SOUTH CHINA SEA FISHERIES DEVELOPMENT AND COORDINATING PROGRAMME

PROGRAMME DE DEVELOPPEMENT ET DE COORDINATION DES PECHES DANS LA MER DE CHINE MERIDIONALE

The Potentials of Aquaculture Development

Indo-Pacific Region

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United Nations Development Programme

Executing Agency
Food and Agriculture Organization
of the United Nations

Work Plan Implementation
(Working Paper)

SCS/74/WP/1

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Manila, November 1974

INDO-PACIFIC REGION

The Potentials of Aquaculture Development

by

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Project Document Identification

Work Plan Activity: 4(b)

4. The objective will be to establish a programme of action for aquaculture development through the improvement of cultural practices in existing areas in particular countries, and the development of new areas. The Work Plan will be implemented through a permanent South China Sea Programme staff member and consultants. The work of consultants will usually be carried out in the individual countries; there will also be desk studies and consultations at the Programme's headquarters. The work will commence in 1974, and will continue over five years of the Programme. The work will involve:

   (b) Determination of the extent and nature of areas in each country suitable for future expansion of aquaculture.

Note: This paper was also contributed to the Second Meeting of the IPFC Working Party on Coastal Aquaculture and Environment, Jakarta, Indonesia, 26-29 October, 1974.

THE POTENTIALS OF AQUACULTURE DEVELOPMENT IN THE INDO-PACIFIC REGION[1]

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1 INTRODUCTION

The world fishery production from all sources during the last five years (1968-1972) was, on the average, about 60 million metric tons. Of these, about 5 to 6 million or 8-10 percent came from aquaculture.

The world aquaculture production, by kind, consists of the following:

	Production in metric tons
1) Finfish	3 657 373
2) Crustaceans	14 298
3) Molluscs	966 400
4) Seaweeds, etc.	373 200
T O T A L	5 011 271

The distribution of world aquaculture areas and production, by regions, is as follows:

Region	Estimated area (ha)	Production (Metric tons)	Percent on total Production
Asia and Far East[2]	1 926 393	4 030 481	80.0
Europe	158 560	497 913	9.9
North America	41 085	447 351	9.5
Australia/New Zealand	10 000	20 500	0.4
South America	25 502	11 367	0.2
Africa	6 562	3 659	0.07
	2 168 102	5 011 271	100

[1] For lack of adequate information, it was not possible to include discussion on China in this paper.

[2] New and updated estimates for this region are given in APPENDIX A.

Asia and the Far East Region is the center of development of the world aquaculture industry. Its over 2 million hectares devoted to this sector of food production is the most extensive and its overall production of over 2 million metric tons is likewise the highest. As one travels to the countries of the region, however, one notices the differences in stage of development in the different areas ranging from those that have barely started (Bhutan, Khmer Republic) to some with extensive areas (Indonesia, Philippines) and some using sophisticated techniques (Japan).* There is also large variation in kinds of resources utilized (finfish, crustaceans, molluscs, seaweeds, etc.) and methods used (ponds, enclosures, cages, running waters, etc.) and divergence in sites developed (brackish waters, freshwaters, protected coasts, etc.)

There is general lack of trained personnel for the industry for extension workers, managers, fish farmers or even specialized skilled labour. In specific areas of development, however, there are noted some specialized local expertise for certain types of cultures.

The potential for increased production is still very high in the region when one considers that there is estimated over 20 million hectares more of available sites which may be suitable for development. Increased production may also be attained through intensification; present productions are relatively low due to the prevailing practice of using minimal inputs specially in the developing countries of the region.

Aquaculture development faces the increasing danger of water pollution in the region due to sewage and industrial development. In some instances there is also conflict with other uses of land-agriculture, urban development, land reclamation, etc.

World-wide evaluation of the capacity for increased production from marine fisheries showed that it can barely double its present production of 50 to 60 million metric tons. Aquaculture production however has been estimated to be able to increase even tenfold given the inputs and support for development. The Region with its established tradition of aquaculture, large and adept labor force, minimum use of critical inputs like fuel oil and big fish-consuming population, can be a focal area for this development. However, inspite of all these bright prospects, it is the general observation that the possible role that aquaculture can play in country economic development planning is often not given consideration.

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*Vital statistics for developing countries in the region are shown in APPENDIX B.

2 AQUACULTURE POTENTIALS IN THE COUNTRIES OF THE REGION

2.1 Australia

Previously aquaculture in Australia had been limited to salmonids and oysters. The Sidney rock oyster (Crassostrea commercialis) is the species of oyster cultivated and rainbow trout (Salmo gairdniri) is the main fish used. Culture practices of oysters developed over the years attained a production valued at $4 million annually. Part is consumed locally while a considerable amount is exported abroad. Thousands of hectares of tidal flats previously unused have been brought under production. Studies on selection of improved strain for culture are being undertaken on the Sidney rock oyster.

Investigations on the possibilities of raft culture of mussels has recently been initiated. The species being used is the Australian edible mussel, Mytilus edulis planulatus, a variety related to the European species. Since mussels from natural waters show poor quality, mussel culture is expected to produce crop of superior condition. It is estimated that an area of about 260 000 ha can be available and suitable for raft culture of mussels in the country. In addition, pearl culture has become a sizable industry in Australia in recent years.

On freshwater fish culture, the sale of trout was previously prohibited in the country in order to protect from commercial catching, the wild trout populations being exploited for sport fishing. This prohibition had discouraged trout farming for sometime. However, in 1971, the government has authorized by legislation, permission for trout farms to be established. The lifting of this regulation is expected to accelerate farming of trout. Rainbow trout (Salmo gairdniri), brown trout (Salmo trutta) and brook trout (Salvelinus fontinales) are the species being utilized.

Expansion in finfish culture is being conducted. Attention is recently being exerted in raising salmonids in brackish and saltwater and in the culture of eels. In Victoria State, Macquarie perch (Macquaria australiasica), trout cod (Maccullochela mitchella) and Murray cod (M. macquariensis) and in New South Wales the golden perch (Plectroplites ambiguus) are being tested for culture.

In brackish waters the culture of shrimps is being investigated using the school shrimp (Metapenaeus macleayi), eastern king shrimp (Penaeus plebius) and greentail (Metapenaeus bennettae). The New South Wales Brackish Water Fish Culture Research Station at Jesse Island, Port Stephens has been established for these studies.

2.2 Bangladesh

The fisheries of Bangladesh is based on its vast extent of inland and territorial marine waters covering an estimated total area of 5.5 to 6 million hectares. It is reported that at least 6 million people or 8 percent of the population depend for their livelihood directly or indirectly on fisheries. Fish constitutes a major source of the protein food for the people; 80 percent coming from fish alone.

Bangladesh has very extensive inland water areas covering an aggregate area of 1 473 101 hectares. These consist of the following:

	Kind of water	Area (ha)
a.	Rivers, streams and canals	830 080
b.	Estuaries and other brackish waters (Sunderbans)	182 900
c.	Ponds, tanks and dams	76 485
d.	Natural depressions (beels), oxbows (baors) and other natural impoundments	292 988
e.	Karnaphuli hydroelectric reservoir	90 648
	TOTAL	1 473 101

In addition to these inland water bodies there are about 2.8 million ha of well-watered ricefields giving a total aggregate area of 4.3 million hectares of inland water areas in the country.

Reliable statistics on fish production are not available. However, it is reported (IBRD, Bangladesh Inland Fishery Project: Identification Pre-Preparation Mission Report, 1973) that the Directorate of Fisheries in collaboration with the Planning Commission published estimated of fish production for a 10-year period from 1960. This was published by the Bureau of Statistics (Statistical Digest of Bangladesh). In part, the figures of production presented were as follows:

Year	Fish Production (000 metric tons)		
(June to July)	Marine	Inland	Total
1960-61	42	646	688
1965-66	81	720	801
1966-67	81	721	802
1967-68	81	723	804
1968-69	82	726	808
1969-70	83	727	810

There was a small amount of export of fish mainly to India ranging from 13 000 to 30 000 metric tons valued at 20 to 70 million taka* (= rupees). This dropped radically in 1965-66; there was none in 1967-71 but exportation was resumed in 1972.

*7.88 taka = US$ 1 as of July 1973

2.3 Bhutan

This country is rich with natural inland waters consisting mainly of rivers and streams. Several small lakes have also been reported in the hilly areas of the country. The main rivers are: Amochu (west), Wangchu (West), Wangduphodrang Tsang Chu (middle west) and Manas (west). Amochu branches into the Hachu, Parochu and Thimpuchu. Wangduphodrang Tsang has several branches but the main ones on its upper courses are Tangchu Phochu and Punakhachu. The Manas is a big river mainly within India which branches as it enters Bhutan into the Mangdechu, Chamkharchu, Kuruchu, and Dangmechu. There are many other lesser rivers specially along the southern border of the country. The lakes are said to be small and largely unexplored. It is reported that there are at least 100 of these lakes.

The rivers are characterized as clear with fast flowing waters during the dry months of the year (October to April) but because of their big watersheds they may swell suddenly and have highly turbid waters during the rainy monsoon period from May to September. Fluctuations of as much as 5-10 meters in water level have been reported.

Most of the rivers have indigenous species of fish in them. No scientific studies have so far been made but the following have been reported:

a. Tor tor - mahaseer
b. Ophicephalus (Channa) sp. - murrel or snakehead
c. Bagarius varrellii (?) - goonch
d. Catla buchanani (?) ... cutla

Undoubtedly there are more species present but this will require further surveys. Mahaseer is known to be common and are caught in good sizes at the Manas River and its upper branches specially the Kuruchu, and also in Wangduphodrang Tsangchu and its branches.

