-)	5.1 (-)	5.5 (-)	4.9 (-)	4.8 (0.21)	5.4 (0.24)	6.5 (0.24)
Sub-Total (East Coast)		25.0 (-)	26.6 (-)	25.9 (-)	24.9 (-)	25.8 (1.34)	27.0 (1.46)	29.6 (1.58)
Total		69.2 (-)	75.4 (-)	71.4 (-)	73.3 (-)	73.8 (6.99)	75.6 (7.66)	83.7 (7.99)

Remarks; Figures in parentheses are numbers of farmers operating freshwater culture ponds.

Source; Ref. 10

Table 4 FISH CONSUMPTION

Year	Marine fish	Trash fish	Marine fish		Import	Export	Fish consumption
			excluding trash fish	Inland fish			
1972	311.2	80.4	230.8	6.7	67.6	116.1	189.0
1973	371.2	114.0	257.2	7.4	72.7	125.4	211.9
1974	439.6	146.6	293.0	7.2	75.2	107.2	268.2
1975	375.2	125.2	250.0	7.0	93.3	93.1	257.2
1976	411.0	127.5	283.5	6.9	114.1	107.3	297.2
1977	497.9	155.0	342.9	7.0	116.8	106.3	360.4
1978	564.9	146.6	418.3	7.1	150.0	124.1	451.3

Unit: 10³ tons

Remarks; Estimated total landing = (Estimated landing from paddy field and other waters (Table 11)) + (Estimated landing from fish culture (Table 12))

Table 5 FISH PRODUCTION PER MARINE FISHERMAN

	Unit: tons/d						
	1972	1973	1974	1975	1976	1977	1978
West Coast	5.14	5.66	6.98	5.58	6.14	7.77	7.59
East Coast	3.17	3.35	4.69	4.20	4.51	4.45	5.20
Total	4.42	4.85	6.15	5.11	5.57	6.59	6.75

Source; Ref. 10

Table 6 INLAND FISHERY ACTIVITIES BY WATER TYPE IN 1980

Water type	Fishing	Culturing		
		Pond	Cage	Pen
Rivers	++	-	-	-
Lakes and Reservoirs	+	-	+	(+)
Tin mining pools	-	-	+	++
Paddy field	++	-	-	-
Constructed ponds	-	++	-	-
Mangrove areas	+	(+)	-	-

Remarks; Activities are expressed by the following symbols;
 ++ comparatively active, + not active,
 (+) tried, - non-existent

Source; Ref. 10

Table 7 PRESENT CONDITION OF RIVERINE FISHING AND ITS MARKETING OBTAINED FROM INTERVIEW SURVEY (1/3)

Code of Location	No. of Full Time Fishermen ^{1/}	Trend of Fish Catch ^{2/}	Main Source of Animal Protein ^{3/}	Marketing of Fish Supply ^{4/}	Balance of S and D ^{5/}
Ked.1	10 <	D	Fish (SF=100%)	M (-)	NS
Ked.2	none	D	Fish (SF > FF)	M (1.6)	Q
Ked.3	none	D	Fish (SF > FF)	LS	Q
Ked.4	none	D	Fish (SF > FF)	FS	Q
Ked.5	none	D	Fish (SF > FF)	FS	N
Ked.6	none	N	Fish (SF > FF)	M (-)	Q
Ked.7	none	D	Fish (SF > FF)	FS or LS	Q
Mud.1	none	D	Fish (SF > FF)	M (0.4)	Q
Mud.2	none	D	Fish (SF > FF)	FS or LS	Q
Mud.3	none	D	Fish (SF > FF)	M (1.6)	Q
Mud.4	none	D	Fish (SF > FF)	FS	Q
Mud.5	none	D	Fish (SF > FF)	M (1.6) or LS	Q
Mud.6	none	D	Fish (SF > FF)	M (1.6)	Q
Ker.1	10 <	D	Fish (SF > FF)	LS	Q
Ker.2	10 <	D	Fish (SF = FF)	FS or LS	Q
Ker.3	none	D	Fish (SF > FF)	FS	Q
Ker.4	none	D	Fish (SF = FF)	FS	Q
Ker.5	none	D	Fish (SF=100%)	LS	Q
Kra.1	10 <	D	Fish (SF < FF)	FS (Seafish only)	Q
Kra.2	none	I	Fish (SF > FF)	FS	Q
Kra.3	10 <	D	Fish (SF < FF)	LS	Q
Kra.4	none	D	Fish (SF > FF)	FS	Q
Kra.5	none	D	Fish (SF = FF)	LS	Q

- Remarks; 1/: Number in parenthesis is that of former time.
- 2/: Redent trend during last 10 years (I = increase, D = decrease, N = No change.)
- 3/: Fish was the main source of animal protein in all the places interviewed. Supply intensity expressed by the following symbols;
 SF > FF : Seafish is stronger than freshwater fish.
 SF = FF : Same intensity.
 SF < FF : Seafish is weaker than freshwater fish.
- 4/: Fish supply source is expressed by the following symbols;
 M: From markets (Km)
 FS: From fish seller by motorcycle or lorries
 LS: From small local stores.
- 5/ It is indicated by the following symbols;
 Q: Fish is always sold out quickly.
 S: Fish is always sold out, but slowly.
 N: Fish is not always sold out.
 NS: Fish is never sold out.

Table 8 PRESENT CONDITION OF RIVERINE FISHING AND ITS MARKETING OBTAINED FROM INTERVIEW SURVEY (2/3)

Code of Location	No. of Full Time Fishermen ^{1/}	Trend of Fish Catch ^{2/}	Main Source of Animal Protein ^{3/}	Marketing of Fish Supply ^{4/}	Balance of S and D ^{5/}
Per.1	10<	D	Fish (SF=FF)	M (-)	Q
Per.2	none	N	Fish (SF=100%)	LS	Q
Per.3	10<	D	Fish (SF > FF)	LS	Q
Per.4	none	D	Fish (SF > FF)	FS	Q
Per.5	none	D	Fish (SF=100%)	M (1.2)	Q
Per.6	10<	D	Fish (SF > FF)	M or FS	?
Per.7	10<	D	Fish (SF = FF)	M (-)	Q
Per.8	10<	D	Fish (SF < FF)	M (-)	Q
Per.9	none	D	Fish (SF > FF)	M (1.6)	Q
Per.10	none	D	Fish (SF > FF)	FS	Q
Per.11	10<	D	Fish (SF = FF)	M (-)	Q
Per.12	none	D	Fish (SF > FF)	M (2)	Q
Per.13	5-10	D	Fish (SF < FF)	M(1.6) FS or LS	Q
Per.14	none	D	Fish (SF=100%)	FS LS	Q
Per.15	10<	D	Fish (SF < FF)	FS	Q
Per.16	2-5	D	Fish (SF > FF)	FS or LS	Q
Per.17	none	D	Fish (SF > FF)	FS	Q
Mlk.1	1-2 (many)	D	Fish (SF > FF)	M (4.8)	N
Mlk.2	none	D	Fish (SF > FF)	M (-)	Q
Mua.1	5-10(10<)	D	Fish (SF=FF)	FS or LS	Q
Mua.2	10	D	Fish (SF < FF)	LS	N(SF only)
Mua.3	2-5(10<)	D	Fish (SF > FF)	M	S
Mua.4	(10<)	D	Fish (SF > FF)	FS	N(SF only)
Mua.5	(3-4)	D	Fish (SF > FF)	LS	N(SF only)
Mua.6	none	D	Fish (SF > FF)	LS	Q
Mua.7	none	D	Fish (SF > FF)	M (0.5)	Q
Joh.1	30	D	Fish (SF > FF)	LS	Q
Joh.2	5-10	N	Fish (SF = FF)	FS	Q
Joh.3	1-2	D	Fish (SF=FF)	M	Q
End.1	none	I	Fish (SF > FF)	FS	Q
End.2	(some)	D	Fish (SF < FF)	FS or M	N(SF) Q(FF)
Rom.1	none	D	Fish (SF > FF)	FS	?
Pah.1	none	D	Fish (SF > FF)	M (-)	N
Pah.2	1-2	D	Fish (SF > FF)	FS	Q
Pah.3	none	D	Fish (SF > FF)	FS	N(SF only)
Pah.4	none	D	Fish (SF < FF)	FS	N(SF only)
Pah.5	none	D	Fish (SF > FF)	LS or FS	Q
Kua.1	none	D	Fish (SF > FF)	FS	N(SF only)
Kua.2	none	D	Fish (SF > FF)	LS	N(SF only)

Table 9 PRESENT CONDITION OF RIVERINE FISHING AND ITS MARKETING OBTAINED FROM INTERVIEW SURVEY (3/3)

Code of Location	Number of Full Time Fishermen ^{1/}	Trend of Fish Catch ^{2/}	Main Source of Animal Protein ^{3/}	Marketing of Fish Supply ^{4/}	Balance of S and D ^{5/}
Trng.1	none	D	Fish (SF > FF)	M or FS	S
Trng.2	none	D	Fish (SF > FF)	FS	S
Trng.3	none	D	Fish (SF > FF)	RS	Q
Kltn.1	none	D	Fish (SF > FF)	FS	Q
Kltn.2	none	I	Fish (SF = FF)	M	Q
Kltn.3	none	I	Fish (SF > FF)	M	Q
Kltn.4	(20-30)	D	Fish (SF > FF)	FS	Q
Kltn.5	(5-10)	D	Fish (SF > FF)	FS	N (SF only)

Table 10 TYPES OF FISH CULTURE IN PENINSULAR MALAYSIA

Type	Characteristics				
	FA ^{1/}	WS ^{2/}	WU ^{3/}	FC ^{4/}	P ^{5/}
1. Pond Culture	Constructed Pond	R, IC	Stagnant, or Running	NF, or F	++ -
2. Pond Culture in Mangrove Area	Cosntructed Pond	B	Stagnant	NF	-
3. Paddy Culture	Paddy Field	IC	Stagnant	NF	+
4. Pen Culture	Net Fence	TP, LR	Open	NF	+
5. Cage Culture	Cage Net	TP, LR	Open	F	-

Remarks; 1/: Facilities to keep fish.

