No 4

Basic Design Study Report
on
Rayong Marine Fisheries Station Extention Project
in
The Kingdom of Thailand

June 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

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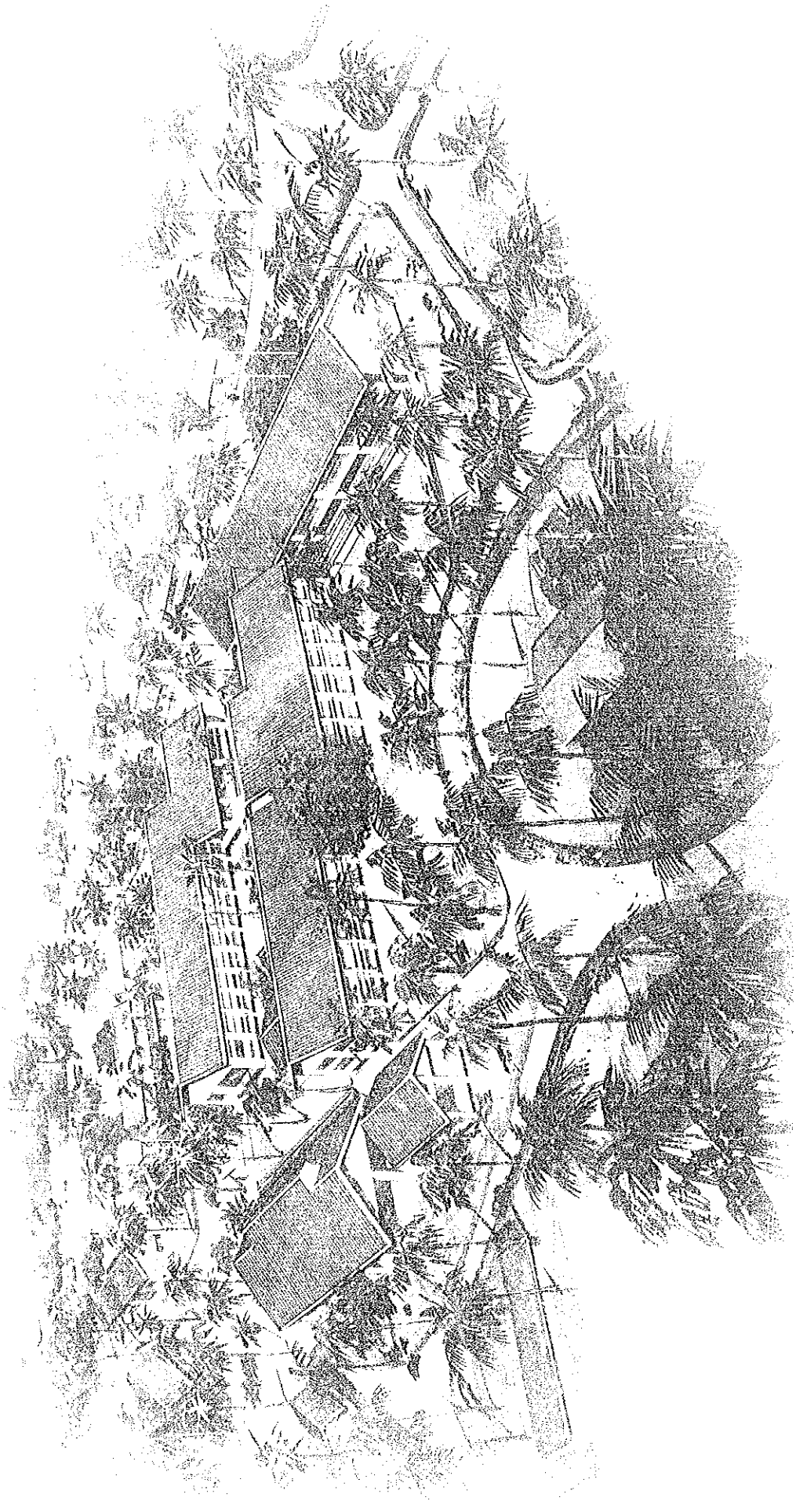

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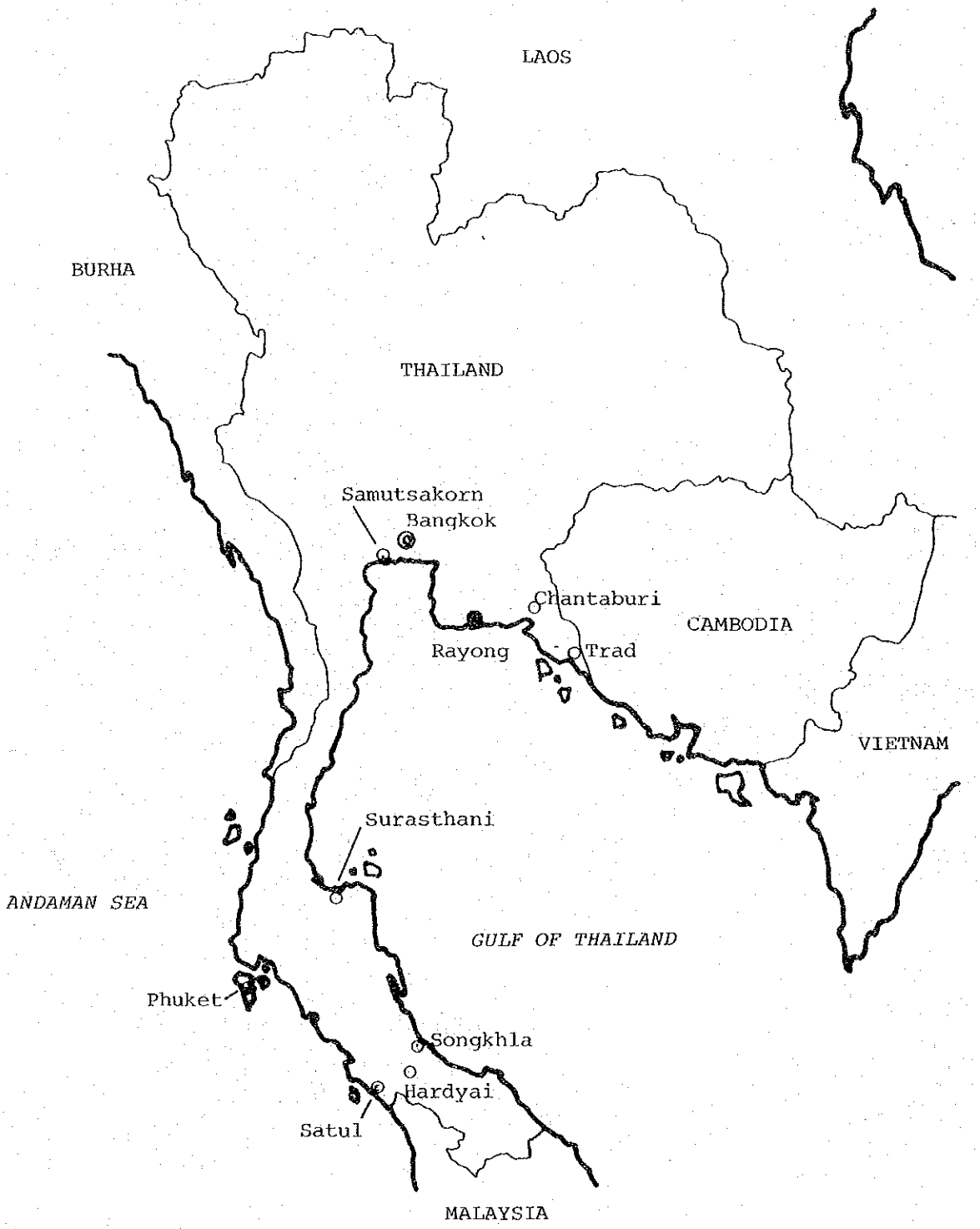