Brown trout (Salmo trutta) was introduced from Kashmir, India by Raja S.T. Dorji in the early forties. First reared in a small nursery unit at Ha, this species has survived and multiplied and it has been introduced in many Bhutanese waters.

The brown trout has now established in many of the rivers where it has been introduced. Only fishing by hook and line is allowed (nets and other gears are prohibited) and fishing can only be done with a license which can be issued by the Forest Conservator or the District Chief (Tzondda). The Thimpu and Ha Rivers, for instance, have an established and perhaps self-replenishing population. Regulated fishing is now feasible in all the waters where the trout population has established itself. Its presence however is reported to be confined only to the colder higher altitudes of the river courses at 4 000 ft (1 200 m) or over, below which the native species specially mahaseer is said to predominate.

The only trout propagation unit is at Ha. It is a very small unit with very limited facilities. A fishery inspector, an assistant fishery inspector and four trainees are presently stationed in this unit. The personnel have very limited training for the work. Inspite of the limited facilities however the

unit is producing some fingerlings to be used for the stocking work being done by the Department.

There is general lack of knowledge on the extent, resources and ecological characteristics of the country's inland waters. Limnological and fisheries development surveys will be necessary. The potentials for cold water as well as for warm-water fish culture will need to be carefully studied and evaluated. There is no question that the demand for fish as food exists and trout fishing in the virgin rivers of the country can be added tourist attraction in the future. Besides filling the local demand, there is also the possibility of sending fresh fish to the neighbouring populous states of India. A preliminary estimate of the fish consumption showed that about 300 metric tons of fresh and dried fish is being consumed annually. This is almost entirely filled by importation from India. Undoubtedly this annual consumption can be considerably increased if more supply can be made available. Besides, under present condition of transport and distribution facilities, better quality fish would be available with the development of local sources.

The country is about to launch its fisheries development programme from a fresh start. It has chosen to exploit and manage its natural waters and to develop its fish culture potential.

2.4 Brunei

There is no available information on the aquaculture status and prospects in this country. Judging from prevailing conditions in this general region, Brunei may have suitable sites for the development of aquaculture such as for brackish water fish and shrimp culture in mangrove areas and tidal flats. If necessary, freshwater culture may also be developed based on experiences in neighboring Sabah and Sarawak, East Malaysia.

2.5 Burma

This country has rich natural resources including that of fisheries. Its marine fishing industry is capable of further expansion and development. Undoubtedly, its vast inland waters can support some inland fishing and production.

The available information on the fisheries is limited. This is specially true of its aquaculture. In recent years the country has received some technical assistance in the initiation of its freshwater fish culture industry through an FAO/UNDP project. Logically, the production of fish seedlings received emphasis in this assistance project. The country has made a start in freshwater aquaculture with the development of about 3 000 ha for pond fish culture.

The potential for aquaculture development is reported to be considerable (6 million ha). This indicates that the country has vast inland areas which may be suitable for development. There is no doubt that many sites along the coastal zones may also be suitable for various types of culture.

2.6 India

This country has well-developed fishing and aquaculture industries. In the field of aquaculture, the potentials for increased production and expansion is still very great. Well-developed types of aquaculture have been noted in different areas of the country. Freshwater culture for the Indian major carps and the common carp is well known. Polyculture is widely practiced. Culture of coldwater species (trout) is practiced in the colder north or in areas of higher altitudes in the country.

Sewage-fed fish farming is one of the unique practices of Indian aquaculture. According to a recent survey, there are more than 132 units covering 12 000 ha utilized for this practice. The major carp species of Labeo rohita, Catla catla and Cirrhina mrigala together with common carp (Cyprims carpio) are used in the multi species culture. Results of recent experiments show production of over 7 tons per hectare per year as compared to previous average of only 3 tons. Since there are extensive available sites in the country which are still to be developed and increase in production can also be accomplished through intensification based on above-mentioned results, the potentials from aquaculture production is still very high.

There are some established practices in brackish water aquaculture that are of long existence. Extensive type paddy-cum shrimp culture is a unique practice in one area of the country. Brackish water aquaculture is rapidly being developed in many other areas and methods for increased production through intensification have recently been identified.

Seed fish production is well-developed in the country. This has been the mainstay in development of the aquaculture industry.

2.7 Indonesia

In 1971 the production of fish and fishery products in Indonesia amounted to 1 244 555 metric tons of which 820 447 tons or 65 percent came from marine fisheries and 424 108 tons or 35 percent from inland fisheries.

The inland fisheries production consisted of the catch from open waters of 285 745 tons and the production from aquaculture amounting to 138 363 tons or equivalent to over 10 percent of the entire fish production and about 18 percent of the inland fish production. The sources of fishery products from aquaculture are as follows:

Source	Production (tons)
1. Freshwater ponds	54 647
2. Ricefields	22 540
3. Brackish	60 788
4. Others (cages, irrigation, canals, etc.)	388
Total	138 363

The area presently used for various types of aquaculture during 1971 are:

Kind	Area (ha)
1. Freshwater ponds	36 167
2. Paddy-cum-fish culture	70 437
3. Brackish water ponds	169 000
Total	275 604

Indonesia is a large country with varied ecological conditions. The potential sites for expansion of the various forms of aquaculture operations is very great. These sites belonging to various ecological types and the estimated acreage of each are as follows:

Type	Area (ha)
1. Freshwater swamps and flood lands	1 760 000
2. Small reservoirs	27 000
3. Irrigated ricefields	3 000 000
4. Brackish water swamp and other tidal lands	6 000 000

Although not all of the entire area of these potential sites of over 10 million hectares can be utilized or are fully suitable for aquaculture production, it can be seen that the industry has indeed very large space for expansion. Upland type ponds suitable for development can be available in the heavy rainfall areas in Sumatra and Sulawesi. New irrigated paddy areas are available in many new places in Java, South Kalimantan, South Sulawesi and North Sumatra. Tidal irrigation areas are available in Sumatra and many parts of Kalimantan. Cage culture has possibilities in the rivers of Kalimantan and Sumatra and also in the natural and man-made lakes of Sunda Shelf islands, Sulawesi and Bali, In addition, brackish water mangrove swamps still abound throughout the country but specially in Sumatra, Kalimantan, West Irian and Sulawesi.

The species used in freshwaters include the common carp, tawes (Puntius gonionotus), giant gourami (osphronemus goramy), kissing gourami (Helostoma temmincki), nilem (Osteochilus hasselti), sepat siam (Trichogaster pectoralis) and mudjair (Tilapia mossambica). More native species have also been tested and found suitable for culture like Leptobarbus hoeveni, Ophicephalus micropeltes, Puntius scwanfeldi; and Pangasius sp. The giant freshwater prawn, Macrobrachium rosenbergii and native species of eels, Anguilla spp. are new species brought into culture. Some species have recently been introduced from other countries like the Chinese carps, Tilapia nilotica and Pangasius sutchi.

Varied management practices have been initiated or actually practised. Use of ponds is a general practice for both freshwater and brackish water cultivation. Fish culture in ricefields is extensive and well developed although this practice is now being hampered with the extensive use of potent pesticides for the rice crop. Fish culture in sewage-fed waters has also been practised with success as well as the use of fish cages for raising fish. Initiatives in the raising of penaeid shrimps in brackish ponds and the giant prawn in freshwater have attracted attention recently because of the good local and foreign market for this commodity. Aquaculture in coastal waters for various molluscs and other resources like seaweeds has also attracted more

attention in recent years.

There are number of problems and constraints in the development of aquaculture in the country: 1) inadequate technical know-how; 2) insufficient amount of fish seedlings for some of the desirable species used for culture; 3) inadequate source of financing to undertake development projects; and 4) unstable nature of market for the product.

The Government is set to solve the above constraints to the level of its capabilities. Research is being intensified by the Inland Fisheries Research Institute and an FAO/UNDP Brackish Water Shrimp and Milkfish Culture Applied Research and Training Project has been put up. During a visit to the project site it was found that modifications of the physical plant and improvement in management will be required. A financing scheme under the World Bank has been applied for and is now being worked out. New sources of fry of cultivable species are being surveyed and transportation and distribution of this commodity are being studied.

2.8 Japan

Fisheries statistics of Japan for 1971 recorded the following production of fish and fishery products:

	Production	
	Weight (000 metric tons)	Value (00 000 000 yen)
1. Sea fisheries	9 149	8 957
2. Inland fisheries	101	214
Subtotal for capture fisheries	9 250	9 171
3. Sea cultures	609	1 374
4. Inland water cultures	50	349
Subtotal for culture fisheries	659	1 723
GRAND TOTAL	9 909	10 894

It is seen that aquaculture accounts for 659 000 metric tons valued 172.3 billion yen. Although the weight from aquaculture production is equivalent to only 6.5 percent, the value of this production is in the order of 15 percent.

The production from sea cultures consisted of the following (1971):

		Metric tons
1.	Yellowtail (Seriola quinqueradiata)	61 743
2.	Pearl (Pinctada martensii)	49
3.	Oyster (Crassostrea gigas)	193 846
4.	Nori (Porphyra tenera) seaweed	244 946
5.	Wakame (Undaria pinnatifida) seaweed	94 350
6.	Others (prawns, other seaweeds, globefish, seabream, Octopus, etc.)	13 750
	Total	608 684

The production from inland water cultures in 1971 was as follows:

		Metric tons
1.	Trout (Salmo gairdneri)	12 749
2.	Carps (Cyprinus carpio and Carassius spp.)	19 049
3.	Eel (Anguilla japonica)	14 233
4.	Others (Sweetfish, etc.)	4 367
	Total	50 398

The raising of penaeid shrimp, mainly Penaeus japonicus (kuruma ebi) being done intensively in about 90 ha area run by 12 companies and producing about 200 tons per year.