2/: Water source R: River, IC: Irrigation Canal, B: Brackish water near to river mouth, TP: Tin mining pond, LR: Lakes or reservoirs.

3/: Water use Stagnant: Water change once a year, Running: Water change 5 times a day, Open: Water pass and change from outside water.

4/: Feeding condition NF: No Feeding, only supply fertilizer to make grow phytoplankton, F: Feeding animal or non-animal protein at least once a day.

5/: Popularity ++ : most prevailing, + : prevailing in some restricted area, - : not prevailing intended to be prevailed by Government policy.

Table 11 SPECIES AND LANDING OF FRESHWATER FISH CULTURE

Local Name	Latin Name	Landing ^{1/}	
		Weight	Share ^{2/}
Lampan Jawa	<i>Puntius goniontus</i>	88.5	(8.2)
Lee Koh	<i>Cyprinus Carpio</i>	44.2	(4.1)
Tilapia Kacokan	<i>Tilapia sp. (hy brid)</i>	86.5	(8.0)
Kap Rumput	<i>Ctenopharyngodon idellus</i>	161.4	(14.9)
Kap Kepala Besar	<i>Arystichtys nobilis</i>	185.5	(17.1)
Kap Perak	<i>Hypohthalmiththys molitrix</i>	7.3	(0.7)
Ikon Mas	<i>Carassius carassius (?)</i>	-	(-)
Kalui	<i>Osphronemus goramy</i>	0.5	(0.0)
Udang galah	<i>Macrobrachium rosenbergi</i>	3.6	(2.9)
Jelawat	<i>Leptobarbus hoevenii</i>	0.5	(0.0)
Chit Hu	<i>Carassius auratus (?)</i>	-	(-)

Remarks; 1/: Average in 1978 and 1979, including production by fishing from natural waters

2/: Average contribution out of average annual landing in 1978 and 1979

Source; Ref. 8, 10

Table 12 ESTIMATED COMPOSITION OF LANDING FROM CULTURE PONDS, PADDY FIELDS AND OTHER WATERS

Unit: 10³ tons (%)

Year	Culture Pond	Paddy Field	Fishing in Other Waters	Total
1972	1.15 (35)	0.54 (16.5)	1.59 (48.5)	3.28 (100)
1973	1.30 (42.6)	0.16 (5.2)	1.59 (52.1)	3.05 (100)
1974	0.64 (31.5)	0.33 (16.5)	1.04 (52.0)	2.01 (100)
1975	0.48 (35.3)	0.0 (0.0)	0.90 (64.7)	1.38 (100)
1976	0.50 (38.8)	0.04 (3.1)	0.75 (58.1)	1.29 (100)
1977	0.57 (47.5)	0.01 (0.8)	0.62 (51.7)	1.20 (100)
1978	0.38 (40.8)	0.03 (3.2)	0.53 (57.0)	0.93 (100)
1979	0.61 (49.2)	0.05 (4.8)	0.57 (46.0)	1.23 (100)

Remarks; Estimated figures are obtained by classifying the Landings of each fish type to those of culture pond, paddy field and other waters based on FISHERIES STATISTICS OF MALAYSIA during 1972-1979.

Table 13 TREND OF THE AREA OF CULTURE PONDS
AND THE NUMBER OF CULTURE FARMERS

Year	Culture Pond ^{1/} in Operation (10 ³ ha)	Number of Farmers ^{2/} (10 ³ persons)	ha/Farmer
1972	3.40	-	-
1973	4.18	-	-
1974	4.38	-	-
1975	4.56	-	-
1976	4.54	6.98	0.65
1977	4.78	7.65	0.62
1978	4.88	7.99	0.61
1979	5.09 (3.57)	8.76	0.58

Remarks; 1/: Including the culture area of tin mining pools which was separately reported in 1979 shown in the parenthesis. The area of constructed ponds in 1979 is 1,520 ha (5,090 ha - 3,570 ha).

2/: The number before 1976 was not considered as reliable values in this report and therefore not shown in this Table.

Table 14 TREND OF THE NUMBER OF CULTURE FARMERS AND
THE AREA OF CULTURE PONDS SUBSIDIZED BY DOFS

State	Year				Unit: ha
	1976	1977	1978	1979	Total
Perlis	0 (0)	1.0 (12)	3.0 (24)	3.9 (13)	7.9 (49)
Kedah	0.2 (29)	19.1 (71)	22.2 (64)	12.3 (97)	53.8 (261)
P. Pinang	0 (18)	0.1 (15)	2.1 (21)	1.4 (29)	3.6 (83)
Perak	0 (112)	8.0 (201)	11.1 (149)	46.2 (366)	65.3 (828)
Selangor	1.3 (56)	11.0 (107)	8.7 (51)	1.3 (37)	22.3 (251)
N. Sembilan	0 (38)	11.3 (117)	26.3 (119)	33.5 (157)	71.1 (431)
Melaka	0 (25)	4.1 (58)	12.8 (60)	11.3 (88)	28.2 (231)
Johor (West)	0 (0)	0 (0)	0 (0)	- (8)	0 (8)
Sub-Total (West Coast)	1.5 (278)	54.6 (581)	86.2 (488)	109.9 (795)	252.2 (2,142)
Pahang	1.8 (49)	7.4 (80)	0 (0)	24.4 (83)	33.6 (212)
Tremnganu	2.2 (14)	1.6 (51)	10.9 (94)	16.1 (114)	30.8 (273)
Kelantan	0 (89)	4.6 (105)	6.3 (148)	26.6 (270)	37.5 (612)
Sub-Total (East Coast)	4.0 (152)	13.6 (236)	17.2 (242)	67.1 (467)	101.9 (1,097)
Grand-Total	5.5 (430)	68.2 (817)	103.4 (730)	177.0 (1,262)	354.1 (3,239)

Remarks; Figures in parentheses are the number of culture farmers.

Source; Ref. 11

Table 15 ESTIMATED FISH PRODUCTION OF CULTURE PONDS
IN PENINSULAR MALAYSIA (1972 - 1979)

Year	Area of Culture Pond (10 ³ ha)	Productivity ^{1/} (t/ha)	Estimated Production (10 ³ tons)
1972	3.40	1.34	4.56
1973	4.18	1.34	5.60
1974	4.38	1.34	5.87
1975	4.56	1.34	6.11
1976	4.54	1.34	6.08
1977	4.78	1.34	6.41
1978	4.88	1.34	6.54
1979	5.09	1.34	6.82

Remarks; ^{1/}: Average value in Peninsular Malaysia estimated from production survey of culture ponds as shown in Table 16.

Table 16 THE RESULT OF PRODUCTION SURVEY OF CULTURE PONDS
IN PENINSULAR MALAYSIA IN 1979

State	Number of Pond Surveyed	Survey Area (ha)	Production (ton)	Productivity (t/ha)
Perlis	4	0.7	1.1	1.57
Kedah	5	2.2	1.5	0.68
Pulau Pinang	4	0.7	1.5	2.14
Perak	36	6.4	7.9	1.23
Selangor	21	5.0	10.6	2.12
N. Sembilan	21	8.2	7.6	0.93
Malacca	22	4.3	6.9	1.60
Johor	11	2.3	4.8	2.09
Pahang	39	8.1	7.6	9.38
Trengganu	118	20.9	22.6	1.08
Kelantan	46	6.5	15.6	2.40
Total	327	65.3	87.7	1.34

Table 17 WATER USE OF FRESHWATER PONDS BY STATE IN 1979

State	Area of Culture Pond ^{1/} (ha)	Water Use (x 10 ⁶ m ³ /Year)
Perlis	9	0.12
Kedah	88	1.19
P. Pinang	19	0.26
Perak	386	5.24
Selangor	106	1.44
N. Sembilan	283	3.84
Melaka	71	0.96
Johor	213	2.89
Pahang	236	3.20
Trennganu	48	0.65
Kelantan	60	0.81
Total	1,519	20.60

Remarks; 1/: Fishery Statistics of Malaysia in 1979

Table 18 GOVERNMENT ALLOCATION FOR FISHERIES SECTOR

	SMP	TMP
DOFS	16.1	110.9 ^{1/}
MAJUIKAN	17.5	151.1 ^{2/}
Total	33.6	262.0

Unit: M\$10⁶

Remarks; 1/: Excluding Sabah and Sarawak
2/: Excluding Sabah

Source; Ref. 3

Table 19 DOFS PROGRAMS AND ALLOCATION UNDER TMP

Type of Programs	Allocation	
	M\$10 ³	%
1. Financial assistance to the fishermen and fish culturists	72,700	65.6
2. Development of Infrastructure	29,700	26.8
3. Regulatory and Enforcement	3,700	3.3
4. Research	830	0.7
5. Extension	2,801	2.5
6. Training	840	0.8
7. Community development project	120	0.1
8. Others	215	0.2
Total	110,906	100