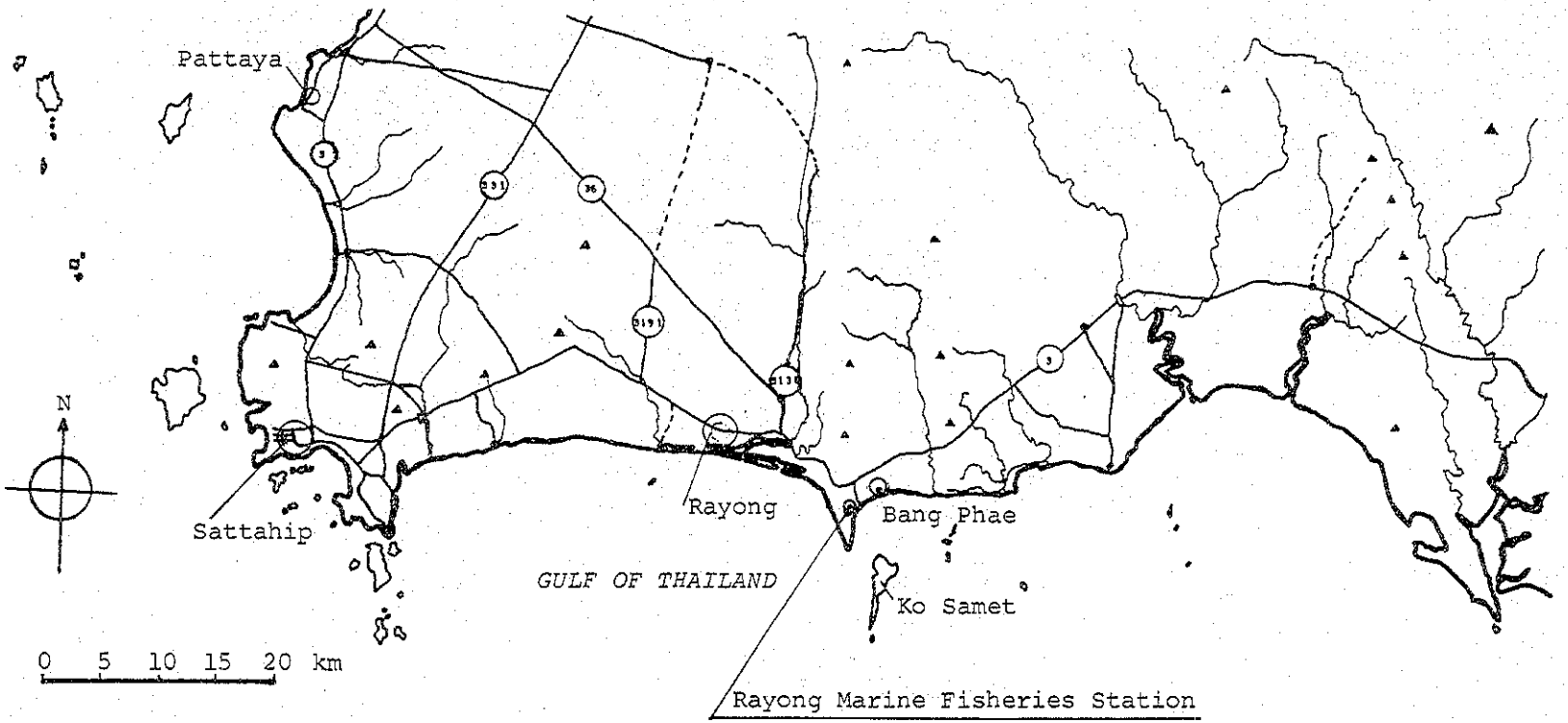
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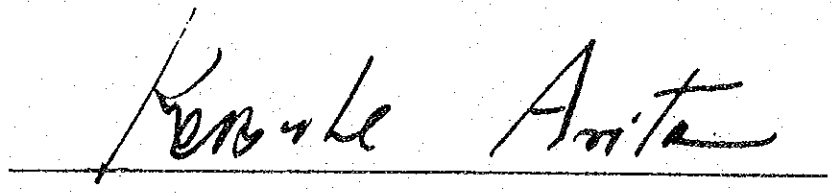
PREFACE

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan has decided to conduct a Basic Design Study on the Extention Project of the Rayong Marine Fisheries Station and entrusted the survey to the Japan International Cooperation Agency (JICA). JICA sent to Thailand a survey team headed by Mr. Tatsuhiko Iwasawa, Duputy Director, International Division, Oceanic Fisheries Department, Fisheries Agency, from March 11 to 31, 1984. The team had discussions with the officials concerned of the Government of Thailand and conducted a field survey in Bangkok and Rayong area. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this Report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Kingdom of Thailand for the close cooperation extended to the team.

June, 1984



Keisuke ARITA
President
Japan International Cooperation Agency

SUMMARY

The fishery industry in the Kingdom of Thailand achieved remarkable development during the last two decades. The production had increased over 10 folds from early 1960's, through introduction of trawl fishery, motarization of fishing vessels and improvement and extention of fisheries technology. This fishery development has contributed not only to the food supply but also to the national economy.

The rapid expansion of fishing efforts is not accompanied with adequate measure for resource management, and the fisheries resources, particularly of the Gulf of Thailand, has excessively exploited toward resource exhaustion. This excessive exploitation can be identified from the decreas in recent fish production after 1977, although a part of the decrease is related to the establishment of 200 mile exclusive economic zone (EEZ) by neighbouring countries.

In consideration of this situation, the Depatment of Fisheries (DOF), Thailand, has set up the Fisheries Development Plan basing on policies of resource management and its utilization, under the Fifth Five-Year National Socio-Economic Development Plan. As the first step to realize this Plan, DOF planned to extend and strengthen the facilities of Rayong Marine Fisheries Station for the fisheries development in the integrated development area designated by the National Development Plan. The Government of Thailand requested the Japanese Government to provide a grant assistance for the facilities and equipment necessary for the implementation of the Project. Upon this request, the Japan International Cooperation Agency (JICA) sent a basic design survey team to Thailand from March 11th to 31st, 1984. The team conducted a field survey in Bangkok and Rayong and held a series of discussions with the officials of DOF on the project scope and the feasibility. As a result of the discussions, the team exchanged and signed the Minutes of Discussion which covered the basic confirments between the team and DOF.

The objectives of the Project are ;

(1) to establish a Marine Fisheries Development Center by extending the facilities of Rayong Marine Fisheries Station and strengthening its functions, namely, research on marine environment and fisheries resources, study on mariculture technology, and training to small-scale local fishermen.

(2) to promote a fisheries development in the eastern part of the Gulf of Thailand.

On the field survey, the team confirmed the necessity of management and appropriate utilization of marine fisheries resources in accordance with the present situation and further development. DOF has a strong intension to promote the Project trying to secure the sufficient budget and manpower to undertake this Project. The team also confirmed no serious problem to implement this Project. The activities related to mariculture have been presently carried out in the station. The staffs for research and investigation of marine resources and environment will be transferred from the Bangkok head office of Marine Fisheries Division, DOF. The overlap of facilities between the new and existing ones is avoided to minimize the cost. As the project site is in the integrated development area designated by the Fifth Five-Year National Socio-economic Development Plan, it is desirable to take appropriate measures against the population inflow and the environmental deterioration to be expected in the promotion of the Plan. In deep consideration of these situations, the implementation of this Project is identified as feasible.

The team prepared the basic design for extension of Rayong Marine Fisheries Station, paying particular attention to the further development of fishery in Thailand.

The main facilities and equipment necessary for executing this Project are as follows;

(1) One laboratory building suitable for conducting experiment and research on marine resources and environment, and its related facilities such as water supply tower, water filteration tank, and aeration system
(2) One workshop for fishing gear
(3) One dormitory for trainees
(4) One laboratory scale feed plant
(5) One generator house
(6) One pump house for water supply
(7) Water gate installed at the seawater reservoir
(8) One fishing research vessel
(9) Equipment necessary for experiments, research and other activities to be conducted in the Station

Total area of the buildings listed above (1 to 6) is approximately 4,000 m^2. The required period for project implementation is approximately 15 months including the detail design and tender.

With the completion of this Project, the first regional marine fisheries development center equipped with facilities necessary for investigation and research on marine resources and environment will be established at the coas of the Gulf of Thailand where the resource exhaustion is worried, and the effective operation of the Center will contribute to the fisheries development based on the appropriate management for the resources and environment. This Center will also play a key-role for development of mariculture and small-scale fishery.