Besides the major species mentioned in the above list, other species cultivated are: Sea bream (Chrysophrys major, Evynnis japonica, Taius tumifrons, Mylio macrocephalus), sea bass (Lateolabrax japonicus), globefish (Fugu rubripes), molluscs (Haliotes gigantea, Venerupis philippinarum, Meretrix lusoria, Pecten yessoensis, Anadara subcrenata, Octopus vulgaris) and sweetfish or ayu (Plecoglossus altivelis).

Considerable advances have been attained in Japanese aquaculture within recent years. The traditional pond cultures both in freshwaters and in salt waters shifted to intensified management. Cage culture in marine waters resulted in very consequential production specially for yellowtails (62 000 tons/year). Cage culture for other species particularly the sea bream and bass is also being tried. The culture of eel has expanded considerably leading to acute shortage of fish seedlings of the desirable species (Anguilla japonica). Use of other species from other regions has also been tried with fair degree of success and imports of elvers from Europe and Southeast Asian countries have been done in commercial scale.

The culture of the Japanese shrimps although intensified has not reached very large quantities. However considerable advances in producing juveniles were attained and the industry is expanding. Due to the large expense involved the production is not consequential at present. However it is claimed that with the stocking of the Seto Inland Sea with considerable quantities of juveniles by the shrimp hatcheries the natural yields from that sea has increased substantially.

One characteristic of Japanese aquaculture is the increasing number of species used for culture. Cultivation has been made a means of producing highly priced foods and the Japanese scientists and specialists go into great pains in experimenting the production of such species with good success.

Recently due to the acute shortages of eel fry, experiments have been started in 1973 on the induced spawning of Anguilla japonica at the Hamanako Station of the Shizuoka Prefecture.

There are a number of constraints to the further rapid development of aquaculture in Japan. These are (1) the acute shortage of stocking material of the cultivated species (e.g. eels) (2) need for suitable and cheap food for raised species (3) control of diseases under the intensified method of culture and (4) the declining number of labour and technician manpower going into aquaculture.

2.9 Khmer Republic

Due to the unsettled political condition in the country, fish production from all sources is not within normal levels at the present time. However, fish production figures collected in 1969 showed figures for a typical year which can be compared with 1971, an abnormal year. These are as follows:

Year	Total (tons)	Production from freshwaters (tons)	Production from marine waters (tons)
1969	165 000	120 000	45 000
1971	95 000	60 000	25 000

Of the above, 5 000 tons is attributed to aquaculture, mainly from fish cages, in 1969. The production from a very limited area of developed freshwater ponds is negligible. The total aquaculture production further declined to 900 metric tons in 1972. The figures for aquaculture are only from freshwater; production from mariculture is at present negligible.

The potential for aquaculture production is rather great. The sites suitable for more cage and pen culture installations in the Great Lake and along the Tonle Sap and Mekong rivers are very extensive. Unlimited sites can also be available for the construction of freshwater fish ponds which is hardly started in the country.

There is also great potential for the development of brackish and marine aquaculture. The development of some 15 000 ha of suitable mangrove areas have been planned. With the over 400 km coastline it is estimated that there are at least 50 000 ha which can be developed for coastal aquaculture.

In freshwater cages, pens and ponds the species commonly raised are Pangasius spp., Ophicephalus spp., and Clarias batrachus and to a lesser extent Oxyeleotris marmoratus, Puntius spp., Anabas testudineus, Cirrhinus auratus and Leptobarbus hoeveni. The use of imported Chinese carps (Aristichthys

nobilis and Hypohthalmichthys molitrix) has been started. The important species which can have good potential for salt water aquaculture include Mugil cephalus, Chanos chanos, Lates calcarifer, Penaeus monodon, P. merguiensis, Metapenaeus monoceros, and Scylla serrata.

2.10 Korea

Parallel with the national economic growth the fisheries of Korea developed rapidly within recent years. During the First (1962-66) and Second (1967-71) Economic Plans the fisheries marked a 12.5 percent growth as compared with 9.9 percent growth in GNP as a whole and it greatly contributed to the national economic development. This has an equivalent value of 61 billion Won (W)* or about 2 percent of the total GNP for 1971. The production from fisheries during recent years were as follows:

Year	Production (metric tons)
1969	862 784
1970	935 462
1971	1 073 733
1972	1 344 000
1973	1 686 000

In 1973 the sources of fisheries production were recorded, as follows:

Kind of fishery	Production (000 M.T.)	Percent
Coastal fisheries	750	44.0
Off-shore fisheries	314	19.0
Deep-sea fisheries	361	21.3
Aquaculture (salt water culture)	260	15.0
Inland fisheries (including fresh water culture fisheries	1.3	0.7
Total	1 686.3	100.0

The development of salt water aquaculture and inland fisheries (including freshwater culture fisheries) can be enumerated from the following:

* US$ 1 - W 400

Year	Production and Percentage on Total Production	
	Salt Water Aquaculture MT (%)	Inland Fisheries MT (%)
1969	86 437	1 015
1970	119 223	398
1971	147 396 (13.7)	871 (0.08)
1972	161 000	800*
1973	260 000 (15.0)	1 300 (0.08)
(Target) 1974	321 000	2 000

Coastal aquaculture. The production from coastal brackish and marine aquaculture has been very rapid (350 percent in 10 years). This consists of shellfish, seaweed and finfish. To illustrate the relative quantity of production of each group, the production, in metric tons, in two selected years, 1962 and 1971, were as follows:

	Shellfish	Seaweed	Fish	Others	TOTAL
1962	12 665	6 054	21	-	18 740
1971	98 354	48 818	174	50	147 396

The shellfish consists of oysters (Crassostrea gigas), hard clam (Meretrix lusoria), short-necked clam (Venerupis japonica), cockle (Anadara hisenensis), sea mussel and others. The relative production, in metric tons, of the different species of shellfish for two selected years were as follows:

	Oyster	Hard clam	Short-necked clam	Cockle	Sea Mussel	Others	TOTAL
1962	7 636	314	2 801	212	203	1 489	12 655
1971	45 663	8 521	8 316	18 087	16 778	989	98 354

The important seaweed species are laver (Porphyra tenera), dulse (Undaria pinnatifica), agar-agar (Gelidium amansii). Cultivated shrimp species are Penaeus japonicus and P. orientalis while the fish species include yellowtail (Seriola quinqueradiata), porgy (Pagrosomus major) and puffer (Fugu sermicularis).

The relative production, in metric tons, of the important seaweed species in 1962 and 1971 were as follows:

	Laver	Agar-agar	Dulse	Others	TOTAL
1962	3 439	896	369	1 350	6 054
1971	34 801	996	11 103	1 918	48 818

As of 1973 the area of production were distributed as follows:

*No available actual figure, this was an estimate.

Species	Area (ha)	Percentage of total area
Oysters	24 625.6	33
Laver	12 593.6	17
Cockle	11 949.2	16
Kelp and dulse	9 865.5	13
Hard clam	4 782.4	6
Short-neck clam	2 306	3
Other clams	984.5	2
Mussel	427.9	1
Others	6 809.9	9
T O T A L	74 344.6	100

Korea has extensive tidelands in the southern and western coasts which are suitable for development as sites for coastal aquaculture. An extensive survey was made of these sites in 1968 and it was found that there are 191 763 ha more available for development. Of these 103 374 ha have been found to be most favourably located and have been selected for future expansion of this industry.

The total exports of fishery products from Korea in 1971 is about US$115 million of which about $12 million or 10 percent come from the export of aquaculture products including oyster ($ 1.4M), hard clam ($ 2 M), laver ($4.7M), agar ($1.17M), and other seaweeds ($2.68M). In this respect the Shellfish Sanitation Agreement which was concluded between the United States and Korea in 1972 will greatly accelerate future exports of shellfish specially oysters to America.

Inland fisheries and Fresh Water Culture. The inland fisheries including fresh water culture production is probably the least developed of the different aspects of Korean fisheries. Consequently the production is low and development meagre. It appears that the value of this fisheries as a source of local food and its possible contribution to international trade and food supply have been underestimated. Locally this sector of production can provide the needed protein food specially in rural areas, promote fisherman's/farmer's income, increase exports and improve the utilization of idle lands.

The quantity and value of inland fisheries production from 1967 to 1971 were reported as follows:

Year	Capture Fisheries		Culture Fisheries		/TOTAL	
	MT	Million Won	MT	Million Won	MT	Million Won
1967	854	44	33	4	887	48
1968	1 086	74	22	3	1 108	77
1969	895	39	120	33	1 015	72
1970	381	63	17	9	398	72
1971	696	88	175	66	871	154

The main species used are common carp (Cyprinus carpio), eel (Anguilla japonica), loach (Misgurnus anguillicaudatus), mullet (Mugil cephalus), silver carp (Hypophthalmichthys molitrix)salmon (Oncorhynchus spp.), trout (Salmo gairdneri) and other species of fish and shells. The production of these species

in metric tons for selected years are the following:

Year	TOTAL	Carp	Eel	Loach	Mullet	Silver carp	Salmon	Trout	Others	Shells
1965	344	30	308	-	-	-	-	-	6	-
1968	1 108	282	276	-	-	3	5	-	542	-
1969	1 015	139	419	4	153	1	-	1	248	-
1971	871	97	242	52	-	115	-	22	200	143

The total area of inland lenetic waters in the country is estimated to be about 87 000 ha (870 km^2). This is besides 23 billion m^3 of flowing river water. This area will increase with the construction of additional dams which is continuing. If effectively utilized these waters are estimated to be able to yield about 200 000 metric tons of fishery products per year.