Source; Ref. 3

Table 20 MAJUIKAN ALLOCATION BY PROJECT UNDER TMP

Project	Allocation	
	M\$10 ³	%
1. Marine Fishing	19,589	13
2. Aquaculture	4,939	3
3. Ancillary Industry	4,094	3
4. Development of Fishermen Cooperatives (Launching Grant)	17,209	11
5. Marketing	3,717	3
6. Equity participation	19,699	13
7. Unallocated	81,878	54
Total	151,128	100

Source; Ref. 3

Table 21 DEVELOPMENT PLAN OF FRESHWATER POND CULTURE
BY STATE UNDER 4MP

State	Inventory Tin Mining Pool	In 1979 Constructed Pond (1)	Unit: ha		Total
			Dev. Plan ^{1/} of DOFS(2)	Dev. Plan ^{1/} of MAJUIKAN(3)	
Perlis	1	9	20	-	30
Kedah	31	88	142	-	261
P. Pinang	2	19	61	-	82
Perak	2,950	386	142	-	3,478
Selangor	305	106	81	81	573
N. Sembilan	117	283	81	81	562
Melaka	4	71	41	-	116
Johor	29	213	81	122	445
Pahang	118	236	122	122	598
Trengganu	14	48	81	162	305
Kelantan	5	60	162	81	308
Estimated Total Increase from 1979 through 1980	-	283 ^{2/}	-	-	283
Plan of Prawn Culture	-	-	243	-	243
Total	3,576	1,802	1,257	649	7,284

Remarks; 1/: Those are all constructed ponds. Fish culture in tin mining pool is not projected during F.M.P.

2/: Estimated from the exponential trend of increased culture are subsidized by DOFS during 1976 - 1979 as shown in Table 24.

Source; Ref. 12

Table 22 DEVELOPMENT PLAN OF FRESHWATER AND BRACKISH WATER CULTURE UNDER 4MP BY GOVERNMENT

Culture Type	Area ^{1/} (ha)	Productivity (ton/ha)	Fish Price (M\$/kg)	Sales (M\$10 ⁶)
1) Freshwater pond culture				
a) Fish by DOFS	6,392	2.47	2.5	39.5
b) Prawn by DOFS	243	0.81	6.6	0.5
c) Fish by MAJUIKAN	649	2.47 ^{2/}	2.5	4.0
2) Freshwater cage culture	5.6	269.11	2.5	3.8
3) Brackish pond culture				
a) Fish by DOFS	405	3.70	3.3	4.9
b) Shrimp by DOFS	202	1.23	11.6	2.9
c) Fish by MAJUIKAN	1,053	3.70	3.3	12.9
4) Brackish cage culture	1.9	269.11	3.3	1.7
Total	8,951	-	-	70.2

Remarks; 1/: Total area in the end of FMP (1985)
2/: Adjust to the productivity of DOFS

Source; Ref. 12

Table 23 EXTENT AND DISTRIBUTION OF MANGROVE FOREST
IN PENINSULAR MALAYSIA IN 1978

Unit: 10³ ha

State	Mangrove Productive	Forest Unproductive	Total
Perlis	-	-	-
Kedah	7.7	7.3	9.0
P. Pinang	0.4	-	0.4
Perak	39.5	1.0	40.5
Selangor	22.3	0.2	22.5 ^{1/}
N. Sembilan	0.9	0.4	1.3
Melaka	0.0	-	0.0
Johor	18.1	7.5	25.6
Pahang	2.5	0.0	2.5
Trengganu	1.0	0.0	1.0
Kelantan	-	0.0	0.0
Total	92.4	10.4	102.8

Remarks; ^{1/}: Exclude 64 x 10³ ha proposed for excision

Source; Ref. 12

Table 24 TREND OF INCREASED CULTURE AREA
SUBSIDIZED BY DOFS

Year	Area (ha)
1972	-
1973	-
1974	-
1975	-
1976	6 ^{1/}
1977	68
1978	103
1979	177
1980	(283) ^{2/}

Remarks; ^{1/}: Subsidy programme was started in 1976, the 1st year of TMP.
^{2/}: Estimated from the exponential trend during 1976 - 1979.

Source; Ref. 11

Table 25

PROSPECTIVE DEVELOPMENT AREA OF INLAND
FISH CULTURE (1980 - 2000)

Unit: ha

Culture Type	Area				
	1980	1985	1990	1995	2000
1. Freshwater pond culture					
a) Fish pond	1,802	2,721 (3,708) ^{1/}	4,015	5,594	7,522
b) Prawn pond	-	243	359	500	672
c) Tin mining cage culture	3,576	3,576	3,576	3,576	3,576
2. Freshwater cage culture	-	5.6	8.4	11.2	11.2
3. Brackish pond culture					
a) Fish pond	-	1,458	1,946	2,429	2,915
b) Shrimp pond	-	202	267	337	405
4. Brackish cage culture	-	1.9	2.8	3.8	3.8
5. Existing future plans of freshwater pond culture	-	-	-	-	(1,131) ^{2/}
Total	5,378	8,208	10,174	12,451	15,105

Remarks; 1/: Projected total area of freshwater fish culture by the Government under FMP.

2/: It will be absorbed in the trend of the prospective culture area of freshwater fishes and freshwater prawns shown in this Table.

The average annual growth rate of the sum of a), b) and c) during 1980--2000 was assumed at 4%.

Table 26 PRODUCTION IN CULTURE AREAS IN 1990

Culture Type	Production	Unit: ton
1. Freshwater pond culture of fishes including tin mining culture	18,750	
2. Freshwater pond culture of prawns	291	
3. Freshwater cage culture	2,261	
4. Brackishwater pond culture of fishes	7,200	
5. Brackishwater pond culture of shrimps	328	
6. Brackishwater cage culture	754	
Total production of fish culture	29,584	

Table 27 PRODUCTION IN CULTURE AREAS IN 2000

Culture Type	Production	Unit: ton
1. Freshwater pond culture of fishes including tin mining culture	27,412	
2. Freshwater pond culture of prawns	544	
3. Freshwater cage culture	1,894	
4. Brackishwater pond culture of fishes	10,786	
5. Brackishwater pond culture of shrimps	498	
6. Brackishwater cage culture	643	
Total production of fish culture	41,777	

Table 28 FUTURE WATER DEMAND OF FRESHWATER POND
BY STATE IN 1990

State	Area ^{1/} (ha)	Water Demand ($10^6 \text{ m}^3/\text{year}$)			
		Initial	Daily (10^3 tons/ha)	Daily Total	Total
Perlis	39	0.4	0.51	0.14	0.54
Kedah	315	3.2	4.16	1.12	4.32
P. Penang	109	1.1	1.44	0.39	1.49
Perak	726	7.3	9.58	2.59	9.89
Selangor	368	3.7	4.86	1.31	5.01
N. Sembilan	613	6.1	8.09	2.18	8.28
Melaka	153	1.5	2.02	0.55	2.05
Johor	573	5.7	7.56	2.04	7.74
Pahang	660	6.6	8.71	2.35	8.95
Trengganu	398	4.0	5.25	1.42	5.42
Kelantan	420	4.2	5.54	1.50	5.70
Total	4,374	43.8	57.73	15.59	59.39

Remarks; 1/: Development area in each State was allotted from the total projected area of freshwater culture pond (4,374 ha) in 1990, based on the allocated area of freshwater pond by State in 1985 at the end of 4MP.

Table 29 FUTURE WATER DEMAND OF FRESHWATER POND
BY STATE IN 2000

Unit: 10^3 tons

State	Area ^{1/} (ha)	Initial (10^6 m ³)	Daily (10^3 m ³)	Daily Total (10^6 m ³ /yr)	Total (10^6 m ³ /yr)
Perlis	74	0.7	0.97	0.26	0.96
Kedah	590	5.9	7.79	2.10	8.00
P. Penang	205	2.1	2.71	0.73	2.83
Perak	1,360	13.6	17.95	4.85	18.45
Selangor	688	6.9	9.08	2.45	9.35
N. Sembilan	1,147	11.5	15.14	4.09	15.59
Melaka	287	2.9	3.79	1.02	3.92
Johor	1,074	10.7	14.18	3.83	14.53
Pahang	1,237	12.4	16.33	4.41	16.81
Trengganu	754	7.5	9.95	2.69	10.19
Kelantan	778	7.8	10.27	2.77	10.57
Total	8,194	82.0	108.16	29.20	111.20

Remarks; ^{1/}: Development area in each State was allotted from the projected total area of freshwater culture pond (8,194 ha) in 2000, based on the allocated area of freshwater pond by State in 1985 at the end of 4MP.