Japanese cooperation for the execution of this Project is valuable and effective, for this Project greatly contributes to the fisheries development in the country.

The practical objective of this Project is to increase the fish production, through adequate management and utilization of fisheries resources, which can be achieved by integration of systematic fishing activities, fishing ground management, and aquaculture development. In order to achieve this objective, however, it would be essential to cooperate with the upper governmental authorities and the related organizations to provide administrative guidances. It is strongly desired that all efforts toward achievement of the objecvtives would be systematically organized under these internal cooperations.

TABLE OF CONTENTS

1. INTRODUCTION

The Kingdom of Thailand, which is basically an agricultural country, has achieved its rapid economic developmentduring the last twenty years or the four successive five-year terms of National Socio-Economic Development Plans from 1962. Improvements on infrastructures such as roads and electric power stations, the multiplication of the agricultural products, and the industrialization were contributed to the development. Through the rapid development, however, Thailand has begun to be suffering from various problems such as difict in the country's international payments, urban centralization of economic activity and population, creation of poverty in rural areas, and contamination of natural environment such as on land, forest and water resources. The Government of Thailand, therefore, has placed a great emphasis on the solution of these problems under the country's Fifth Five-Year National Socio-Economic Development Plan (1982-1986).

This tendency of accompanied problems with rapid development can be seen in the field of fishery which occupies an important part in the primary sector in Thailand.

Fishery in Thailand, particularly its marine fishery, has developed largely through introduction and extention of new fishing technologies from developed countries, for instance, the introduction of trawl fishery from the West Germany in the early 1960's. The total fish landing in the country has increased to 2,190,000 tons in 1977, approximately ten folds of the early 1960's. This great increase of marine fish landing has greatly contributed not only to the domestic food supply but also to the foreign currency earnings through export of the fishes.

In recent years, however, the fishery resources in the Gulf of Thailand appeared to be over-exploited. For instance, the trend can be seen in the decline of the country's fish production after recorded its peak in 1977.

Such decline of the products was considered to be brought from the lack of appropriate resource management as well as the reduction of fishing area by the declaration of 200 mile exclusive economic zone (EEZ) by the neighbouring countries. It is anticipated that the decline of fish production would continue in the future, and would cause a heavy damage to the Thai economy if adequate countermeasure for the resource conservation and utilization were not undertaken.

In order to meet the present situation, the Department of Fisheries (DOF) has formulated several fisheries development projects aiming at i) provision of appropriate guidance for the fisheries industry, ii) conservation and management of marine resources and environment, iii) small-scalle fisheries development, and iv) aquaculture development, under the Fifth Five-Year National Socio-Economic Development Plan.

As the first step for achieving these objectives, Marine Fisheries Division of DOF has formurated the Rayong Marine Fisheries Station Extention Project in which various fisheries development would be promoted.

In this context, the Government of Japan was requested by the Government of Thailand to provide a bilateral assistance in the form of a grant for the facilities and equipment neccessary for execution of the Project.

In response to this request from the Thai Government, JICA conducted the preliminary study and sent the Basic Design Servey team from March 11th to 31st in 1984 headed by Mr. Tatsuhiko Iwasawa, Duputy Director, International Division, Oceanic Fisheries Department, Japan Fisheries Agency as the Mission Leader.

The objective of the servey team was to study the feasibility of the Project. The team visited Bangkok and Rayong in Thailand and conducted a survey including

collection of data relevant to the present fisheries development projects, observation of the the existing facilities and related fisheries infrastructure. Discussions were held in detail with the officials of Marine Fisheries Division, DOF as to the most suitable scope, personnel, budget, and management plans for the Project. The Minutes of the Discussion were duly signed and exchanged. The list of team members, itinerary, relevant officials of the Thai Government, and the Minutes of Discussion are presented in Annex at the end of this report.

2. BACKGROUND

2-1 Fishery in Thailand

2-1-1 Present Status of Fishery

(1) Fishery Status in National Economy

The Thai people prefer fish well in general and they are dependent on fish for more than 55% of their total animal protein intake (Table 1, Annex 1). Fish which are cheaper food than live stock meat are much important nutrition source for the poor people. High value fishes such as shrimps are also important to earn foreign currency through export and tourism industries.

The total fish production in 1981 was approximately 1,989,000 tons or 746 million US dollars. Thailand, together with Indonesia and the Phillipines, is certainly a major fishery country in the Southeast Asia in respect to the production. However, the recent fish production of Thailand is gradually declining after the peak production of 2,190,000 tons was achieved in 1977 (Fig. 1, Annex 1) while the other two countries continue to raise their productions. In addition to this decrease in total production, the increase in population forced the annual fish comsumption per capita to be decreased seriously (Table 2, Annex 1). The demand of fish production losted balance with the supply in Thailand, contrary to the scope of the government.

The situation of the fishery sector explained above was considered to be brought not only from the decrease in total fish production but also from the decrease in production of table fishes occupied in the total (See the chapter 2-2).

In contrast to the situation of the domestic consumption, the contribution of the fisheries industry to

the foreign currency earning is prominant. Thailand is a net exporter of fisheries products since 1963, and ranked frozen seafoods, mainly composed of shrimp, at the tenth foreign exchange earners in the country in 1981. The total export of fishereis products was about 300,000 tons (or about 381 million US dollars) while the total import of those was 47,000 tons (or 24 million US dollars). The export of fisheries products in value occupied about 5.7% of the total export of 6,645 million US dollars and it is still increasing.

The fisheris industry of Thailand produced about 2% of GNP in 1981 (Table 3, Annex 1). The fisheries population was estimated at 330,000 people occupying 1.4% of the total working population. The significance of the industry, however, is more than these figures appeared in the statistics in respect of the contributions as sources of animal protein for the rural people, and foreign currency.

(1) Inland Fishery

Having a long history, inland fishery in Thailand has been supplying a large part of animal protein to the people through bodies of waters such as rivers, streams, lakes and ponds. Most of farmars are also fishermen in this country according to seasons.

The inland fishery production (except aquaculture) was approximately 116,000 tons or about 5.8% of total fish production in 1981. These figures include only the fish appeared on market without counting the fish self-consumed by the fishermen. Although the exact amount of the production from inland fishery is unknown due to the self-consumed fishes, the production is gradually increasing at least on the official statistics.

The major freshwater fishes caught are snakehead (23% in volume), catfishes (17%), sepat siam (15%), carps

(12%), amphibians (5%, flogs etc.), shrimps (3%), eels (2%), and others (23%). The fishing gears used are varied from place to place. Bag net, sweep net, cast net, gill net, lift net, scoop net, hook and line, long-line, fish corral, etc. are used.

The total water surface area used for inland fishery is estimated at 454,000 ha of which 400,000 ha consist of rice fields and flood plains which appears only in rainy seasons. Nowadays, due to the development of modern irrigation system and agricultural chemicals, the area suitable for fisheries activities in rice fields and flood plains are decreasing year after year. In order to cope with this situation, efforts for increasing productivity per unit of area are being made.

The income level of people living in inland region, specially that of the farmers, is low while the rate of its self-sufficiency is high. The inland fishery is quite important for these people because it provides additional income and its animal protein without much investment to them.

(2) Marine Fishery

1) Fishing grounds and methods;

The fishery activities are conducted in the Gulf of Thailand and the Andaman Ocean. The Gulf of Thailand is the major fishing area where the effluents from the three biggest rivers in Thailand, Mae Nam Chao Playa, Mae Nam Tha Chin and Mae Nam Klong, make the productivity of the Gulf of Thailand high. Purse seine nets and gill nets and trawl nets introduced in 1960's are used in the area as large-scale fishing. Traditional fish traps, push nets, cast nets are used as small-scale fishings. The fishing seasons and grounds change depending on the climate, particularly on the monsoon condition.