Status of Inland Water Areas

Type	Number	Surface Area (ha)	Water Volume (000 000 m^3)
Damlake	9	78 807.1	2 035.8
Reservoir	262	6 703.9	884.5
River*	-	-	23 000.0
Brackish water	6	577.5	45.0
Fish farm	673	915.3	13.7
TOTAL		87 003.8	25 978.0

A number of exotic species have also been introduced into the country. These include the Chinese grass and silver carp, chum and coho salmon, rainbow trout, bluegill sunfish and yellow bullhead catfish.

Two problems presently confront inland fisheries development:

1) Lack of market due to preference of the population for marine species which they have been more used to

2) Growing danger of pollution from industries and urban seweage.

Inland fish production as export crop is fast gaining in importance. The trade for eel juveniles to Japan and Taiwan has increased radically within the last few years. The culture of marketable eel for export will follow. Trout and salmon can also be good items for export. Attempts to develop salmon runs in some Korean rivers are now under trial.

The economic possibilities of incorporating fish culture in constructed reservoirs in watershed development areas have been studied by the FAO/UNDP

*No estimate of river area is given but it is estimated that Korean rivers have a flow length of 30 290 km and river valley area of 98 477 km^2.

Korea Upland Development and Watershed Management Project (M.J. Gauchon, N. Gil, B.C. John and I.B. Kim, Water Storage and Fish Culture, AGL/ROK 67/522, W.P. (8), 1973) and it was concluded that this system brings two major benefits - irrigation benefits and returns from fish culture.

2.11 Laos

The economy of this country is at present low and undernutrition and malnutrition are common. Present consumption of fish, which can be a good potential source of protein, is very low estimated at only 3 kg per person per year. It has been reported that the annual consumption of fish is about 8 600 tons of which about 7 700 tons are produced locally while some 900 tons are imported from Thailand.

Fish as food is well-liked by the people and the country abound with natural inland waters (rivers, marshes, reservoirs, etc.). There is also great potential for the production of fish through fish culture. Present production of fish should and can be increased by at least 8 times to take care of the nutrition requirement of the entire population, estimated at 60 000 tons to give a per capita consumption of about 20 kg per year.

No accurate survey of the waters of Laos has yet been made. However, estimates gathered from various sources show the following:

	Name of Water	Area (ha)
1)	Mekong River, main basin	200 000
2)	Other main rivers (20)	54 000
3)	Nam Ngum Reservoir	37 000
4)	Nam Tan Reservoir	5 000
5)	Selabam Reservoir	4 000
6)	Nam Dong Reservoir	1 500
7)	Bung-Khatkhao Marsh (near Vientiane)	1 000
8)	Thatlueng Marsh	800
9)	Fishponds	180
10)	Well-watered and irrigated ricefields (only 15 000 ha are currently irrigated	400 000
	GRAND TOTAL	703 480

It is estimated that the present acreage of the waters of Laos can be able to produce about 30 000 tons of fish if fully utilized. This is about 3-4 times the present total production showing that these waters are underutilized. The highest prospect for increased production can be expected with the development of fishponds. A long-range programme designed to develop from 500 to 1000 hectares each year until an estimated maximum of 20 000 hectares for the entire country is attained should be formulated. At the conservative estimated production of 2 000 kg per hectare per year the above pond area will be producing about 40 000 tons of fish which if added to the production from natural waters will amount to about 70 000 tons - a quantity deemed adequate for the country even considering the growth of the population during the programme period. At present there is a tradition of small home-lot fishponds of less

than 200 m^2 in the country. Larger commercial type ponds, however, have yet to be developed.

Economic and cultivable species. R. Serene listed 85 species from Laos in 1951 (R. Serene, Sur la faune ichthyologique du Laos, IPFC, 1951). Recently the Fisheries Team of the USAID in Laos published "Notes on a Collection of Fishes from Lowland Laos". This paper listed 119 species in 25 families, including notes of their abundance, utilization and occurrence.

Thirty six species in 12 families were noted as occurring in abundance in natural waters or can be used for pond culture.

2.12 Malaysia

The total production of fish and other fishery products (shrimps, prawns, molluscs, etc.) in 1971 was as follows:

		Production (tons)
a)	West Malaysia	317 973
b)	Sabah, East Malaysia	27 300
c)	Sarawak, East Malaysia	14 170
	Total	359 443

Out of this the production through aquaculture was estimated to be as follows:

		Production (tons)
a)	Fish produced from 1 900 ha ponds	4 000
b)	Fish from 66 700 ha of padifields with controlled irrigation	7 500
c)	Cockle from 1 200 ha culture flats	28 000
d)	Shrimps (Penaeidae) from 350 ha trapping ponds	250
e)	Cage culture of sea bass	5
	Total	39 755

The potential for aquaculture is very great specially with regards to pond culture both in fresh and brackish situations. Fish species for freshwater culture include common carp (Cyprinus carpio) and the Chinese silver, bighead and grass carp (Hypophthalmichthys molitrix, Aristichthys nobilis, Ctenopharyngodon idella), Puntius gonionotus, Osphronemus goramy and Trichogaster pectoralis, Clarias batrachus, Ophicephalus striatus, Oxyeleotris marmoratus and the giant prawn Macrobrachium rosenbergii.

With heavy rainfall and irregular topography the sites for the construction of freshwater ponds are extensive. Abandoned tin mining pools and man-made reservoirs are also additional sites for raising fish.

Brackish water fish culture is barely started in the country. The 350 ha of established shrimp trapping ponds is a good start for this type of culture. It is estimated that there are at least 50 000 ha of mangrove swamp in West Malaysia which can be converted into coastal fish farms. Another 70 000 ha of potential mangrove areas is available in Sabah and an unknown acreage in Sarawak, or a total of at least 120 000 ha which can be developed in the whole country. An experimental and demonstration brackish water fish farm will be established shortly in Johore, West Malaysia.

The species of salt water fish which have potential for culture are mullet (Mugil cephalus) and milkfish (Chanos chanos). The present acreage of penaeid trapping ponds can be improved and expanded to increase production from 300-500 kg/ha/year as at present to at least 1 000 kg/ha.

The culture of eel, Anguilla sp. also holds good promise. Due to the lucrative foreign market for this species, new eel farms are being started in the country. The raising of aquarium fish both for local and foreign market is also on the increase..

Research and training in the field of aquaculture is included in the government fisheries programme. Freshwater fish culture research is being handled by the Malacca station of the Malaysian Agricultural Research and Development Institute (MARDI). The research on brackish and marine aquaculture is under the Fisheries Research Institute of the Fisheries Division at Glugor in Penang. The universities of the country particularly the University of Malaya and the University of Agriculture both at Kuala Lumpur and the Science University at Penang contribute part of their resources in research and training work in aquaculture. The brackish-water fish culture station to be established in Gelang Patah in Johore state will conduct finfish and crustacean culture experiments and demonstration.

The Fisheries Division also maintains six demonstration stations at Bukit Tinggi, Pahang; Machung, Kelantan; Enggor, Perak; Tapah, Perak; Tanah Rata, Cameron Highlands; and Jitra, Kedah. That at Bukit Tinggi has a fish culture training unit for fish farmers and extension workers.

There are a number of constraints and problems hampering aquaculture development in Malaysia. These are: (1) inadequate technical know-how; (2) insufficiency or uncertainty of the supply of seeds of the cultivated species; (3) lack of development incentives and in some cases market (as in the case of cockles) for the product.

2.13 Nepal

Nepal with an area of 143 650 km^2 and a population of 11.3 million is favoured by having numerous inland waters in the form of rivers and lakes. Most of these waters have an indigenous fish population the exploitation of which can contribute to the economic development and nutritional needs of the country. The value of this fish production has long been recognized so that the Government

has been including fisheries development in its 5-year plans.

Technical assistance from the United Nations Development Programme in inland fisheries and fish culture development has been rendered to the country as early as 1962 with the assignment of a fish culturist. This was continued until the end of 1973 and a new request for a comprehensive regional fisheries development for the Pokhara region is now in the pipeline.

Besides three UN-assisted projects, the Government has built 10 fish farms, fisheries development centres and hatcheries in various parts of the country.

2.14 New Zealand

The commercial aquaculture industry in New Zealand centres on the rock oyster, Crassostrea glomerata. Available statistics show a production of about 3 000 sacks (230 tons) worth about US$80 000; the value of production rose to over $150 000 in 1970. Oyster is an export crop and is therefore a foreign exchange earner.

Experimental culture of the mussel, Perna canaliculatus has recently been initiated with encouraging results. The cultivation seems to be favoured by very suitable climatic conditions for this culture. The Spanish method of raft culture is being adopted.

By the Marine Farming Act of 1968, the development of sea fish farming is being accelerated. More recently, the New Zealand Parliament has approved a legislation to allow the farming of trout, salmon, eels, koura (freshwater crayfish) and other freshwater species. Lifting of this long-standing prohibition is expected to result in the expansion of freshwater fish farming in the country.