Table 30 UNIT CONSTRUCTION AND O&M COSTS

Costs	Constructed Pond Culture	Cage Culture
Financial		
Construction (M\$10 ³ /ha)	20.7	592.0
O&M (M\$10 ³ /ha/y)	0.2	11.8
Economic		
Construction (M\$10 ³ /ha)	16.6	473.6
O&M (M\$10 ³ /ha/y)	0.2	9.4

- Remarks; (1) At 1980 end price
 (2) Including physical contingency but excluding price contingency

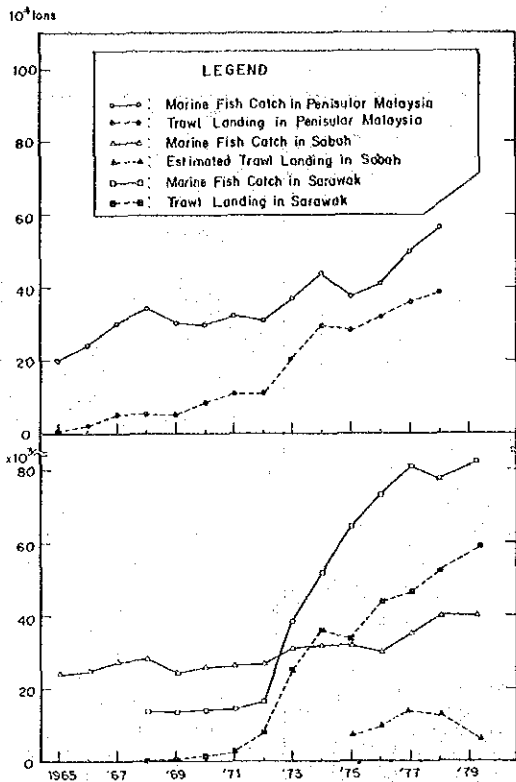
Table 31 NET ANNUAL PRODUCTION VALUE OF CAGE CULTURE AND POND CULTURE

Unit: M\$10³/ha/y

Item	Cage Culture	Pond Culture
1. Gross Production Value		
(1) Productivity	269.1 tons/ha/y	1.34 tons/ha/y
(2) Fish price	M\$2.5 x 10 ³ /ton	M\$2.5 x 10 ³ /ton
Gross production value	672.8	3.4
2. Financial Production Cost		
(1) Labor		
M\$250/month/74.3 m ² (2 rafts)/ 10,000 m ² /ha x 12 months/y	403.8	
(2) Seeds		
140 x 10 ³ pcs/ha/y x M\$0.4/pce	56.0	
(3) Fuel		
M\$10/month/74.3 m ² x 10,000 m ² x 12 months/y	16.2	
(4) Licence fee	0.1	
Total	476.1	0.9
3. Net Annual Production Value (Financial)		
M\$672.8 x 10 ³ /ha/y - M\$476.1 x 10 ³ /ha/y	196.7	
M\$3.4 x 10 ³ /ha/y - M\$0.9 x 10 ³ /ha/y		2.5
4. Net Annual Production Value (Economic)		
M\$196.7 x 10 ³ /ha/y x 0.8	157.4	
M\$2.5 x 10 ³ /ha/y x 0.8		2.0

Remarks; (1) At 1980 end price
(2) Including physical contingency but excluding price contingency

FIGURES



Remark 2.1: Estimated trawl Landings in SABAH do not include prawn catch.
Fig.1 Comparison of Total Fish Catch and Trawl Catch among Peninsular Malaysia, Sabah and Sarawak

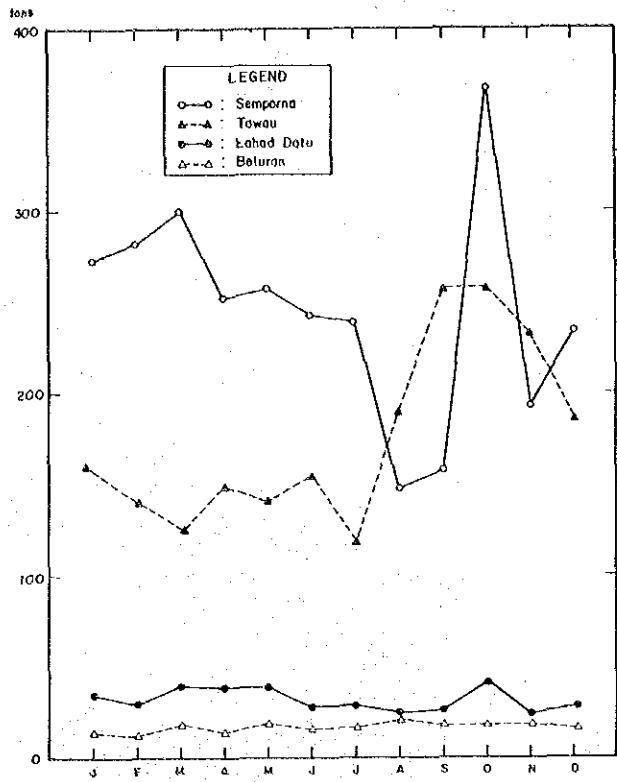


Fig.4 Seasonal Change of Landings at Main Market in Sabah, 1979 (3/3)

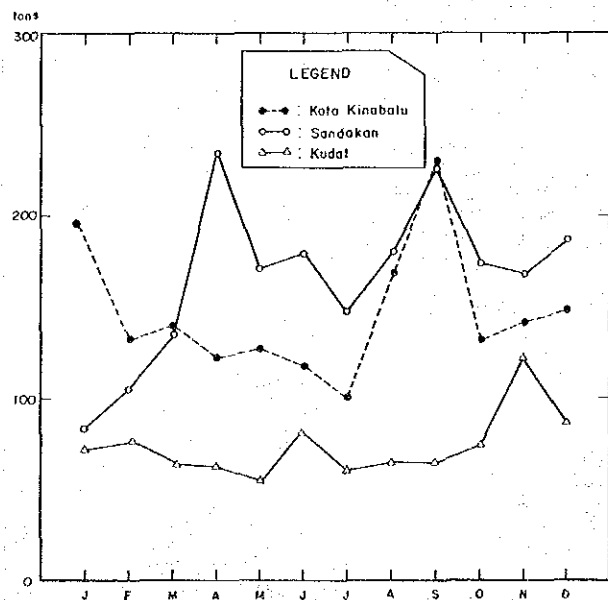


Fig.2 Seasonal Change of Landings at Main Market in Sabah, 1979 (1/3)

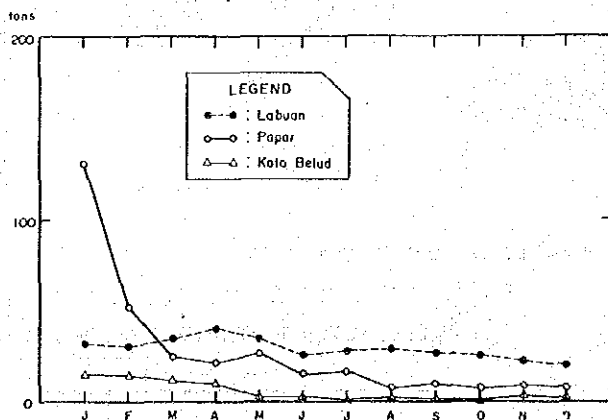


Fig.3 Seasonal Change of Landings at Main Market in Sabah, 1979 (2/3)