2) Fish Catch

The marine fishery in Thailand is the major part of fishery sector occupying 90% of the total fish prododuction. The fish catch from the marine fishery was approximately 1,760,000 tons or 88.3% of the total fish production in 1981. The landing is gradually decreasing from 1,916,ooo tons in 1977, though the catch in 1981 was slightly larger than that in 1980. Out of the total fish catch, about 1,518,000 tons or 86.4% are landed from the Gulf of Thailand in 1981. About 60% of the total were caught by the trawl fishing and about 75% of that were caught by the large scale fishing. About 50% (790,000 to 800,000 tons) were treated as trash fish which were uilized as feeds for live stocks and fishes. The fish caught consist of quite many species such as sardins, mackerels, shrimps, crabs, squids, shells, etc. and none of these were predominant to the others (Table 4, Annex 1).

3) Fishing Vessels and Fishermen

The total number of motorized vessels (equipped with in-board engine) had been increased year after year untill the number reached 19,511 in 1980. In 1981, the number decreased to 14,723 mainly because of reduction in trawl fishng vessel, although more than half of the motorized vessels are still consist of the trawl vessels such as otter trawl, pair trawl and beam trawl, now. Besides these in-board motorized vessels, 5,492 of out-board motarized vessels and 3,488 of non-motalized vessels are registered to DOF. Furthermore, many non-registered vessels are said to be operated in the coastal water, although the number is not known.

According to the official statistics, the number of fishermen and households were 89,777 and 54,961, respectively, although such data did not seem to acccount for small-scale fishermen (Fig.2, Annex 1).

(3) Aquaculture

The production from aquaculture industry was approximately 116,000 tons or 81.29 million US dollars which was equivalent to 5.8% in volume or 10.9% of in value of the total fish production in 1981. Thus, the impact to the national economy is not small though production in volume is small. The aquacultural production, particularly that from brackishwater and freshwater, has gradually but steadily increased.

Aquaculture in Thailand can be divided into three sectors; 1) mariculture, 2)brackishwater culture, and 3) freshwater culture.

1) Mariculture

The mariculture production is exclusively occupied by bivalves. Mussels, bloody cockle, and oysters are cultured in an extensive manner. The total production in 1981 was 53,746 tons (including shell weight) which occupied about 80% of the country's total bivalves production including the non-cultural ones.

2) Brackishwater culture

The production from brackishwater culture was 13,759 tons or 29.23 million dollars in 1981 and is still increasing. The major species cultured are shrimp (10,729 tons), mullet (370 tons), and sea bass (226 tons). Technical and economic foreign aids succeeded to make the production level launch from that of extensive type culture in which the availability of natural fingerlings and natural food limited the production level. The seed production technologies for penaeid shrimps and sea bass were already established and the controls of whole life cycles for these species are possible now.

3) Freshwater cultute

The production from freshwater culture was 48,113 tons or 43.65 million US dollars and is still incresing. The species cultured includes gouramies, catfishes, snakehead, carps, tilapias, etc. Various methods from no-feed culture to intensive type culture were conducted.

The methods of extensive type are similar to those of fishing or catching traditionally practised in this country. DOF is making an effort on development and extension of aquaculture technologies with the help of technical and economic assistance from developed countries.

(4) Fish Marketing

1) Fish landing

There are about 30 landing stations in Thailand. The major stations are Samut Sakhon and Samut Prakan (located nearby Bangkok), Pattani and Songkhla (nearby the second largest city, Hatyai), and Ranong (along the Indian Ocean). About 80% of the total fish production are landed at the piers owned by private enterprises and marketed through the private marketing systems. Fish Marketing Organization (FMO), a governmental enterprize under Ministry of Agriculture and Cooperatives, operates its own marketing facilities at each major fish landing station, dealing with the rest of 20% of the landing.

2) Fish marketing

Fish collector, so called "middleman", takes a important position in the marketing system in Thailand. About 85% of the total fish dealt with at Bangkok

Wholesale Market are collected by these middlemen at local stations. Middlemen finances local fishermen for their fishing operation and facilities so as to have influences to them. Although some fishermen engaging in large-scale commercial fishery directly consign the fish for sale to the Bangkok Wholesale Market, almost all artisanal fishermen sell their products to middlemen against their will of the direct consignment. The embryonic development of fishermen's cooperatives is one of the reasons for the situation.

(5) Fish Utilization

Out of the total marine fish production of 1,824,000 tons in 1981, 505,000 tons (27.7%) are consumed as fresh and 122,000 tons (6.7%) are processed for frozen products. The other fishes consumed as table fish include salted and dried fish for 126,000 tons (6.9%), fish sause (Nam-Pla) for 90,000 tons (4.9%), canned products for 41,000 tons (2.9%), fish past, fish sausage, etc. In addition to the above table fishes, about 841,000 tons (46.1%) are utilized as materials for fishmeal.

Thailand is a net exporter of fish products. The total fish exoprt in 1981 was about 3000,000 tons or 380,700 US dollars, while the total fish import was 47,000 tons or 238,000 US dollars. Both export and import, particularly export, have achieved the prominent increase for the past 15 years.

The major export items and countries are frozen products of shrimp, squid and fish to Japan, U.S.A. and European countries, canned products to U.S.A., Austraria, and European countries, and fish meal to the Southeast Asian counties (Table 6, Annex 1). On the other hand, the major import items and countries are fresh and frozen products of fish from Singapore, Burma, and Maldives, giant freshwater prawn from Bruma, bloody cockle from Malaysia, and shark fin

from Hong Kong. Among the above major import items, the freshwater prawn, bloody cockle and shark fin are mainly consumed domestically, while frozen fishes are utilized as raw materials for canned products and packed in Thailand for re-export.

2-1-2 Marine Fishery

(1) History and Development

Before trawl fishery was introduced to Thailand in the early 1960's, marine fishery in Thailand mainly composed of small-scale coastal fishermen operating the traditional fish traps (e.g. fish corral, a typical Thai style fish trap made by bomboo poles) with non-motorized boats. They caught small pelagic fishes and shellfishes by the traditional fishing methods on self-sufficient basis. Since the modern trawl fishing technology was introduced under the bilateral assistance from West Germany in 1962, annual fish production had rapidly increased by ten folds, from less than 150,000 tons in 1962 to over 1,500,000 tons in 1972 through the extention of motorized fishing boats and large and modern fishing nets such as purse seines and gill nets. The fisheries operational area was also extended from the coastal water toward offshore and then toward the offshore of the neighboring countries such as Malaysia, Cambodia, Indonesia, Burma, etc.

After such remarkable development of Thai fisheries industry was achieved during the period of 1960's to early 1970's, however, annual fish productions have remained at about the same level because of the price escalation of the fuel for the fishing vessels, despite that the size of the fishing vessels become large and their number is also increased. The excessive exploitation of fisheries resources in the Gulf of Thailand is the other reason causing the decline of fish production.

(2) Present Status

As mentioned above, the recent production from the Thai marine fishery, which is the major constituent of Thai fisheries producing about 90% of the total fishes in the country, remained at a level of 1.5 to 1.8 million tons.

The followings can be considered as the reasons for the decrease in production.

1) Reduction of the fishing ground by neighboring countries' 200 mile EEZ

Thailand borders Cambodia to the east, Malaysia to the south, and Burma to the west. About 30% of the formar public water surface in the Gulf of Thailand became the exclusive economic zones of the neighboring countries at the time of 200 mile EEZ declaration.

2) Excessive operation of trawl fishery in the Gulf of Thailand

The most important type of fishery is the trawl fishery providing about 60% of the total marine fish catch. Although the trawl fishery has been rapidly developed and extended since 1960's, the catch per unit effort (CPUE) has declined since 1970 in the country.

According to results of the trawl fishing trials made by Department of Fisheries (DOF), average CPUE has declined from 249.88 kg/hr in 1961 to 102.74 kg/hr, 46.99 kg/hr, and 47.92 kg/hr in 1969, 1975 and 1980, respectively. The decline of CPUE forced the fishermen to extend the operational hours and to reduce the net mesh size resulting in the over-exploitation of the resources. The nets with reduced mesh size catches small juvenile fishes of economically important species which are treated as trash fish after the landing. Furthermore, it is suspected that natural spawning

grounds for the economically important fishes in the Gulf of Thailand were destroyed by the excessive operations of trawl and push nets.

It is considered as one of the symptons of the resource exhaustion caused by such excessive operation of the fishing gears with the reduced mesh size that the rate of trash fish to the total marine fish catch increased from 20 - 30% to 45 - 50% during the last twenty years. The rate of trash fish to the total is especially large in trawl and push net fishing since these methods do not possess a mechanism of selection of fish species and size (Table 7, Annex 1).