2.15 Philippines

The amount and value of fish and fishery products produced in the Philippines in 1971 were as follows:

Source	Production	
	Weight (tons)	Value (pesos)[1]
1. Commercial fishing vessels	382 276	879 235
2. Municipal fisheries and subsistence fishing	542 904	1 406 121
3. Aquaculture	97 915	328 016
TOTAL	1 023 095	2 613 372

The production from aquaculture is about 10 percent of the total tonnage and also of the value of production. This is derived mainly from brackish water ponds used for the raising of milkfish (Chanos chanos) and several species of penaeid shrimps. The area of developed fish ponds cover 171 446 ha in 1971 and with extensive type management the average production is about 500 kg/ha/year.

[1] 1US$ equals 6.5 Philippine pesos (1973)

Freshwater fish culture is just getting a start in the country. Growth of this industry was slow probably because of the lack of indigenous species well suited for rearing. Recently, however, introduction of tried species from other countries was made. The introduced species are common carp, tawes (Puntius gonionotus), giant gourami and more recently the Chinese carps; silver, bighead and grass carps, and tilapia (Tilapia mossambica and T. nilotica). Local species which are also suitable for cultivation are Clarias spp. Trichogaster spp., Ophicephalus striatus and Anabas testudineus. The eel, Anguilla spp. recently attracted considerable attention due to the lucrative demand for the elvers and marketable sizes in the world market specially Japan. The fresh water giant prawn is also indigenous in the country and although harvested from natural waters, its culture has not been started.

In brackish and salt waters besides milkfish, the main species of penaeids raised are Penaous monodon, P. indicus, Penaeus spp., Metapenaeus sp.. Other finfish like Mugil cephalus, Siganus spp., Scatophagus argus are also cultivable.

In open salt waters and estuaries, oyster (Crassostrea spp.) and mussel (Mytilus smaragdinus) are raised in commercial scale. The culture of seaweeds, mainly Eucheuma sp.. has also recently attracted attention.

The major aquaculture management practice is based on the use of fish ponds - either in fresh or brackish waters. Recently however, raising fish in fish pens has been tried with encouraging results utilizing Tilapia and Chanos species. The pens or cages are set in freshwater lakes. Fish pen culture has expanded from 40 ha in 1969 to 2 000 ha in 1973 and producing over 8 000 tons of fish per year.

There are still large potential sites which can be developed for aquaculture production, these consists of 126 248 ha of freshwater swamplands and 367 378 of brackish water mangrove areas or a total of 493 626 ha still available for development. Besides these, it has also been found that with the heavy annual rainfall of 2.5 to 3 m per year, small impoundments which can be used as fish ponds can be used as fish ponds can easily be constructed in uplands with undulating topography. Recently also the conversion of floodlands and coastal tidal flats and estuaries into aquaculture sites has been found to be feasible.

There are a number of problems or constraints to development. These are: 1) lack of technical know-how in many aspects of aquacultural operations and management; 2) inadequate number of qualified technicians and extension workers; 3) high cost required for development; and 4) inadequacy of stocking material for the increasing acreage and intensification of management.

2.16 Singapore

The production of fish and fishery products in Singapore for 1971 was as follows:

	Production (tons)	Percent
1. Offshore fisheries	11 642	76.5
2. Inshore fisheries	2 651	17.5
3. Aquaculture (fresh and brackish)	917	6.0
	15 210	100.0

The aquaculture production was derived from 325 ha of freshwater ponds and 465 ha of brackish ponds for penaeid crustaceans or a total of 790 ha. Polyculture of various carp species (common carp and Chinese carp) is practised in freshwater ponds. The main species of penaeids raised in brackish water are Penaeus indicus and Metapenaeus ensis.

With the rapid economic growth of Singapore, land has become more valuable for use in industrialization and housing. The acreage used for aquaculture is therefore fast decreasing and new areas and new systems of management have to be adopted. Carp ponds for instance are now being diversified to include stocking of high-priced species like Oxyeleotris marmoratus and the giant freshwater prawn. Some ponds are also being shifted for raising eel, Anguilla japonica, soft-shelled turtle, Trionyx sp., and aquarium fishes. Other ponds are now being used for sport fishing purposes.

The present government policy is to maximize the production from the limited area available and to use only high-valued species. Additional initiatives have been taken like the use of floating cages for raising Epinephelus tauvina, Siganus oramin and Mugil cephalus in protected coastal areas and bighead carp in Selatar freshwater reservoir. Intensive culture in small ponds is being tried for Epinephelus tauvina, Chanos chanos, Scylla serrata and Mugil cephalus. A multipurpose hatchery to raise juveniles of Macrobrachium and Penaeidae has been put up. Meanwhile the raising of aquarium fishes and also of crocodiles for skin are additional sources of income for the country.

The main constraints to further development are lack of space for expansion and the inadequacy of seeding material. However, aquaculture will continue to supply the country with quality food items as well as high priced fishery commodities.

Training and research are being provided by the Aquaculture Unit of the Department of Primary Industry, the University of Singapore and the Southeast Asian Fisheries Development Centre, Research Department.

2.17 Sri Lanka

The total fish production from all sources during 1969-1970 was 99 467 tons which is very inadequate to fill present requirements; 88 700 tons has to be filled by importation of this commodity valued at Rs 85 million.[1]

The main source of fish production is from the sea landings amounting to about 88 000 tons while inland fisheries supplied over 8 000 tons in 1969-1970. However, due to fuel shortage and the need for bigger capital expenditures sea fisheries development is expected to be greatly curtailed. To accelerate the increase of production of fish to meet the ever increasing demand, the country is very keen on considering the development of inland fisheries and aquaculture.

There is good scope for the development of this aspect of fisheries in the country. It is favoured by suitable climate, numerous inland waters and high rainfall in some areas, for this development. The topography in the south central is an upland with elevation ranging from 1 130 m (3 700 ft) to 2 424 m (8 281 ft). The rivers start from this highland and flow radially into the surrounding seas.

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[1] Rs = rupees; Rs 6.65 = US$ 1 (Official exchange rate as of May 1974)

The climate is generally tropical and warm but the upland region is colder and more pleasant. The coastal zones are dotted with numerous small, medium and big-sized lagoons, swampy areas and tidal flats. Inland, several long existing water tanks and new hydroelectric and irrigation reservoirs have been developed. There are also very extensive span of fresh water marshes and floodlands and lakes which abound with fresh water resources.

The status and potential of inland fisheries production in Sri Lanka are shown in the following table. The data show that about 10 000 tons are being produced from over 200 000 ha (550 000 acres) of inland fresh and brackish waters. On full development and management these waters are predicted to be able to yield 4-5 times more than present production or equivalent to 40 000 to 50 000 tons of fish.

STATUS AND POTENTIAL OF INLAND FISHERIES

Type of Water	Area (ha)	Unit Production (kg/ha)	Total Production (tons)	Potential on full development: Unit Production (kg/ha)	Potential on full development: Total Production (tons)
A. Fresh waters					
1. Shallow irrigation reservoirs	48 000	110	5 280	200	9 600
2. Flood lakes (villus)	12 000	79	448	100	1 200
3. Seasonal village tanks	12 000	39	468	100	1 200
4. Deep reservoirs	20 000	28	560	50	1 000
5. Rivers and streams	8 000	5.6	45	25	200
Present total for fresh waters	100 000		6 191		
6. Freshwater fish ponds to be developed	10 000			1 000	10 000
Total potential for freshwaters					23 200
B. Brackish waters					
7. Shallow lagoons, tidal flats and mangrove swamps	40 000	28	3 360	50 (for 30 000 ha only)	1 500
8. Deep lagoons and estuaries	80 000			100	8 000
Present total for brackish waters	120 000	-			19 500
Brackish water fish ponds to be developed	10 000			1 000	10 000
Total potential for brackish waters					19 500
GRAND TOTAL	220 000		9 551		42 700

Note: The data on status of inland fisheries is based on various reports published in the Bulletin of the Fisheries Research Station Ceylon and refers to the period between 1969-1972. Potentials are rough estimates made by the adviser.

The administration and management of the fisheries of the country is mainly under the Ministry of Fisheries. Under this Ministry are the Department of Fisheries, Ceylon Fisheries Corporation and Ceylon Fishery Harbours Corporation. Work on fishery cooperatives is being done with the Office of Cooperatives in the Ministry of External and Internal Trade. The Department of Fisheries is the office charge for the management, training and research in fisheries.

For field work and extension there are twelve district fishery extension offices in the country. These are under the Assistant Director of Extension of the Central Office. There are 12 District Fishery Extension Offices located in the following places: Colombo, Nagombo, Puttalam, Jaffna, Mullativa, Galle, Trincomalee, Chilaw, Kalmunai, Batticaloa, Tangalle and Mannar.

The complement of personnel for each district includes one district fishery extension officer, 1 dividional fishery inspector, fishery inspectors (number based on size of district) and 2 statistical collectors. It is noted however that all these fields offices are located in coastal areas. Inspite of the rounded shape of the country no field district office is situated in inland areas to be easily accessible to service inland fisheries development and management.

For demonstration and development there are three stations for fresh water and one for brackish water:

1. Freshwater fishery station - Polonnaruwa
2. Freshwater fishery station - Uda Walawe
3. Trout hatchery - Nuwara Eliya
4. Brackish water fishery station - Negombo

For training in marine fishing, gears and marine engines there are four established centres. The centres give one year training to selected fishermen on fishing methods, making and repair of fishing gears and maintenance and repairs of marine engines. There is no institution giving instruction specifically for inland fisheries work.

Coastal lagoons, tidal flats and mangrove swamps. The country abound with numerous coastal lagoons of varying sizes. There are three types: (1) permanently closed lagoons that derive its water by seepage from the sea, (2) seasonally opened lagoons during the rainy period, and (3) lagoons continuously connected with the sea by a permanent channel. The closed lagoons have very poor productivity but the seasonally open and permanently sea-connected lagoons show better fish production. All these lagoons illustrate various ecological types and have a certain number of fishermen attached to them. Mugil, Chanos, Tilapia, Penaeus spp. and Etroplus sp. are the main catches from these lagoons.