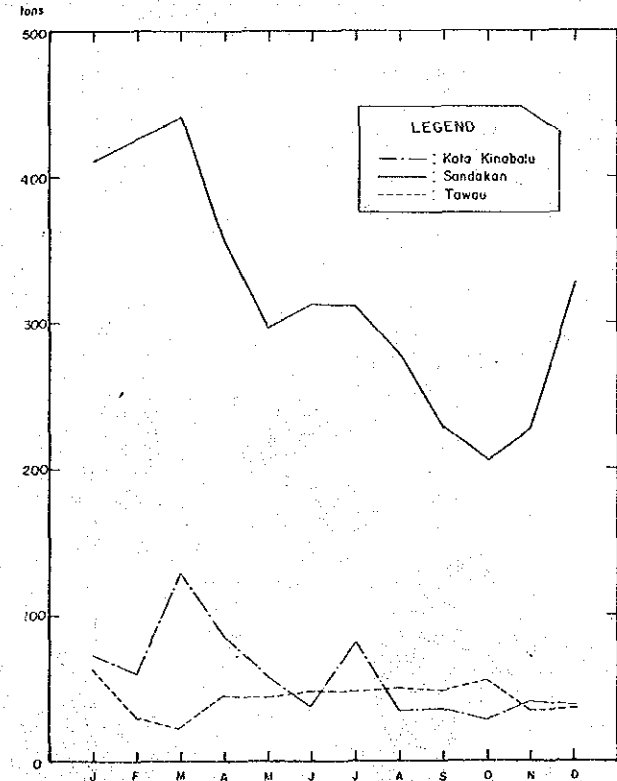


Fig.5 Monthly Landings of Prawns by Trawler, Sabah, 1979

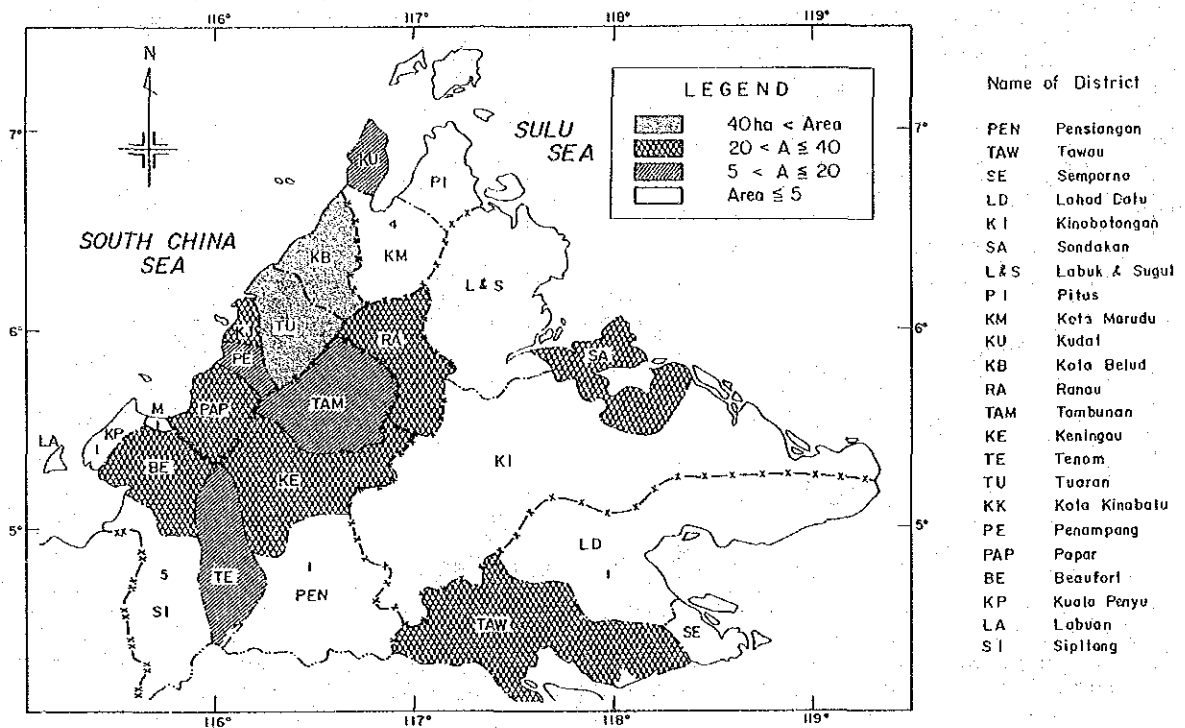


Fig. 6 Comparison of Freshwater Pond Area by District in Sabah, 1979

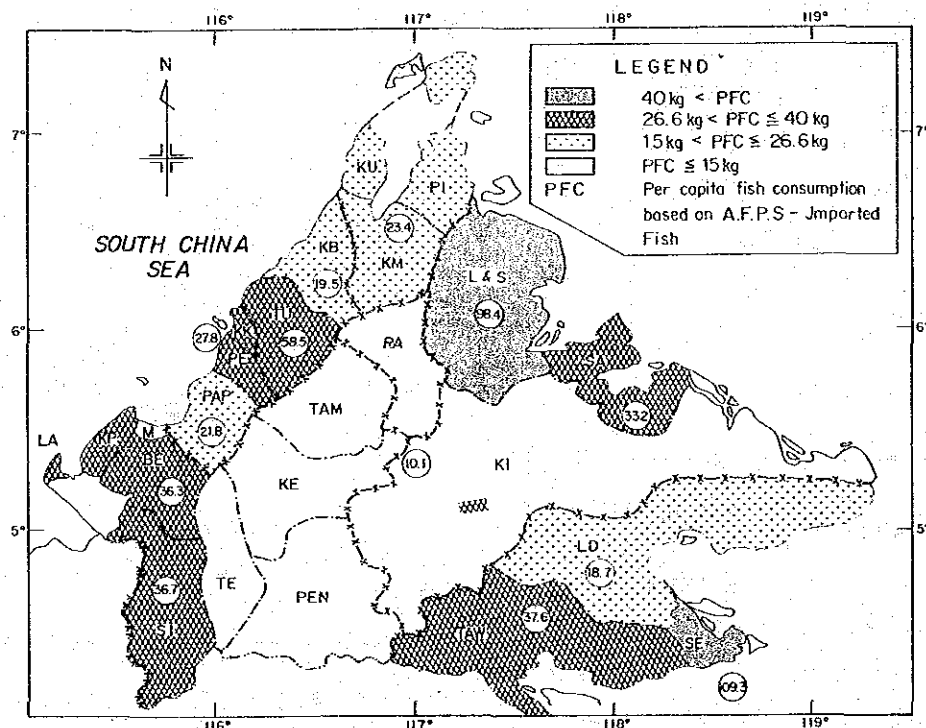


Fig. 7 Comparison of Per Capita Fish Consumption by District in Sabah, 1979

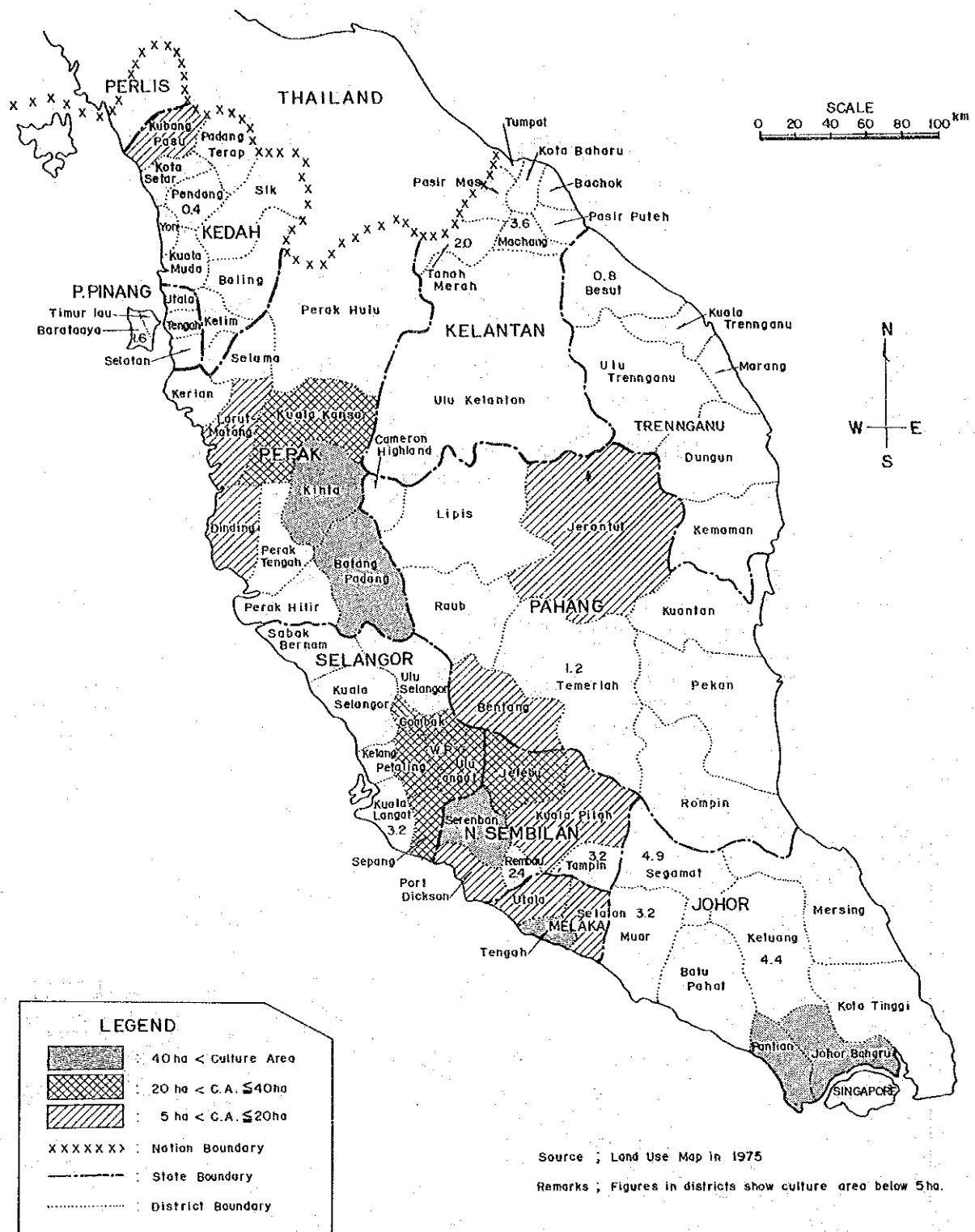


Fig.8 Main Districts of Freshwater Fish Culture in Peninsular Malaysia in 1975

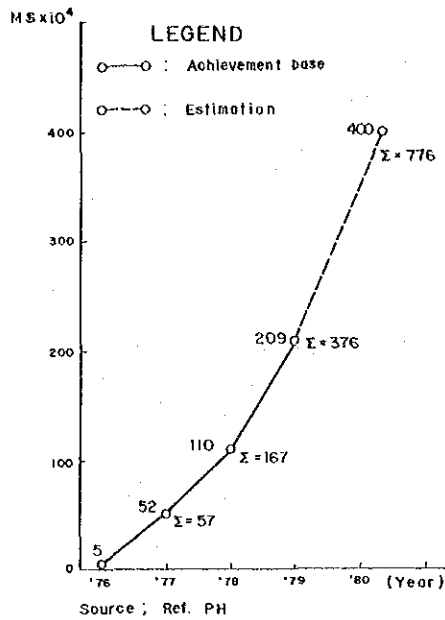


Fig. 9 Trend of Subsidized Area for Inland Fish Culture under TMP

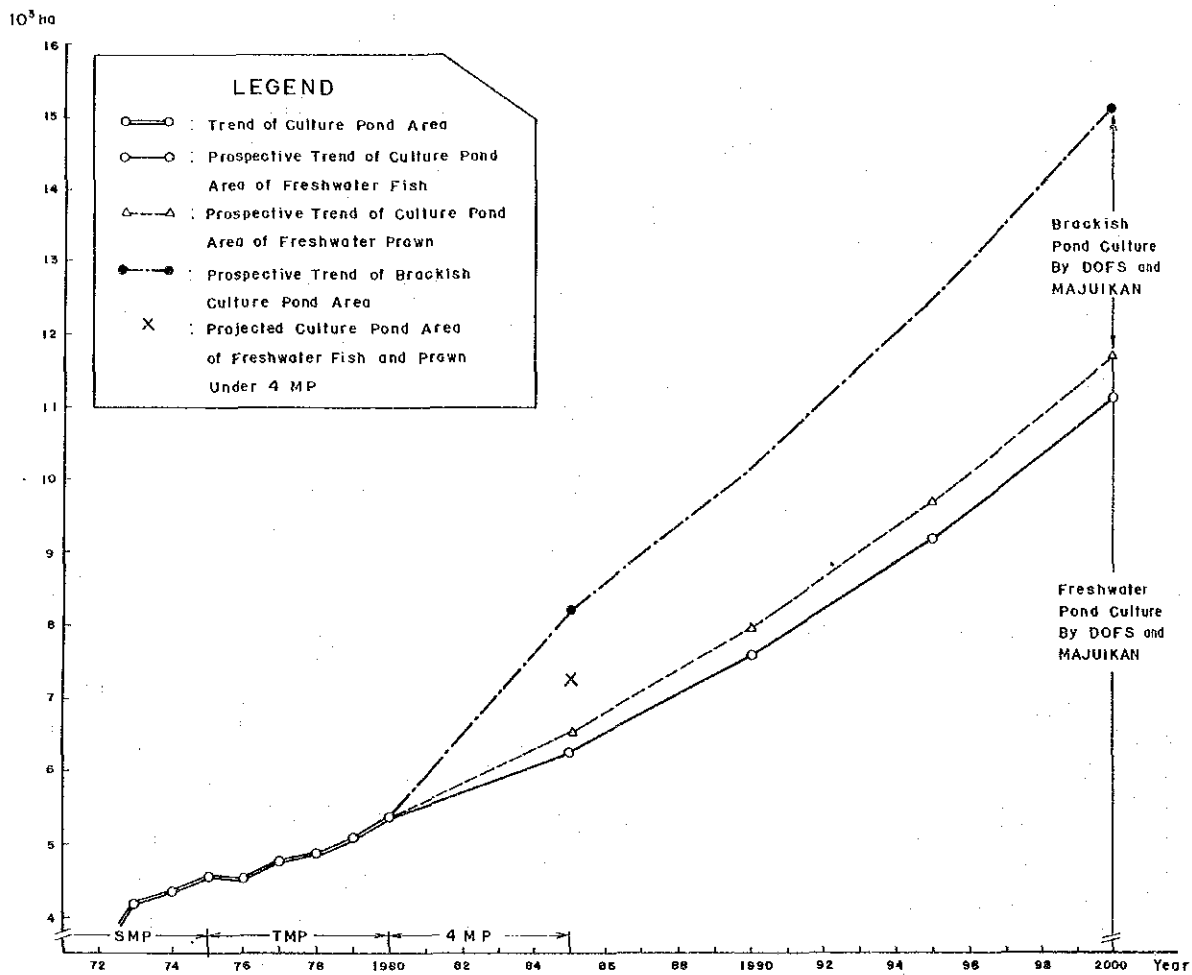


Fig. 10 Prospective Trend of Culture Area of Inland Culture (1980-2000)

PART 2
SABAH AND
SARAWAK

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1. INTRODUCTION

Fishery activities of Malaysia consist of two categories; marine fishery and inland fishery. In this Study, brackish water activity is included into the category of inland fishery.

The main objectives of the Study are as follows:

- (a) to clarify the present condition of fishery activities both in Sabah and Sarawak, and to estimate the present water use by the inland fishery activity,
- (b) to project the future direction and production of inland fishery taking the Government policies into consideration,
- (c) to estimate the future freshwater demand, and
- (d) to identify the problems and needs required for the development of inland fishery.

2. PRESENT CONDITION OF INLAND FISHERY

2.1 Present Condition in Sabah

2.1.1 Fishery administration

In Sabah, fishery activities, both in marine and inland waters, are under the administration of Department of Fisheries (DOFS) of the State Government in concurrence with the Federal DOFS. The State DOFS is divided into the following six divisions; Inland Fisheries Division, Marine Fisheries Division, Administration, Aquaculture Division, Research Center, and Marine Statistics and Extension Section. The State established the Sabah Multi-Purpose Fishermen's Cooperative Limited (KO-NELAYAN) in 1978 as a statutory body. Under the consultation of State DOFS, KO-NELAYAN supports fishermen activities such as off-shore fishing and coastal aquaculture with provisions of technical aid and financial assistant programs. The function of KO-NELAYAN is similar to that of the Fisheries Development Authority (MAJUIKAN) in Peninsular Malaysia and Sarawak (Ref. 1).

2.1.2 Fish production and consumption

(1) Marine fish production

The coastal line of Sabah borders on the South China Sea in the northwest, on the Sulu Sea in the northeast and on the Celebes Sea in the southeast.

According to the fisheries statistics, the total fish production in Sabah increased from 25,000 to 41,900 tons during the past 15 years from 1965 to 1979 as shown in Table 1 (Refs. 2 & 3). Its average annual growth rate is 3.8% and relatively slow compared with that of Peninsular Malaysia and Sarawak. Table 2 shows historical record on the number of trawlers in Sabah and Sarawak. Fig. 1 made on the basis of statistical figures portrays that introduction of trawl fishing to Sabah has not induced to increase fish landings like Peninsular Malaysia and Sarawak. Although trawl fishing in Sabah and Sarawak principally aims at catching prawns, DOFS's estimate based on sampling catches by prawn trawling clarifies that the proportion of prawn catch to the total catch is only 3.3%. On the other hand, various marketable fishes share 25.1% and trash fishes occupy 71.6% (Refs. 