Although the Thai marine fishery was remerkably developed through the introduction of modern fishing technologies, enermous number of small-scale artisanal fishermen were remained behined such development. It is surmised that such artisanal fishermen exist all over the Thai coast and non-registered fishermen are particularly abundant in number of several thousands in the southern part of Thailand. They operate small-scale fishing gears such as gill nets, cast nets, lift nets, and fish traps in coastal water using wooden boats of 3 to 6 m long equipped with/without out-board engine (diesel engine with long shaft and propeller, assembled locally). Their fishing operations are expected accerelate more or less the exhaustion of fisheries resources, although the individual operational scale is small. It is difficult for the Thai Government to extend the appropriate guidance on the resource management to these fishermen throughout the Thai coast because of the enermous number and no particular organization.

(3) Problems of marine fishery

The resource exhaustion caused by the excessive fisheries operation is pointed out as the major problem for Thai fishery. While the fishery operational area is tried to

be kept as wide as before the decraration of 200 mile EEZ by means of fishery conventions and joint fishing operations with the neighbouring countries, effective utilization of the limited fisheries resource shoud also be considered.

In order to conserve the marine fishery resources, Thai Government set up regulations such as restrictions on fishing gears and provision of the closed seasons and areas. However, the regulations have not been fully enforced, and some of the fishermen are said to operate illegal fishing gears evading the regurations. Especially, the complete emforcement of the regulations to small-scale fishermen is difficult and their illegal operations of push nets and beam trawls in the coastal water make resource management difficult.

In consideration of the present sitiuation, appropriate fisheries administration accorded to the resource condition should be performed, with re-establishment of the regurations, if necessary. Development of mariculture and its extention to local fishermen will become important for the realization of the adequate resource management.

2-2 Development Policy

2-2-1 National Development Plan and Fishery Development Plan

(1) National Development Plan

Through the provisions of four consecutive Five-Year National Socio-Economic Development Plans, Thailand achieved the 14 folds increase of gross national products (GNP) from 60 billion bahts to 817 billion bahts, the 8 times increase of gross income per capita from 2,200 bahts to 17,200 bahts, and the 16 folds increase of export from 9.9 billion bahts to 1,630 billion bahts. The rapid development, however, caused various social problems such as the centralization of economic activities and population to

Metropolitan Bangkok, large difference in income earnings between urban and rural areas, and the contamination of natural environment such as on lands, forests, and water resources. In deep consideration of these situations, the following policies are emphasized in the Fifth National Development Plan (October 1981 - September 1986).

1) Restoration of the country's economic and financial position with appropriate fiscal and monetary policies
2) Development of social structure and distribution of social services
3) Poverty alleviation in backward area
4) Coordination of the economic delopment activities with national security management
5) Adjustment of economic structure and raising economic efficiency
6) Collaboration of the private sector

In this Plan, the Thai Government has placed the highest priority on the increase of industrial products in the total export goods and tried to convert the nation's economic base from the agriculture to the industry. As for the primary sector led by agriculture, improvement of productivity was emphasized giving the following annual rates of increase of the productions; 4.7%, 4.2%, and 5.4% for ariculture, livestock, and fisheries sectors, respectively. It is another characteristic in this Plan that the economic development is harmonized with the regional development to solve the problem of dense population in Bangkok through the dispersion of the economic activities.

(2) Fisheries Development Plan

In order to solve the problems fased by the fisheries industry in Thailand, DOF set up the following policies.

1) Extention of fishing area through cooperative fishing with the neighbouring countries

The establishment of 200 mile EEZ reduced the fishing operational area of Thai vessels. The Thai government is in the treaties of cooperative fishing with Bangladesh, India, Indonesia, China, and Malaysia, and has an intention to promote the negotiations for the similar treaties with other relevant countries such as Burma, Cambodia and Vietnam.

2) Aquaculture Development

Thailand has a long history of aquaculture in inland and coastal regions. To increase fisheries resources, it is required to develop more productive aquaculture technology and facilities related to seed production, feed quality, and fish pathology. It is also helpful for the purpose of increasing fish resources to release fingerlings to natural environment under proper management.

3) Marine Fisheries Development

Former fisheries development policies had mainly aimed at the increase of the fish production. The resource conservation and management are emphasized in the new development policy in addition to fish production. Conservation of the marine fishery resources, demersal fish resource in the Gulf of Thailand in particular, and full utilization of present resouces based on careful investigations are strongly recommended. Up-lift of the living standard of the artisanal fishermen is also included in the new policy.

2-2-2 Eastern Seaboard Development

For the diversification of economic activities to rural area, in relation to the policies in the Fifth National Development Plan, the Eastern Seaboard Development Plan aiming at integrated regional development is now under the implementation stage. This regional development is planned to be achieved by integration of several components; 1) establishment of the Gas Separation Plant around Rayong and other related industrial complexes such as the Petrochemical Complex and Fertirizer Complex, 2) improvement of infrastructure such as Sttahip Deep Sea Port, water pipeline and city planning, and 3) invitation of private industries attracted by the fuel produced by the gas plant and the infrastructure. In the implementation of this integrated plan, special care will be paid on the harmonization of land utilization among agriculture, industry, and housing. Care to the environmental conservation related to fishery and tourism should be also paid.

Through the promotion of the Eastern Seaboard Development Plan, rapid changes of both natural and social environments in the project area are prospected.

As for the natural environment, it is desirable for fishery sector to make an appropriate countermeasure for conservation of marine environment related to fisheries resources based on the proper analysis of regular and consequent investigations.

As for social environment, the population inflow to this area is prospected. Being relatively close to Metroplitan Bangkok, the project area has several fish landing sites from where the food supply to Bangkok is convenient. In the eastern part of Thailand, therefore, the incease of fish production will be essensial not only to satisfy the increasing demand for the local comsumption but also to meet the demand for the Bangkok metropolitans.

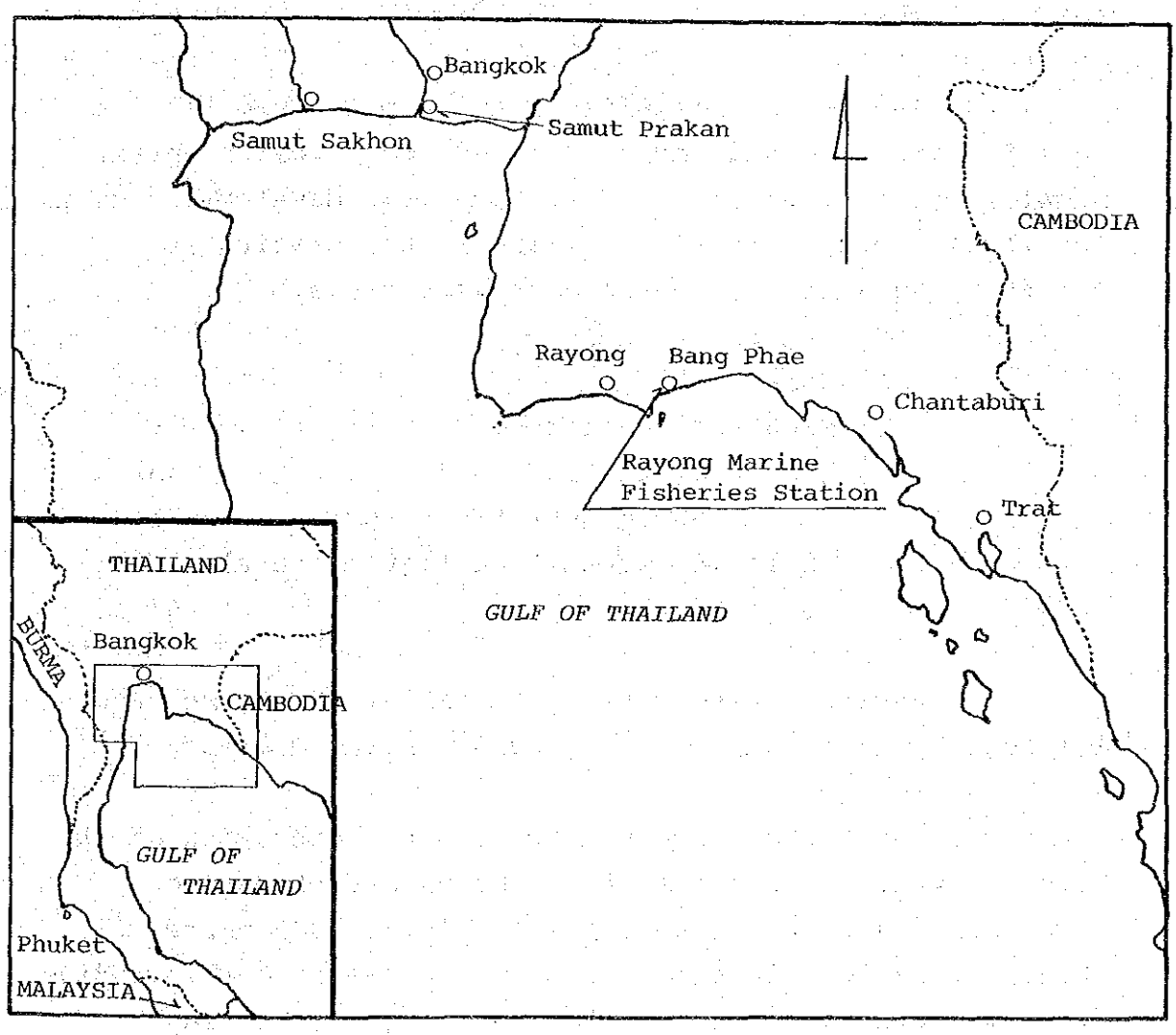
Furthermore, although the Eastern Seaboard Development will contribute to upgrade the regional economic level, poor people may still remain getting no benefit from the development to be achieved by the project. An attention should be paid to the uplift of living standard of the poor people as well as the activation of economy in the area. As for fishermen falling in that category, increase of seasonal income by introduction of aquaculture under adequate management of coastal fisheries resources is desired.