There are also wide areas of tidal flats and, mangrove swamps in the country.

Freshwater tanks and reservoirs. Big freshwater reservoirs locally called tanks were constructed during the rule of the early kings of Sri Lanka. These were built to store water for agriculture and for domestic uses. Many of these tanks were very well constructed and have lasted with the ages but most of them

were reconstructed and are now being maintained by the Irrigation Department. It is reported that there are 10 000 such tanks varying in size from a few hectares to 6 500 ha (Senanayake Samudi).

Being of long existence, these tanks are very stabilized and fertile water bodies. In previous years no serious attempt to manage them for fish production were made. Within recent years, however, their use for fish production has been gaining in importance.

Fishponds in rubber and tea estates. Many tea and rubber estates in the upland areas of the country have adequate sources of water (springs) and suitable sites for building fish ponds. Within recent years the Department of Fisheries have been waging a campaign for the establishment of such ponds. Free fish stock and technical assistance is being provided. The practice is not yet widespread but there is good prospect that this will increase rapidly in the future.

2.18 Thailand

The total production of fish and other aquatic products in 1972 was 1 679 540 metric tons consisting of 1 540 157 tons or equivalent to 90 percent from marine fisheries and 131 303 tons or 10 percent from fresh water fisheries. The Department of Fisheries reported the production in 1971/72 as composed of the following:

Kind	Production (tons) Year 1971	1972
I Marine fisheries		
1. Mackerel	149 076	119 190
2. Shark	9 502	10 540
3. Miscellaneous finfish	1 003 530	1 111 089
4. Crustaceans	127 162	145 725
5. Molluscs	181 019	161 613
Total for marine fisheries	1 470 289	1 548 157
II Freshwater fisheries		
1. Air breathing fishes	48 913	76 626
2. Carps	10 030	12 068
3. Miscellaneous fish	59 926	45 041
4. Prawns	2 919	3 648
Total for freshwater fisheries	116 788	131 383
GRAND TOTAL.....	1 587 077	1 679 540

Reliable statistics on the production from aquaculture are not readily available. From various recent papers and reports the rough estimations for this sector are as follows:

Aquaculture Production

	Kind	Production (metric tons)
I	Freshwater	
	1. Clarias catfish	55 000
	2. Cage culture of Pangasius spp.	1 600
	3. Chinese carps	500
	4. Ricefield fish culture	6 600
	Total from freshwater culture	63 700
II	Saltwater	
	5. Penaeidae (shrimps)	3 400
	6. Brackish water finfish (milkfish, bass, mullet, etc.)	400
	7. Mussels	40 000
	8. Oysters	6 000
	9. Cockles	15 000
	Total from saltwater culture	64 800
	GRAND TOTAL	128 500

The above estimates show that aquaculture probably contributes about 8 percent of the total fisheries production in the form of valuable resources directly used for human food.

The areas used for aquaculture and the total area of inland waters including potential areas for future development have also been estimated by various fishery workers. It is shown that there are about 60 000 hectares of freshwater areas and some 10 000 hectares of brackish and marine areas now probably utilized for aquaculture production. Rice field fish production although very low per unit area (estimated at 30 kg/ha with minimal management inputs) is reported to be suitable in about 200 000 hectares of the 4 million hectares of irrigated ricelands in the entire country. If the fish producing ricefield area is added to the other culture areas of the country the total hectarage being used for aquaculture would total about 260 000 hectares.

Thailand Inland Waters and Areas used for Aquaculture Production

Type of Water	Area Actually Used for Aquaculture (ha)	Total Potential Area (ha)	Source of Information
1. Ponds (Freshwater)	2 238	-	Fisheries Record, 197
2. Water ditches of vegetable and fruit farms	50	5 000	Fisheries Dept.,1961
3. Paddy fields (irrigated)	200 000	4 000 000	Boonbrahm, 1972
4. Irrigation tank	5 000	30 000	Fisheries Dept. 19[illegible] and Boonbrahm, 197-
5. Large impoundments	-	215 000	Boonbrahm, 1972
6. Rivers and canals	-	120 000	Boonbrahm, 1972
7. Mangrove and tidal flats	9 504	152 000	Shribhibadh, 1972
TOTAL		4 522 000	

The foregoing data show that there is an established aquaculture industry in the country and it has good prospect of further expansion. Freshwater fish culture is well developed with Clarias spp., Pangasius spp., Chinese grass, silver and bighead carp, common carp, and Tilapia spp. as the main species. Trichogaster spp., Ophiscephalus striatus, Anabas testudineus and Puntius gonionotus are the main species from rice fields.

Hatchery work for the giant freshwater prawn, Macrobrachium rosenbergii has attained commercial scale and the raising of these species in ponds for the market is expanding.

In brackish and marine waters various finfish - sea bass (Lates calcarifer) milkfish (Chanos, chanos) and mullet (Mugil cephalus) are being used. The main salt waters species cultivated however are species of the Family Penaeidae (shrimps) mainly Penaeus merguiensis and Metapenaeus monoceros. The molluscs include mussel, Mytilus spp.; cockles, Anadara granosa; and oyster, Crassostrea spp.

Freshwater fish culture is relatively well developed and the production is high. The projects in this field are however beset with problems of sanitation and diseases. Finfish culture in salt and brackish water is not yet developed and shellfish culture will expand if market is available.

2.19 United Kingdom for Hongkong

In 1971 the production of fish and fishery products in Hong Kong were as follows:

Kind	Weight (tons)	Value (000 US$)
A. Capture fisheries		
1. Marine fish	99 060	33 314
2. Crustacea (shrimps, prawns, crabs and lobsters)	12 489	17 127
3. Molluscs gathered from natural grounds	6 288	3 385
4. Others (seaweeds, sea snakes, etc.)	122	168
Total for capture fisheries	117 959	53 994
B. Auaculture fisheries		
5. Freshwater fish	2 121	2 532
6. Cultivated oysters	154	317
7. Aquarium fish	-	3 585
Total for aquaculture fisheries	2 275	6 434
GRAND TOTAL	120 234	60 428

The production from aquaculture although only 2 percent of the total weight is 11 percent of the total value. The finfish production was derived from ponds; the main species raised are the grey mullet (Mugil cephalus) and a predetermined combination of the common carp and Chinese bighead, silver and grass carps. Small number of mud carp (Cirrhina molitorella) and an edible form of the goldfish (Carassius auratus) and recently Tilapia mossambica are also increasingly being used.

Oyster, mainly Crassostrea gigas and C. rivularis, is raised in brackish water tidal flats specially in Deep Bay.

There were 2 689 acres (1 085 ha) of fish ponds by the end of 1972. There is limited area for expansion consisting of coastal low-lying land of about 500 ha.

Culture of marine species using floating cage was started in Hong Kong in 1970. The species used are high-priced species and the practice resulted in encouraging results. In a survey made in June 1973, in 7 districts of Hong Kong where fish cage culture is practised it was found that there were 460 units, consisting of 2 076 cages with an estimated 260 tons of fish under culture. The species used are red grouper (Epinephelus akaara), mud grouper (E. brunneus), yellow grouper (E. awoara), red pargo (Chrysophrys major), white bream (mylio berda), yellow-finned bream (M. latus), mangrove snapper (Lutjanus argentimaculatus and Siganus spp.).

Culture cages are made of synthetic nets or wooden slats with floats of drums, wooden rafts or other material. The usual size is 8' x 6' x 6' while larger ones may be 12' x 10' x 10' and 9' x 6' x 7'. There are a few large-sized cages with 40' x 20' x 10' dimension. No data has been compiled on the production from cages but it may be estimated that the present number of set cages can produce as much as 10 000 tons per year. Unfortunately, in November 1973 an oil spill from the depository tank of an oil company at Aplichau damaged the fish being raised in cages near Lamma Island.

2.20 Vietnam

The total production of fish and fishery products from Vietnam in 1962 were as follows:

Kind	Production (tons)
1. Marine fish	501 278
2. Freshwater fish	81 772
3. Shrimps	54 250
4. Squid	10 695
5. Crabs and molluscs	29 725
Total	677 720

Aquaculture contributed a substantial amount of the fishery production of Vietnam. This comes from the following sources:

	Weight (tons)
1. Freshwater fish ponds	16 500
2. Brackish water shrimp ponds	25 000
3. Brackish ponds for finfish	10 000
4. 5 000 units of fish cages	50 000
Total	101 500

It is estimated that the area of existing freshwater ponds is 25 000 ha. The range of production of ponds, which are usually of small sizes and intensively managed, is from 2 000 to 4 000 kg/ha/year. However, due to the unsettled political condition, only 25 percent of the production is presently being realized.

The acreage of brackish ponds used for trapping and growing shrimps (Penaeus spp.)is 50 000 ha. Present production average of those ponds is reported to be in the order of 500 kg/ha. Brackish water finfish ponds used to raise mullets, milkfish, gobies and sea bass, etc. cover an area of 20 000 ha and producing about 500 kg/ha/year.

The species raised in freshwater ponds are Pangasius species namely P. sutchi, P. pangasius, and P. laernaudi, common carp; kissing gourami (Helostoma temmincki), giant gourami (Osphronemus goramy); Tilapia spp., Trichogaster spp., Puntius spp., and Clarias batrachus. The culture of eel, Anguilla sp. is being initiated. It is reported that Vietnam may have the preferred cultivable species, A. japonica or a closely related species. The Chinese grass, silver and bighead carps have also been introduced.