4 & 5). It is reported in the statistics that the landed amount of prawns by trawlers in 1979 is 5,400 tons. Landing amount of other fishes can be expected to be 41,000 tons for marketable fishes and 117,000 tons for trash fishes during 1979 based on the above sampling test, while, in the statistics, marketable fishes recorded are 6,800 tons and trash fishes are only 1,200 tons. From this fact, it can be considered that (1) more than 80% of marketable fishes caught by trawlers deteriorate quality before landing due to lack of proper stocking facilities, (2) considerable portion of fish catch has a channel to consumers by-passing the existing market after landing, and (3) some amount is brought back to fishermen's home for their family consumption.

(2) Seasonal change of marine fish catch

Figs. 2 to 4 show monthly landings at the following markets during 1979; Tawau, Lahad Datu and Semporna located in the southeast coast; Sandakan, Beluran and Kudat in the northeast coast; and Kota Belud, Kota Kinabalu, Papar and Labuan in the southwest coast. As Sabah and Sarawak are affected by monsoon twice a year, i.e. the northeast monsoon prevailing in a period from November to January and the southwest monsoon from May to July, fish catch generally becomes high during the respective Inter-monsoon seasons. Seasonal fluctuation of fish landing amount is, however, limitedly seen at good lucrative markets such as Tawau, Semporna, Sandakan and Kota Kinabalu as illustrated in Figs. 2 to 4. On the contrary as illustrated in Fig. 5, prawn trawling shown one peak season from December to April throughout a year.

(3) Freshwater fish production

Freshwater fish production from ponds and rivers mainly comes from inland areas such as Tenom, Keningau and Kinabatangan, and increased from 1,000 to 1,700 tons during the period from 1970 to 1979 as shown in Table 1. The freshwater fish production in 1979 occupied only 4.1% of the total fish production. In Sabah, freshwater fish ponds of 366 ha, which is 80% of the whole fish ponds, are mostly located in the surrounding of big towns in the coastal areas as shown in Table 3 and Fig. 6. If the productivity of freshwater ponds is assumed to be 2.47 tons/ha/y taking into account Federal DOFS's projection for 4MP, another some 900 tons can be added to the said production. Freshwater fish production from ponds and rivers in 1979 was, therefore, estimated to be around 1,800 tons, corresponding to about 6% of total fish production in Sabah.

(4) Fish consumption

The definition of fish consumption in this Study is the demand for available fish as protein source (A.F.P.S) which is expressed by the following formula:

$$\text{A.F.P.S} = (\text{Total fish production} - \text{Trash fish production}) \\ + (\text{Imported fish} - \text{Exported fish})$$

In 1979 as shown in Table 4, the State of Sabah exported about 4,200 tons of fishery products among which 3,800 tons were chilled or frozen prawns, and imported about 7,100 tons of fishery products out of which 6,500 tons were canned fishes including about 4,700 tons of cheap canned fishes and horse mackerel. Per capita consumption in the whole Sabah was estimated on the basis of equation mentioned above. The estimated per capita consumption is 33.6 kg as a value of A.F.P.S minus imported fishes and exceeds the national target projected by the Federal DOFS for 4MP by 7.0 kg. Fig. 5 portrays the characteristics of per capita consumption by district level in 1979.