To hold the three policies for the marine fisheries development in the eastern seabord as mentiond above (See 2-2, (2)) it is desirable to establish the facilities as a core of various activities for the promotion of fisheries development in the objective region.

3. PRESENT STATUS OF RAYONG MARINE FISHERIES STATION

3-1 Location

Rayong Marine Fisheries Station, the objective facilities of this Project, is the branch station of Marine Fisheries Division of DOF on the Gulf of Thailand. Established in 1950, the Station conducts research and development of mariculture and fishing gear as main activities. The Station is located in Ban Pe District, Rayong Province on the southeastern coast of the Gulf of Thailand, about 220 km from Bangkok.



The site of this Station occupies about 130.5 Rai (209,000 m^2, about 600 m from north to south and about 40 m from east to west) and faces to the Gulf of Thailand to the east, and to a range of hillock from the south to south-western side of the site. As shown in Annex 2, the main facilities of the Station includes a main building (management & administration building), aquaculture facilities including hatcheries, a small port with a slipway, a fishing gear workshop, and staff houses. The aquaculture facilities of Brackishwater Fisheries Station is presently located in same site (Annex 4). These facilities are independent from the Marine Fisheries Division and not included in this Project.

3-2 Organization

The Marine Fisheries Station presently has one administration & management unit and two research units, namely, mariculture unit and fishing gear development unit. The total number of staffs working in the Station is currentry 80 which is broken-down as follows;

Chief	1
Fisheries researcher	6
Biologist	(5)
Fishing gear technologist	(1)
Fisheries technician (aquaculture)	6
Laborers	67

Besides these permanent staffs, part-time laborers are occassionally employed depending on the demands.

The annual budget allocated for operation of the Station, which is arranged from the budget of Marine Fisheries Division, is approximately 4,700,000 bahts Of which, 3,000,000 bahts are used for manpower cost including overtime working fee and travel cost. The remaining 1,700,000 bahts are used for the operation cost for

facilities such as electricity, fuel, consumable goods, repairing and communication (1,500,000 bahts) and purchasing of new equipment such as pump and research kit (200,000 bahts).

3-3 Activities

The major activities during the first decade from the establishment of the Station is related to fishing gears. The Station worked on the research first then developed and extended the know-how to the local fishermen. The activities concerning to aquaculture have been commenced since 1974.

The present major activities undertaken are 1) seed production, 2) improvement of fishing gears, and 3) research on fish apartment (an artificial structure installed on shore to attract fish.

(1) Seed production

The seed production of sea bass (Lates calcarifer) and swimming blue crab (Portunus pelagicus) has been carried out since 1981. The following table shows the amount of the production.

Species	Year			
	1981	1982	1983	1984
Sea bass	12,200,000	30,000,000	4,930,000	-
Swimming blue crab	3,000,000	2,340,000	3,080,000	3,520,000
Total	15,200,000	32,340,000	8,010,000	3,520,000

The seeds of sea bass were sold to the private fishermen, while the crab seeds were released to the sea at the age of 15 days old to increase the natural stocks.

The seed production of sea bass was terminated in 1984 since the relevant technologies were transferrd to the private farmers successfully enough to produce the seed indipendently. Instead of sea bass, the Station started the research on high value marine fishes like snapper and grouper.

(2) Improvement of fishing gears

In order to raise efficiency of fishing gear used by local fishermen, the Station has been making an effort on improvment and extention of appropriate fishing gears. Presently, the activity is focused on crab traps. Studies of fish basket and small-scale long line for small fishes are also planned to be carried out by the Station.

(3) Experiment and research of fish apartment

As one of the methods to conserve the resources and to upgrade the productivity in the coastal water, the Station has started the research on fish apartment since 1978. Old rubber tires and concrete blocks are used as the materials. Six fish apartments were already constructed around the Station. According to the investigations made with fish traps and hook-and-line, the attractive effect of the fish apattments was confirmed by experimental fishing, catching economically important fishes such as sea bass, groupers, snappers and spanish mackerel.

3-4 Facilities

(1) Aquaculture facilities

The seawater supply system, composing of a intake well, pumps and a intake piping line, is installed at the east end of the site. The intake pipe (700 mm in

inner diameter, made of concreate) is extended about 220 m from the seashore to the sea. The water come through the pipe is pumped up from the intake well (3 m in length, 2 m in width, and 6m in diameter, made of concrete) and provided to the onshore facilities. All the pumps are damaged of seawater corrosion and reduced in efficiencies.

An earthen seawater reservoir (about 19,200 m^2 in area, 2 m in average depth) is located at the east end of the Station. In addition, Marine Fisheries Devision posseses the following facilities.

Earthen rearing pond	
800 m^2, 1 m deep	3 units
Concrete broodstock tank	
245 m^2, 1 m deep	1 unit
190 m^2, 1 m deep	1 unit
Concrete circular tank (60 ton)	
with filteration tank	1 unit
without filteration tank	1 unit
Concrete culture tank	
30 ton, for zooplankton	4 units
6 ton, for phytoplankton	6 units
2 ton, for larval rearing	25 units
FRP culture tank (1 tons)	15 units
Concrete rectangular tank for larval rearing	
1.8 ton capacity	44 units
6 ton capacity	4 units
Laboratory for analysis and plankton culture	
2 m x 5 m	1 unit
Air compressor house	1 unit
Auxilliary seawater intake pump	1 unit

As these facilities have been extended at several times ocasionally since about 10 years ago, they are not systematically designed to achieve an effective

operations among the units. In addition, due to exhaustions of the facilities and equipment as well as inadequate constructions, some of them are not capable of operating efficiently as described as follows.

a) Most of the concrete rectangular tanks for larval rearing are leaking from the bottoms and the walls, and out of order.
b) Three units of the existing air compressors (1 to 2 hp) are too old to supply enough air to all tanks.
c) The laboratory for analysis and plankton culture is not sufficient in size and equipment.
d) All earthen ponds (seawater reservoir and rearing ponds) are out of order because of heavy silt sedimentation around the gate except one installed at the southeastern end of the reservoir.