For rearing in fish cages, Ophicephalus micropeltes, Puntius gonionotus and species of Pangasius are commonly used (P. altus, P. schwanenfeldii and P. nasutus), Labeo sp. and Puntioplites sp. are also used.

The species of penaeid shrimps raised in coastal ponds belong to Penaeus spp. and Metapenaeus spp. The crab, Scylla serrata is also a potential species for this pond situation. Of the finfishes mullet (Mugil spp.), milkfish (Chanos chanos) and sea bass (Lates spp.) are being used.

In open waters, the raising of molluscs and seaweeds have good prospects. Oyster species in the country include Crassostrea gigas and C. denselamelosa. The mussel (Mytilus sp.), cockle (Anadara granosa) and clam (Paphia sp.) can also be raised. The seaweed species belong to Gracilaria.

Given the enormous drainage basin of the Mekong River system, the area of expansion for freshwater fish culture is very extensive. In the coastal brackish water mangrove and tidal areas the estimated potential is 600 000 ha. Fish cage culture expansion also has considerable potential in the lake areas and the river systems.

Present constraints to aquaculture development are varied. The unsettled political situation prevents full scale production. There is lack of technical manpower of all levels for aquaculture operations. Sources of fish seedlings of desirable species are inadequate and funding for development is not readily available under present circumstances.

3 CONCLUSIONS AND RECOMMENDATIONS

3.1 Aquaculture in national economic development programmes. In the light of present circumstances (fuel shortages, big capital risks, presence of cheap labour in region, etc.) it is recommended that aquaculture development should be considered very seriously in national economic development programmes as one of the major sources of protein for human food and for earning valuable foreign exchange.

3.2 Regional focus. Asia and the Far East Region, the centre of development of many types of aquaculture industries, should continue to lead other regions in this aspect of food as well as cash crop production. To attain this objective it is recommended that adequate international, regional and national support should be given in this field of development.

3.3 Need for research. Inspite of the long existing and established tradition of aquaculture in the region, productivity per unit effort, space and time is relatively low specially in the developing countries. Building of the technical base for this industry through research should be encouraged. International aid agencies are urged to provide support for this work and the regional cooperative programme initiated by FAO/IPFC should be promoted.

3.4 Increased production through expansion and intensification. Increased production in this field can be achieved through expansion in area and intensification of management. The increase of production through expansion in acreage is still feasible since there are still extensive available areas in the region suitable for development. In the case of intensification of production it is recommended that this should be initiated only in so far as necessary inputs for this intensification are available and sufficiently cheap within the region.

3.5 Training and extension. A general obstacle for rapid progress in development and production intensification is the lack of trained managers, extension workers and fish farmers for aquaculture operations. An aggressive programme of training and extension should be developed both regionally and on the national level.

3.6 Statistics on status and potential of aquaculture. One big obstacle in formulating rational programmes on aquaculture development is the lack of accurate and up-to-date statistics on the present status and potential for future development of this industry in the different countries in the region. A regional or national programme in this field can be based on a sound foundation if these statistics are available. National and regional surveys to accumulate these data should therefore be given adequate encouragement and support.

3.7 Effect of water pollution. Water pollution is a growing problem in the region. As this could greatly affect the aquaculture industry and its future improvement and expansion, attention should be called on the possible consequences of this problem to the policy makers and administration in the different countries so that appropriate safeguards can be instituted.

3.8 Multidisciplinary approach. Because of the use of a number of species, employment of various culture methods and the varying environmental conditions of aquaculture sites in the various countries, the aquaculture industry will require a multidisciplinary approach in its development. The services of a regional aquaculture coordinator will be required to coordinate the work of the various disciplines and the various areas or foci of development. Training of specialized expertise will also be needed for the industry.

3.9 Regional technical exchange. Although expertise in aquaculture is extremely scarce, it has been noted that there are a number of specialists proficient for specific aquaculture problems based in the region. Facility for the exchange of technical information as well as personnel among the countries in the region should be established.

APPENDIX A

Status and Potential of Aquaculture in Asia and the Far East Region[1]

Country	Area utilized (ha)	Production (t)	Potential sites (ha)
Bangladesh	76 485	23 000	476 000
Burma	2 920	1 494	6 477 000
China	700 000	2 240 000	*
India	611 915	483 800	2 730 000
Indonesia	299 283	144 403	6 000 000
Hong Kong	1 500	2 776	2 100
Japan	508	649 200	*
Khmer[2]	350	5 500	15 000
Korea	75 260	147 571	452 000
Laos	180	360	20 000
Malaysia	91 343	54 498	375 000
Nepal	77	90	2 500
Pakistan[3]	30 780	37 540	682 000
Philippines	171 400	100 400	493 600
Singapore	789	917	*
Sri Lanka	10 000	15 000	278 000
Taiwan	39 234	68 945	53 800
Thailand	216 792	128 500	4 187 000
Vietnam[4]	95 000	101 500	500 000
TOTAL	2 423 816	4 205 494	22 744 000

* - No data available
1 - This is a preliminary evaluation from all available sources; data in some countries are incomplete or not available
2 - Includes production of 1000 fish cage units. The potential sites consist of mangrove only; freshwater areas very extensive.
3 - Estimate for this country was made before Bangladesh was separated.
4 - Includes production of 5000 units of fish cage. Potential areas include mangrove only; freshwater sites very extensive.

APPENDIX B

Vital Statistics of Countries in Region*

COUNTRY	Area (000 km^2)	1973 Population (000 000)	Density (1973) Persons/km^2	Average Annual Population rate 1964/73	Per Capita GNP 1971 $	Growth Rate of Per Capita GNP (% 1965-1971)
Bangladesh	141.1	64.19	455	1.9	70	-0.1
Burma	678.0	29.56	44	2.2	80	0.1
Hong Kong	1.0	4.16	4 160	1.9	900	5.6
India	3 268.1	575.22	176	2.2	110	2.4
Indonesia	1 904.3	122.93	65	2.2	80	3.4
Khmer Republic	181.0	7.31	40	2.3	130	-2.2
Korea, Republic of	98.5	32.90	334	2.0	290	10.0
Laos	236.8	3.18	13	2.4	120	3.5
Malaysia	332.6	11.83	36	2.9	400	3.3
Nepal	140.8	11.65	83	1.8	90	0.6
Pakistan	803.9	63.36	79	2.7	130	3.0
Philippines	300.0	40.22	134	3.0	240	2.7
Singapore	0.6	2.19	3 650	2.0	1 200	10.6
Sri Lanka	65.6	13.30	203	2.3	100	1.8
Thailand	514.0	39.24	76	3.1	210	4.7
Vietnam, Republic of	173.8	19.80	114	2.6	230	-0.7

*Taken from: ADB, Key Indicators of Developing Member Countries of ADB: 5 (1) 1974.

WORKING PAPERS OF THE SOUTH CHINA SEA FISHERIES DEVELOPMENT AND COORDINATING PROGRAMME

SCS/74/WP/1 Rabanal, H. R. The potentials of aquaculture development in the Indo-Pacific Region. Manila, 1974. 34p.

SCS/74/WP/2 Crutchfield, J. A., D. A. Lawson and G. K. Moore. Malaysia-Legal and institutional aspects of fisheries development. Manila, 1974. 27p.

SCS/74/WP/3 Marr, J. C. Republic of Vietnam - Legal and institutional aspects of fisheries development. Manila, 1974. 20p.

SCS/74/WP/4 Larsson, S. O. R., G. C. A. Van Noort and E. O. Oswald. Malaysia - A report on artisanal fisheries of Peninsular Malaysia with particular reference to Kuala Besut. Manila, 1975. 58p.

SCS/75/WP/5 Rabanal, H. R. Irian Jaya, Indonesia - Survey of possibilities and recommendations for development of brackish water fish production. Manila, 1975. 27p.

SCS/75/WP/6 Tussing, A. R. Fishery development perspectives. Sub-Region V: South China Sea. Manila, 1975 (IPFC/74/Sym/7) 23p.

SCS/75/WP/7 Murdoch, W. R. and M. A. Myers. Republic of Singapore - An assessment of the Jurong Fishing Harbour complex and expansion site on the east bank of the Jurong River. Manila, 1975. 46p.

SCS/75/WP/8 Peterson, C. L., K.J. Rosenberg and A. C. Simpson. Regional - Trip reports of chartered purse seine vessels Royal Venture and Southward Ho covering voyages I and II. Dec. 1-13, 1974 and Jan. 5-Feb. 3, 1975. Manila, 1975. 37p.

SCS/75/WP/9 Oswald, E. O. and R. E.K.D. Lee. Regional - A proposal for a live bait pole and line tuna fishing survey in the South China Sea and adjacent waters. Manila, 1975. 38p.

SCS/75/WP/10 Rosenberg, K. J. and A. C. Simpson. Regional - Trip reports of chartered purse seine vessels Royal Venture and Southward Ho covering voyage 3. 9 February to 26 March 1975. Manila, 1975. 28p.

SCS/75/WP/11 Peterson, C. L. Regional - Resource survey of larger pelagic fish. Manila, 1975. 32p.

SCS/75/WP/12 Rosenberg, K. J., A. C. Simpson and C. M. Renwick. Regional - Trip reports of chartered purse seine vessels Royal Venture and Southward Ho covering voyage 4. 9 April to 24 May 1975. Manila, 1975. 36p.