The Districts of Renau, Tambunan, Keningau, Tenom, Pensiangan and Kinabatangan are deficit areas with per capita consumption of 10.1 kg/y; The Districts of Lahad Datu, Kota Belud, Papar, Kudat, Pitas and Kota Marudu are comparatively deficit areas with per capita consumption of

18.7 to 23.4 kg/y; the Districts of Sandakan, Tawau, Tuaran, Kota Kinabalu, Beaufort and Labuan are relatively enough supplied areas with per capita consumption of 27.8 to 38.5 kg/y; and the Districts of Semporna and Lubuk/Sugut are definitely surplus areas with per capita consumption of 98.4 to 109.3 kg/y.

Although landed fish is brought in markets of deficit areas to fill local gap in per capita consumption, its distribution is restricted between landing places and towns of which accessibility is expected to be good enough for fish transportation. It seems, therefore, that people in the rural areas depend on preservable protein source such as dried fishes and canned fishes. People in town areas such as Kota Kinabalu and Labuan also buy imported canned fishes such as sardines and horse mackerels, because those prices are competitive with those of fresh fishes especially during the monsoon seasons. The background of such tendency can be imagined by reviewing of price elasticity from the standpoint of fluctuation in market prices of imported canned fish and landed fresh fish as shown in Fig. 8.

A.F.P.S in Sabah has been increasing at an average annual growth rate of 4.9% from 1975 to 1979 as shown in Fig. 9. Per capita fish consumption as A.F.P.S is estimated at 45.2 kg in 1979. This value is much higher than the national target of 26.6 kg during 4MP.

2.1.3 Marine fishery resources

Information on the marine fisheries resources, whether it be of prawns or fin fishes such as pelagic, demersal and coral reef types, is available only in the form of data on catches and in the form of survey reports by a number of research vessels. Comparison of marine fish resources estimated by the Federal Ministry of Agriculture and by FAO/South China Sea Survey (Ref. 6), is as shown in Table 5. Both of the estimates show almost similar results on the potentials of pelagic and demersal fishes. For the convenience of further discussion, FAO's estimate is taken in this Study because it presents breakdown figures.

When comparing the marine fishery resources with the actual fish catch in 1979, the following findings on the resources balance are obtained as shown in Table 6:

- (1) Resources of pelagic fish in the northwest coast have still surplus of 13,000 tons, but those of the northeast/southeast coast have already become deficit of 8,300 tons; and
- (2) Resources of demersal fish in both the coasts of northwest and northeast/southeast have still much surplus of more than 30,000 tons each, but, if discarded fishes by prawn trawlers are counted, the northwest coast remains surplus of only 6,000 tons and the northeast/southeast coast become deficit of more than 90,000 tons.

These conditions of demersal fish resources can be pointed out by constant or declining trend of prawn catch per boat in both the coasts as follows:

- (1) Prawn catch in the northwest coast shows rapid increase after 1976 as shown in Fig. 10, but this trend will not be continued so long in future because prawn catch per trawler has already been declining since 1976 as shown in Fig. 11. Almost the same trend can be observed in the southeast coast as shown in Fig. 12; and
- (2) Prawn catch in the northeast coast has reached maximum level of potential resources, because the number of trawler has been in inverse proportion to prawn catch per trawler since 1970 as shown in Fig. 13.

Therefore, the marine fisheries resources in Sabah might not have so much allowance, unless trash fish caught by prawn trawler will be utilized for good consumption purpose in future, supported by the improvement of marketing and transportation facilities.

2.1.4 Inland fishery activities

In Sabah, there are three types of inland fishery activities such as riverine fishing, freshwater pond culture and brackish pond culture.

(1) Riverine fishing

No data are available on the activities of riverine fishing. Based on the interview survey to village people who have been living along the Moyog, Padas, Sugut and Labuk rivers, the following facts are clarified as shown in Table 7:

- (a) Compared with fish catch in 10 to 20 years before, the recent fish catch much decreased in most rivers;
- (b) Increase in population and siltation mainly causes decrease in fish catch; and
- (c) Fish catch is only conducted for home consumption in most rivers.

According to information obtained from an officer of Federal DOE undertaking water quality observation in the middle stream of the Kinabatangan river, most people living along this river are catching river fishes for their protein source.

(2) Brackish pond culture

Sabah DOFS established Mengattal Brackish-water Culture Station in 1975. This Station has property of 120 ha and 18 ponds with the total water surface area of 10 ha. This target fishes are marine prawns,

milkfish, groupers, mullets and snappers. The State Government is further trying to encourage local people to start brackish pond culture provided with subsidy of M\$3,710/ha (M\$1,500/acre) for the newly constructed pond. In 1980, about 32 ha of brackish ponds were firstly constructed in Sandakan, Tawau and Semporna. In Tawau, one private company, Teck Guan Sdn. Bhd., is developing fish ponds of about 800 ha by using pumped water.

There are vast suitable locations for brackish pond culture in Sabah. But the State Government still needs more accumulation of basic technical data to give feasible visions of this culture to the local people.

(3) Freshwater pond culture

In Sabah, freshwater pond culture is still much more popular than brackish pond culture. The State Government is giving the following assistances only to small fish farmers:

- (a) subsidy of M\$7,410/ha (M\$3,000/acre) to the newly constructed pond,
- (b) supply of fish fry without charge for local species and with charge for imported chinese carps, and
- (c) technical advice to fish farmers.

By this assistance, almost 100% of freshwater fish culture activities has been being supported since 1965. During the period from 1961 to 1980, total number of fish ponds increased from 715 to 4,000, and those surface areas increased from 23 to 484 ha. The Residencies of West Coast and Kudat show sharp increase in their surface area of fish pond as shown in Fig. 14.

According to information from Sabah DOFS, the average annual productivity of freshwater pond estimated is about 2.5 tons/ha or 17 piculs/acre. This figure seems to be over the target productivity of 2.5 tons/ha/y set by Federal DOFS for 4MP. However, the number of fish fry distributed is too few to operate all the existing ponds at a standard fish density as shown in Table 8. Because farmers would not harvest every year from the commercial viewpoint. The harvest depends on farmers' own needs. The total average operation rate is only 25.7% for the total surface area of pond of 454 ha in 1979. As shown in Table 8 and Fig. 15, half of the total fish pond areas show operation rate below 20%. In consequence, most of the existing freshwater ponds are not properly operated even though the State Government provides technical and financial aids.

2.2 Present Condition in Sarawak

2.2.1 Fishery administration

In Sarawak, marine fishery activities are under the administration of the branch offices of Federal DOFS and MAJUJIKAN. On the other hand, inland fishery activities including fresh and brackish water fisheries are under the jurisdiction of Inland Fisheries and Aquaculture Section of the State DOA.

2.2.2 Fish production and consumption

(1) Marine fish production

All coastal line in Sarawak is bordered to the South China Sea. Its eastern half lies on the continental shelf with a muddy, sandy and coral bed. But its western half is engulfed by the Sarawak Bay which is shallow and extends far from shore and into which many rivers run down.

According to the fisheries statistics (Ref. 3), the total marine fish production in Sarawak rapidly increased from 13,700 to 82,300 tons during the period from 1968 to 1979. This is apparently caused by the introduction of trawl fishing as shown in Fig. 1.

In Sarawak, trawlers are also landing not only marketable fishes and prawns but also much amount of trash fish. Historical records of landings from 1968 to 1979 are as shown in Table 9.

(2) Seasonal change of marine fish catch

Monthly loadings of marine fish catch in 1979 clearly show seasonal change with its peak from May to September and its bottom from November to January, the monsoon season, as shown in Fig. 16. The monthly landings in Division facing the coast also show the same tendency in the seasonal change as shown in Fig. 17. The gap between monthly average landing of three months during the peak season and that during the bottom season amounts to 6,300 tons per month in 1979. Such seasonal fluctuation of landings causes to induce import pressure of fishery products as shown in Fig. 18.

(3) Inland fish production

In Sarawak, inland fish production mainly comes from riverine fishing and freshwater pond culture. Brackish pond culture is still under the experimental stage by the State Government.

According to the statistical records of the Inland Fisheries and Aquaculture Section since 1960, the maximum river fish landing recorded was 137 tons in 1976 and the minimum was 1 ton in 1979 as shown in Table 10. Though there seems to be declining trend in its production, it is said that many people are still being engaged in fisheries along the

Rajang and the Baran rivers or at estuaries of the Sarawak, the Kayan and other rivers.

Freshwater pond culture has been rapidly developing since 1958. The number of ponds increased from 3,300 in 1958 to 22,900 in 1980 and surface area of ponds extended from 3 ha in 1958 to 1,700 ha in 1980 respectively, as shown in Table 11. The fish production from these freshwater ponds is estimated at about 1,300 tons in 1980 as shown in Table 12. This production figure is equivalent to only 1.6% of total marine fish production of 82,300 tons in 1980.

(4) Fish consumption

As of 1979, per capita fish consumption in Sarawak was estimated to be 42.1 kg as A.F.S.P minus imported fish and 50.1 kg as A.F.S.P. Both are much higher than the national target of 26.6 kg under 4MP. Import of fish products has overcome export of those during the recent 10 years since 1970 as shown in Table 13. Per capita consumption by division level obtained on the A.F.S.P minus imported fish basis is illustrated in Fig. 19. That based on A.F.S.P is as shown in Fig. 20.