The main facilities of Brackishwater Fisheries Division are large concrete rectangular tanks for shrimp seed production. Twenty five units of 3 ton concrete circular hatching tanks installed at the southern part of the site belonging to the division is planned to be handed over to Marine Fisheries Division upon the establishment of the Center. Brackishwater Fisheries Division is planned to move to a new site within three years and all the other existing facilities will be also transferred to Marine Fisheries Division thereafter for the possession. The facilities belonging to Brackishwater Fisheries Division have been constructed or installed occasionally at several times since 10 years ago. The condition of these facilities are better than those possessed by Marine Fisheries Division.

(2) Small port equipped with a slipway, a workshop, and a elecric winch for repare of small wooden fishing vessels

The workshop is old but still capable of repairing small wooden fishing vessels owned by the fishermen around the Station. Some of wooden work machinery have been already out of order.

(3) Fishing gear workshop

The area of the workshop is about 1,000 m^2 including storage space. No machinary is equipped to this workshop.

(4) Other facilities

Pipes of 163 m in length and 16 inches in diameter are installed for the drainage system in the Station. Two drainage piping systems, one comes from the facilities of Marine Fisheries Division and the other from the staff houses, are connected at wells and then led to the small port for releasing. The pipe lines are apt to clog since a few years ago. The drainage sytem comes from the facilities of Marine Fisheries Division is maintained for use by water jet pressure. The drainage from the facilities of Brackishwater Fisheries Division is released through the other drainage system to the seawater reservoir located at the east end of the Station.

(5) Sub-Station

A sub-station for conducting mariculture experiment with floating cage nets is annexed to the Station. The cages are set up in the water along the northeastern side of Ko Samet island located two mile off the Station. The area is preferable beacuse of the relatively calm condition throughout the year, even in monsoon season in which wind comes from the southwest direction.

4. THE PROJECT

4-1 Objectives

The objectives of this Project are;

1) to set up Marine Fisheries Development Center by extending and strengthing both facilities and manpower of the Rayong Marine Fisheries Station; and on the basis of the establishment of the center,

2) to promote marine fisheries development in the eastern regeon of the Gulf of Thailand by integration of the following accomplishments.

    1) Conservation of the fisheries resources and the marine environment
    2) Appropriate management of the fisheries resources
    3) Development of small-scale fisheries
    4) Development of fishing gears
    5) Development of mariculture

4-2 Scope of the Project

4-2-1 Eastern Sea Marine Fisheries Development Center

All various fisheries related activities presently conducted in the Rayong Marine Fisheries Station will be carried over by Marine Fisheries Development Center. Effort will be made specially on the following activities;

1) Seed production of marine fishes
2) Studies on fishing gears and methods
3) Experiments and examinations of fish apartment
4) Trainings and instructions for the neighbouring fishermen

In addition to these present activities to be extended, the Center will perform research on resource conservation and its utilization with the help of the newly provided facilities.

The Center will be managed by Marine Fisheries Division, according to the fisheries development policy and guidance of DOF.

The research area of the Center includes the coastal region, from Laem Chabang District, Cholburi Province reaching to Haad Lek District, Trad Province and the eastern region of the gulf of Thailand enclosed by the following lines ; 11^{o}-39'N latitude line which passes on Haad Lek, 100^{o}-49'E longitude line which passes the point of 5 mile off Laem Chabang, and the seashore line. The area of the region is 5,275 square miles (approx. 10,650 km^2) (Annex 4)

The Center is composed of 5 units, each of which has the following function (Annex 5).

1) Conservation and management of the marine resources
2) Investigation of the marine environment
3) Improvement of fishing gears and methods
4) Development of small-scale fisheries
5) Development of mariculture

The objective and activities of each unit are as follows.

(1) Marine Resources Management and Conservation Unit

The objective of this unit is to prevent the fisheries resources from detrioration and to conduct the proper management of them in order to achieve the effective utilization in a permanent term. Its actual activities will be to collect and analyze data concerning to the fish caught in the objective region such as the catching place and season, net mesh size,

catch per unit effort (CPUE), species, length, wight, sex ratio, and maturity. Concurrently, the ecological study and monitoring by the fisheres research vessel in the objective region will be conducted. Through these activities, the unit will intend to grasp the resource status in terms of ecology, productivity, potential stock, maximum sustainable yield (MSY), etc. in the objective region in order to formurate adequate and effective means of conservation and management for the resources. Regulation on the net mesh size and provision of closed area and seasons are examples of them.

(2) Marine Environmental Research Unit

This unit will investigate and analyze the marine environment surrounding the fishes objected by the fisheries industry to maintaine them suitable to propagation and growth for the fishes. In this unit, marine environmental research and analysis of the sea water and the bottom soil will be regularly and periodically performed. Regurations and measures for the environmental conservation will be formurated by the unit in cooperation with other relevant organizations in order to manage the marine environment properly.

(3) Fishing Gear Development Unit

Improvement on the fishing gears suitable for the resource condition in the Gulf of Thailand is targeted by this unit. The gears used by the small-scale coastal fishermen will be specially taken into consideration.

(4) Small-scale Fisheries Development Unit

Intending to raise the living standard of the small-scale artisanal fishermen in the eastern coastal region of the Gulf of Thailand, the unit will try to provide the adequate guidance to them based on the study

on effective utilization of the marine resources. The unit will extend the appropriate means of raising their production capability suitable to thier socio-economic status and the resource condition.

The followings are the planned means for increase of the yield and proper exploitation of the fishing grounds.

1) Construction of fish apartments in use of old tires, concrete blocks, worn-out boats, etc.
2) Release of fingerlings propagated in the Center to the sea
3) Rearing the economically important fishes in fish cages made of bamboo and net
4) Improvement of fishing gears and methods

(5) Mariculture Development Unit

Aiming at increase of yield of the useful marine fish through aquacultural development, the following activities will be performed;

1) Examination for technology of propagation and rearing of the useful marine fishes
2) Seed-production of marine fish
3) Examination for the adequate artificial feeds

(6) Administrative Unit

This unit is responsible for managerial and administrative affairs of the Center. In addition to this fundamental activities, it will provide trainings and instructions to local fishermen and fisheries related persons in use of the facilities of the Center and in field trips.

The main activities will be as follows:

1) Field training on the basic aquacultural technology for the trainees including fishermen and governmental personnels concerned.
2) Instructions on fishing gears, methods and aquacultureal technology to local fishermen

Besides, it is an important issue to enlighten and educate fishermen and fisheries related persons about the principle and kow-how on conservation of the resources.

All the activities are performed and progressed as these units are mutually organised and functioned.

4-2-2 Plan of Activities and Necessary Facilities

(1) Research on Marine Resources and Environment

The Center conducts experimental fishing and environmental research, and collects information on the landings at fish ports and fishing villages in the objective area. Then, the Center provides the appropriate fisheries management and resource conservation based on the analysis of these data and informations.

To perform these activities, the Center should be equipped with a fisheries research vessel for collection of field data, and a laboratory with research equipment for analysis of the data.

(2) Research on Mariculture Development

Marine fish culture is a new technology and the development requires a great deal of basic research. The Center continues the research on red snapper, grouper, swimming blue crab, shrimp including basic studies of seed production and fish releasing.

These activities will be performed with the existing facilities mainly and some newly supplied facilities under this Project. A laboratory for conducting the basic research and a feed plant will be set up. The seawater intake system and the aeration supply system will be improved. FRP tanks and nets for fish stocking will be supplied.

(3) Education and Training

The Center's education and training will be provided to fishermen, students, and staffs of fisheries related institutions in the objective area.

These trainings are planned to be performed in and/or out of the Center. The training provided in the Center will be as follows;

a) Training to local fishermen on the fisheries technologies regarding on fishing gears, fishing methods, and fish culture. Number of trainees and period of one training will be planned to be 10 to 20 persons and 10 to 30 days, respectively, according to the levels of the training content and the trainees. The Center will provide high level trainings aiming at generation of leading personnels of fisheries associations.

b) Training to university students and staffs of fisheries related institutions at the Center, mainly on mariculture technology. The number of trainees and the period of one training are planned to be 25 persons and 7 to 10 days, respectively.

The training performed out of the Center mainly includes trainings to fishermen and cooperatives on fishing gears, fishing methods, and fish culture.