NOTE: Copies of these papers can be obtained by writing to the Programme in Manila, Philippines

8.9.76

SCS/75/WP/13 Baum, G. A. Kuala Besut II - A supplementary report on selected socio-economic aspects and problems in a fishermen's community on the East Coast of Peninsular Malaysia. Manila, 1975. 43p.

SCS/75/WP/14 Cuerden, C. Library services for the South China Sea Fisheries Programme and its participating countries. Manila, 1975. 48p.

SCS/75/WP/15 Lawson, R. M. Malaysia - an interim report on socio-economic aspects of the development of artisanal fisheries on the East Coast of Malaysia. Manila, 1975. 29p.

SCS/75/WP/16 Jamandre, T. J. and H. R. Rabanal. Engineering aspects of brackish water aquaculture in the South China Sea Region. Manila, 1975. 96p.

SCS/75/WP/17 (not used)

SCS/75/WP/18 Cleaver, W. D. Malaysia - A preliminary design and general arrangement for an offshore purse seine vessels for the East Coast of West Malaysia. Manila, 1975. 35p.

SCS/75/WP/19 Pischedda, J. L. Republic of the Philippines - Legal and institutional aspects in the development of the fishing industry. Preliminary observations and identification of the main obstacles. Manila, 1975. 35p.

SCS/75/WP/20 Simpson, A. C. Regional - Acoustic surveys of pelagic resources. Report No. 1. Gulf of Thailand, July 1975. Manila, 1975. 28p.

SCS/75/WP/21 Cintas, D. and C. M. Renwick. Regional - Report of aerial survey for schooling pelagic fish. 1. Philippine waters, 12-29 June 1975. Manila, 1975. 28p.

SCS/75/WP/22 Baum, G. A. and J. A. Maynard. Tobuan/Sual, Pangasinan Province Central Luzon - A socio-economic study on a rural fishing population in Central Luzon in connection with the Municipal Fisheries Pilot Programme. Manila, 1976. 44p. (Country - Philippines)

SCS/75/WP/23 _____. Panigayan, Lampinigan, Baluk-Baluk and Manangal, Basilan Province. A socio-economic study on four fishermen's communities affiliated to the Basilan Fishing Association (BFA/Isabela in connection with the Municipal Fisheries Pilot Programme). Manila, 1976. 62p.

SCS/76/WP/24 Barica, J. Nutrient dynamics in eutrophic inland waters used for aquaculture in some countries bordering the South China Sea, with particular reference to mass fish mortalities: Proposal for monitoring programmes, Philippines, Thailand and Hong Kong. Manila, 1976. 43p.

SCS/76/WP/25 Rosenberg, K. J., A. C. Simpson and J. A. Maynard. Regional - Trip reports of chartered purse seine vessels Royal Venture and Southward Ho covering voyages 5 and 6, 13 June to 10 September 1975. Manila, 1976. 52p.

SCS/76/WP/26 Moore, G. K. Malaysia - Legal and institutional aspects of fisheries development. (2nd working paper) Manila, 1976. 38p.

SCS/76/WP/27 Wheeland, H. A. Malaysia - Preliminary observations and recommendations concerning the fisheries statistics programme of Peninsular Malaysia. Manila, 1976. 22p.

SCS/76/WP/28 Maynard, J. A. Regional - Report of aerial survey for schooling pelagic fish. II. Thailand - 20 November to 1 December 1975. Manila, 1975. 20p.

SCS/76/WP/29 Baum, G. A. and J. A. Maynard. Salay, Misamis Oriental Province - A Socio-economic study on the fishing population of the seven coastal barrios of Salay Municipality in connection with the Municipal Fisheries Pilot Programme. Manila, 1976. 47p. (country - Philippines)

SCS/76/WP/30 Murdoch, W. R. Hong Kong - A preliminary feasibility study to prosecute offshore pelagic stocks from Hong Kong. Manila 1976. 27p.

SCS/76/WP/31 Johnson, R. F. Preliminary report on aquatic pollution in the South China Sea Region. Manila, 1976. 34p.

SCS/76/WP/32 Wheeland, H. A. Prelimary observations and recommendations concerning the fisheries statistics programme of Singapore. Manila, 1976.

SCS/76/WP/33 Baum, G. A. and J. A. Maynard. Coron/Tagumpay - Busuanga Island/Calamianes Group (Palawan Province). A socio-economic study on two rural fishing populations in northern Palawan in connection with Municipal Fisheries Pilot Programme. Manila, 1976.

SCS/76/WP/34 Jones, R. Mesh regulations in the demersal fisheries of the South China Sea area. Regional. Manila, 1976. 79p.

SCS/76/WP/35 Simpson, A. C. and S. Chikuni. Progress report on fishing for tuna in Philippine waters by FAO chartered purse seiners. Manila, 1976. 38p.

SCS/76/WP/36 Bonga, O, B. Vessel specifications and drawings for two 10m multi-purpose fishing vessels for the small-scale fisheries project - Kuala Besut. Manila, 1976. 36p.

SCS/76/WP/37 Shang, Y. C. Economics of various management techniques for pond culture of finfish. Manila, 1976. 36p.

SCS/76/WP/38 Johnson, H. N. Malaysia - A preliminary study of investment opportunities for the development of small-scale fisheries on the East Coast of Peninsular Malaysia. Manila, 1976. 21p.

SCS/76/WP/39 Shang, Y. C. Follow-up programmes on economics of aquaculture in the South China Sea Region. Manila, 1976. 19p.

SCS/76/WP/40 Cook, J. L. Problems in shrimp culture in the South China Sea Region. Manila, 1976. 50p.

SCS/76/WP/41 Johnson, H., J. Dibbs and R. Nasoetion. Indonesia - A preliminary assessment for small-scale fisheries development in Riau, North Sumatra and West Kalimantan Provinces. Manila 1976. 51p.

SCS/76/WP/42 Baum, G. A. and J. A. Maynard. Bayawan Municipality, Negros Oriental Province/Negros.A socio-economic study on the rural fishing population of Bayawan Municipality in connection with the Municipal Fisheries Pilot Programme. Manila, 1976. (country - Philippines)

Revision 2
14/8/76

COORDINATING COMMITTEE REPORTS

SCSP: 74/1 REP — Report of AD HOC Coordinating Committee Meeting of the South China Sea Fisheries Development and Coordinating Programme. Manila, 18-19 June 1974. Rome, FAO, 1974. 22p.

SCSP: 74/2 REP — Report of the first session of the Coordinating Committee of the South China Sea Fisheries Development and Coordinating Programme. Jakarta, Indonesia, 6 November 1974. Rome, FAO, 1974.

SCSP: 76/1 REP — Report of the second session of the Coordinating Committee of the South China Sea Fisheries Development and Coordinating Programme. Manila, 9 April 1976. Manila, South China Sea Fisheries Programme, 1976. 16p.

WORKSHOP REPORTS

SCS/Gen/74/1 — Report of the workshop on planning and coordination of resources survey and evaluation in the South China Sea. 28 August - 4 September 1974. Manila, South China Sea Fisheries Programme, 1974. 197p.

SCS/Gen/76/2 — Workshop on resources of the St. of Malacca. 29 March - 2 Apr.1976. Jakarta, Indonesia. Summary Report. Manila, South China Sea Fisheries Programme, 1976.

SCS/Gen/76/3 — Report of workshop on legal and institutional aspects of fishery development. 5 - 8 April 1976. Manila, South China Sea Fisheries Programme, 1976.

PERIODIC PROGRESS REPORTS

SCS/PR/74/1 — Woodland, A. G. Project progress report of the South China Sea Fisheries Development and Coordinating Programme. 1 July - 31 December 1974. Manila, South China Sea Fisheries Programme, 1974. 19p.

SCS/PR/75/2 — _____. Project progress report of the South China Sea Fisheries Development and Coordinating Programme. 1 January - 30 June 1975. Manila, South China Sea Fisheries Programme, 1975. 40p.

SCS/PR/75/3 — _____. Project progress report of the South China Sea Fisheries Development and Coordinating Programme. 1 July - 31 December 1975. Manila, South China Sea Fisheries Programme, 1975. 38p.

***

21.8.76

TECHNICAL REPORTS CONTRIBUTED TO SYMPOSIA/MEETINGS, ETC.

Rabanal, H. R. FAO activities in inland fisheries and aquaculture
1975 with particular reference to Asia and the Far East. Manila, South China Sea Fisheries Programme. 17p. (Contributed to the First Fisheries Research Congress, Philippine Council for Agricultural Research, 7-10 March 1975, Legaspi City Philippines)

_____. Preliminary report on the macrobrachium fishery in
1975 the Indo-Pacific Region. Manila, South China Sea Fisheries Programme. 20p. (Contributed to the International Conference on Prawn Farming, Vung Tau, Vietnam, 31 March - 4 April 1975)

_____. Mangrove and their utilization for aquaculture. Manila
1976 South China Sea Fisheries Programme. 20p. (Contributed to the National Workshop on Mangrove Ecology held in Phuket, Thailand 10-16 January 1976)

Simpson, A. C. Some proposals for research related to the understand-
1976 ing of mangrove ecology and the utilization of mangrove areas. Manila, South China Sea Fisheries Programme. 10p. (Contributed to the National Workshop on Mangrove Ecology held in Phuket, Thailand 10-16 January 1976)

Cook, H. L. Some aspects of shrimp culture research with particular
1976 reference to Philippine species. Manila, South China Sea Fisheries Programme. 7p. (Contributed to the Philippine Council for Agriculture and Resources Research (PCARR),Fisheries Workshop, Subic, Zambales, Philippines 15-17 January 1976)

27.8.76