The Fourth and Fifth Divisions are deficit areas with per capita consumption of 11.7 to 19.7 kg/y; the eastern part of First Division including Kuching, the biggest city in Sarawak, is relatively enough supplied area with per capita consumption of 30.2 kg/y; and other Divisions are enough surplus areas with per capita consumption of 44.9 to 181.6 kg/y. Especially, the western part of the First and the Sixth Divisions are definitely surplus areas.

To fill gaps among local consumption of fresh fishes and to supplement seasonal fluctuation in fish catch, domestic trading and import of fish products are scantily made in limited rural areas with fairly good accessibility.

2.2.3 Marine fishery resources

Outline of marine fisheries resources in Sarawak is explained in Table 5. When comparing the marine fishery resources with the actual fish catch in 1979, the following findings are obtained as shown in Table 15:

- (1) Resources of pelagic and demersal fish have still surplus in Sarawak; and
- (2) Resources of demersal fish in the eastern coast of Sarawak remains 9,500 tons mainly due to over fish catching.

As shown in Fig. 21, total landing in Sarawak has sharply increased during the period from 1972 to 1980 as a result of introduction of trawlings. Since 1976, fishermen have accelerated modernization of their fishery activities by replacement of their traditional fishing boats to new trawlers with fish catch capacity of 70 tons on an average as shown in Fig. 22.

2.2.4 Inland fishery activities

Same as in Sabah, there are also three types of inland fishery activities in Sarawak, riverine fishing, brackish pond culture and freshwater pond culture.

(1) Riverine fishing

Based on the interview survey under the Study, the following facts were found out as shown in Table 16:

- (a) Fish catch decreased much in most parts of the rivers during previous 10 to 20 years;
- (b) Fish catch is usually done for home consumption, but, in the lower reaches, full-time and part-time fishing were observed in all rivers surveyed; and
- (c) Though cause of decrease in fish catch is not so clear, siltation and bottom-up of riverbed may have severely affected riverine fishing in upstream reaches.

(2) Brackish pond culture

The Inland Fishery and Aquaculture Section of DOA has strong intention of developing brackish pond culture and has been conducting its experiment since 1968. Up to date, four coastal aquaculture stations have been established and undertaken research works. The major station among them is Semariang Batu Station in the First Division. Its target fishes are mullet, milk fish, seabass, grouper, thread fish, tilapia and marine and freshwater prawns. The Inland Fishery and Aquaculture Section has recently reached a conclusion that mullet is most suitable target fish in Sarawak. Basic data such as its productivity, optimum density and growth rate have not been obtained yet, but the good result is expected in view of its omnivorous habit, its fast growth, its rich fry resources and its high market price.

Within coming few years, the State Government could be expected to establish the feasible system of fish pond management for mullet culture.

(3) Freshwater pond culture

According to the statistical information, freshwater pond culture is quite popular in Sarawak. The Government is giving the following assistances only to small-scale fish farmers:

- (a) subsidy of M\$3,700/ha (M\$1,500/acre) to the newly constructed pond, M\$2,470/ha (M\$1,000/acre) to valley type and M\$2,970/ha (M\$1,200/acre) to dug-out type,
- (b) rental of a tractor and its driver at lower rate than the market rate,

- (c) supply of fish fry without charge both for local species and imported chinese carps in the initial stage, but with charge from the second stage, and
- (d) technical training of fish farmers in the Government training center.

The said subsidy program was started in 1961. As of 1980, almost all of fish culture activities are supported by these assistances. However, annual productivity level is still low, ranging from 1.07 ton/ha in the First Division to 0.24 ton/ha in the Third Division. These are quite lower than the national target of 2.5 ton/ha under 4MP. The Government has recognized that the main cause is the poor management of pond operation. The renovation program for the low productive ponds or abandoned ponds has been initiated since 1981.

Development of freshwater pond has been mostly concentrated in the First and Second Divisions. The surface area of freshwater pond in these two Divisions occupies 62.6% of the total as shown in Fig. 23. The population of these Divisions is about 640,000 in 1980, which corresponds to 48.7% of the total of 1.31×10^6 in Sarawak.

3. PRESENT WATER USE OF INLAND FISHERY

3.1 Sabah

3.1.1 Riverine fishing

As described in Section 2.1.4, river fishes are caught only for home consumption in most rivers in Sabah. Although people have recently not been able to catch fish so much, many of them are still going fishing to the rivers.

Compared with the river conditions in Peninsular Malaysia, natural river conditions still remain in Sabah and many people rely on the rivers.

3.1.2 Fish culture in inland water

(1) Brackish pond culture

Brackish ponds should be principally located in tidal flat areas. The salinity of the pond water is expected to be 15 to 25 g/l. But most target fishes are strong against fluctuation of salinity concentration. It is considered that special supply of freshwater is not necessary for brackish pond culture.

(2) Freshwater pond culture

There are two types of freshwater pond in Sabah and Sarawak. One is a dug-out type which is excavated in flat land and water is supplied from irrigation canals, small streams or only rainfalls. The other is a valley type which forms a reservoir by a small dike with the height of 10 to 15 feet and water is stored stream flow. According to an officer of DOFS in Sabah (Ref. 6), about 70% of freshwater ponds is the dug-out type and mainly depends on the water from small streams, irrigation canals and rainfalls. Present water demand for dug-out type ponds was estimated based on the following assumptions:

- (a) Maximum 70% of ponds in each District is composed of the dug-out type to which water is supplied from small streams other than rainfalls;
- (b) Pond is kept in stagnant condition and its average depth is 1 m;
- (c) Pond water is completely drained out once a year for harvest;
- (d) Water is daily supplied to a pond to supplement the water loss caused by percolation and evaporation; and
- (e) Percolation loss was estimated to be 2 mm/day in the whole State and evaporation loss was estimated as shown in Table 17.

The present water demand for a dug-out type of pond was estimated by District. The results are as shown in Table 18. In 1980, about 11×10^6 tons of water was annually consumed by freshwater pond with the dug-out type in Sabah. The annual water consumption was concentrated to the Districts of Kota Belud, Tuaran, Kota Kinabalu and Papar of which total water use was 5.94×10^6 tons or 54.7% of the total in Sabah. As pointed out in Section 2.2.4, many ponds are not operated at present so that this estimate can be considered as maximum water demand for the existing dug-out ponds of which water is supplied from irrigation canal.

3.2 Sarawak

3.2.1 Riverine fishing

As described in Section 2.2.4, river fishing in Sarawak is being done not only for home consumption but also for sale to markets in the whole rivers. Fish catch has recently decreased nearly half when compared with that of 10 to 20 years before. Especially, upstreams of rivers in Sarawak seem to be suffering from siltation caused by logging and shifting cultivation.

3.2.2 Fish culture in inland water

As described in Section 3.1.2, brackish pond culture is not necessary for freshwater supply. As for freshwater pond culture, there are also two types in Sarawak; dug-out type, and valley type. According to the information of State DOA, about 80% of freshwater ponds are the valley type, and the remaining 20% is the dug-out type. The valley type ponds are supplied with water only from small streams other than rainfalls. The dug-out type ponds reserve only rainfalls. As of 1980, there is no pond provided with water from irrigation canals in Sarawak. It is said that ponds of dug-out type are not so often suffering from low water level even during the dry season. The major causes of low productivity of freshwater ponds in Sarawak are poor management of pond and, to some extent, too much depending on the rainfall in case of dug-out type pond.

4. PROSPECTIVE DIRECTION OF INLAND FISHERY DEVELOPMENT

4.1 Sabah

4.1.1 Development policies of the State Government

Fisheries development policies of TMP was to eradicate the poverty of artisanal fishermen and to fulfill the self-sufficiency of food by means of increasing:

- (a) the income earning capacity of fishermen through the development of aquaculture such as freshwater and brackish water and marine cage culture; and
- (b) the production of fish by introducing efficient fishing methods including deep sea fishing (Ref. 7).

According to 4MP (Ref. 8), the development policies of TMP are taken over to 4MP. Proposed budget for inland fisheries development is about M\$4.2 x 10⁶ corresponding to 14.7% of total proposed budget of M\$28.3 x 10⁶ for marine and inland fisheries projects as shown in Table 19.

4.1.2 Existing development plans

At present, only one fisheries development plan with a level of prefeasibility study is available, which is the Sabah Regional Planning Study (Ref. 5). Following matters in relation to inland fisheries activities are discussed in this report:

- (1) Prawn culture represents the best opportunity for the aquaculture in Sabah from the viewpoint of existence of extensive areas suited to prawn culture. Future prawn production by aquaculture is estimated to be 180 tons in 1980, 540 tons in 1985 and 2,256 tons in 2000, respectively. This estimate is made by taking into consideration the successful result in the Teck Guan's Prawn Culture Project with new ponds of 800 ha;
- (2) A long-term ecological research on the mangrove areas and a monitoring survey on productivity of prawn culture from technical aspect are recommended;
- (3) The potential of freshwater pond culture is highly evaluated from viewpoint of suitable environmental conditions and continuous efforts for assistances by the Government to small fish farmers. No future production in the year 2000 is projected; and
- (4) A recommendation is presented with regard to the review of assistant program by the Government and the improvement of the statistical reliability in collecting information on freshwater pond culture.