The necessary facilities for the educational activities include a dormitory, a laboratory, and training rooms with audio-visual education equipment. Auto-vehicles are required for the extention services. These vehicles will be also utilized for collection of inforamation and data useful for other activities.

(4) Studies on Fishing Gear and Fish Apartment

Construction of fish apartments is planned for the development of coastal fishery. The fishing gears and fish apartments materials will be produced at the Center. A workshop equipped with necessary machinery and tools is needed. The workshop can be also used for repair of other machinery of the Center.

4-2-3 Executing Agency

The executing agency of the Project is the Department of Fisheries (DOF). Marine Fisheries Division of DOF will actually carry out large part of the Project.

(1) Department of Fisheries (DOF)

DOF which belongs to the Ministry of Agriculture and Cooperatives (MOAC) is responsible for development of the fisheries sector, all the matters partaining to administration, planning, enforcement of fishery laws and regulations, training, research, extention and compilation of fishery statistics. DOF was established under the Fisheries Act in 1947. It is headed by Director-General who is assisted by three diputies; one responsible for the administration, one for the technical matters, and the other for development planning. The organization chart of DOF is shown in Annex 6. The current manpower of DOF (1982) is total of 5,596 in number, composing 1,477 fisheries officers and 4,119 suppportng staffs.

(2) Marine Fisheries Division

The head office of Marine Fisheries Division, constructed in 1965, is located at Yannawa District, Bangkok. Both the administrative and technical activities of the division is conducted in the same building. The unit responsible for technical activities are composed pelagic fisheries unit, demersal fisheries unit, invertebrates fisheries unit, and marine laboratory (Annex 6). Present manpower of the division is 435 in number of which 148 is fisheries biologist and technicians.

There are two marine fisheries stations each at Rayong and Phuket belonging to Marine Fisheries Division. Phuket Station is located on the coast of the Andamam Sea, and conducts research and extention activities regarding to fisheries resources, fishing technology and fishery related manufacturing. As for Rayong Station, the former chapter 3 showed the details.

4-3 Project Status

Fishing operation in the Gulf of Thailand has exceeded the level of optimum exploitation or the level keeping the maximum sustainable yield. It is necessary to consider the resource management and its effective utilization.

Based on this basic understandings, the extension and strengthening of Rayong Marine Fisheries Station should be formulated so as to promote marine fisheries development.

In order to realize resource management, systematic fisheries operation is essential. As mentioned earlier, investigation and research on resource condition and marine environment are necessary to promote such systematic fisheries and related environmental conservation which copes with the environmental deterioration caused by the integrated industrial development.

The research unit of Marine Fisheries Division is taking responsibility for the research on fisheries resources, but super-annuration of the research vessels and shortage of the necessary equipment are suppressing its efficiency at low level. Out of the total four vessels (40 to 90 gross tons), three are 19 to 23 years old. The inland locality of the research unit makes difficulties on smooth acquisition of the data. The facilities are insufficient to deal with the entire area of the Gulf of Thailand.

In consideration of the above situation, this Project is formulated to promote researches on the marine resource and environment in the area of eastern region of the Gulf of Thailand.

In addition to the resource conservational aspect, the future fishery should consider about artificial production to increase the resources directly. Mariculture Development Unit of the Center becomes important in this respect. The present mariculture development in Thailand, largely owes to Brackishwater Fisheries Division. The culture technology for some species such as Penaeus monodon and Lates calcarifer established by Brackishwater Fisheries Division is already utilized in the private enterprises. Mariculture Development Unit of the Center should deal with pelagic species to avoid an overlap in the activities with Brackishwater Fisheries Division. Since marine fish culture is new technology, it requires a great deal of basic researches to progress its development. The Mariculture Development Unit should, therefore, lay an emphasis on the accumulation of the basic data.

5. BASIC DESIGN

5-1 Outline of Project Site

(1) Geographical and Meteological Condition

Rayong Marine Fisheries Station, the objective facilities of this Project, is located at Ban Pe District, Rayong Province on the southeastern coast of the Gulf of Thailand, about 220 km from Bangkok. The Station is about 1.5 km from Ban Pe fishing port. No railway is extended to the project area so that auto-vehicles are main traffic means to visit the site. Major highway and road systems from Bangkok through Cholburi and Rayong to Trat are paved and maintained in a good condition. It takes about 2.5 to 3 hours to get the Station from Bangkok.

The climate at the site is oceanic and tropical characterised by high temperature and humidity and heavy rainfall. According to the meteological data observed at Rayong (Annex 7), annual average temperature is 27.9 °C ranging from 24.8 °C to 31.6 °C, and the annual average humidity is 77.0% ranging from 64.2% to 87.3%. The data recorded the wind force averaged for a year at 4.5 m/sec. The monsoon blows from the southwest or the west during March to October and from the north or the northeast during November to February. The annual number of rainy days is about 110 with annual precipitation of about 1,200 to 1,300 mm. The region is rarely flooded even in the rainy season (from May to October). The Project site is scarcely suffered from thunderbolts and earthquakes.

(2) Site Condition

The Station occupies about 130.5 Rai (209,000 m^2, 600 m from north to south and 400 m from east to west). The eastern side of the Station faces to the Gulf of Thailand and the north to northeastern side to a range of hillock.

Entering to the Station is made by a concrete-made bridge crossing to the water canal at the northeastern side. There are two other roads of 2 to 3 m in width accessing to the Station from outside, one is for the use of Station's residents and the other is presently closed.

Since the water from the well in the Station is not suitable for drinking water due to the salt concentration, rainwater tanks are installed in the station and the water is delivered to each staff house through piping. The capacity of the tanks is insufficient so that additional own rainwater tank is presently installed for each house. A reservoir of 30,000 ton capacity constructed by Ministry of Agriculture and Cooperatives exists 1.4 km east from the Station. There is a plan to construct a pipe line from the reservoir to the Station with the budget of 1,160,000 bahts by the end of September 1984.

The sewer is released to the small port directly through piping or to the infilteration tanks. Feces is treated in a septic tank before releasing.

The electric supply is of 250 KVA. There is an emergency generator which is old but capable for the operation. Each staff house uses propane gas as fuel. Propane gas, gasoline, diesel oil and fuel for fishing vessel are available at Ban Pae area. There is no public telephone line and there is no plan to extend it to the Station. A wireless set is used as a mean of telecommunication with outside the Station.

The building at the Station has basic structure consisting of concrete floor, concrete pillar, wooden beam and slate roof. These buildings were constructed 10 to more than 20 years ago, but are kept in good condition without serious damage so as to be stood for the future use. Particularily, the main building is strong showing beautiful external appearnance so that DOF is planning to utilize it as the administration building. Partial modification of the

building such as of transoms, is recommended to ventilate well enough for office work.

The bridge at main gate of the Station is 4.2 m in width and 3.7 m in height. Its bearing capacity is roughly estimated at 40 tons and is enough for the implementation of the Project. The heavy construction machines are expected to cross the canal at the east side of the bridge if the shallows are filled up even in the case that the bridge would not bear the weight of the heavy machines.

5-2 Designing Policy

5-2-1 Principle of Basic Design

The general planning of the facilities is carried out in conformity with the policy described in the followings.

(1) The facilities should harmonize with such features as natural conditions, culture, lifestyle, etc. of Thailand. This premise will be the background in connection with the selection of the materials, type of structure, form and other relevant characteristics of the facilities.

(2) The facilities to be constructed anew will be planned in such a way to interconnect them with the existing ones in a functional way and to make the most effective use of the flow lines of the facilities. Furthermore, these will be planned in such a way to guarantee the safety of people living in the project site and not to obstruct the activities of the existing facilities during the construction work.

(3) The costs will be cut down as much as possible, while maintaining the required functions and environment.

Concrete measures for this purpose consist of considerations related to the design in general, adoption of construction methods suiting the state of things of the project site, use of produced domestically or easily available at the project site, etc.

(4) The facilities in question will be designed in such a way to facilitate as much as possible the maintenance and control and to cut down as much as possible the running cost, through the use of the natural conditions for the sake of ventilation and lighting, as well as considerations related to the architecture and equipment.

(5) As for the models of the equipment for investigation and research, they will be selected by taking into consideration the ease of maintenance and control, as well as the possibility of procuring parts and components in Thailand.

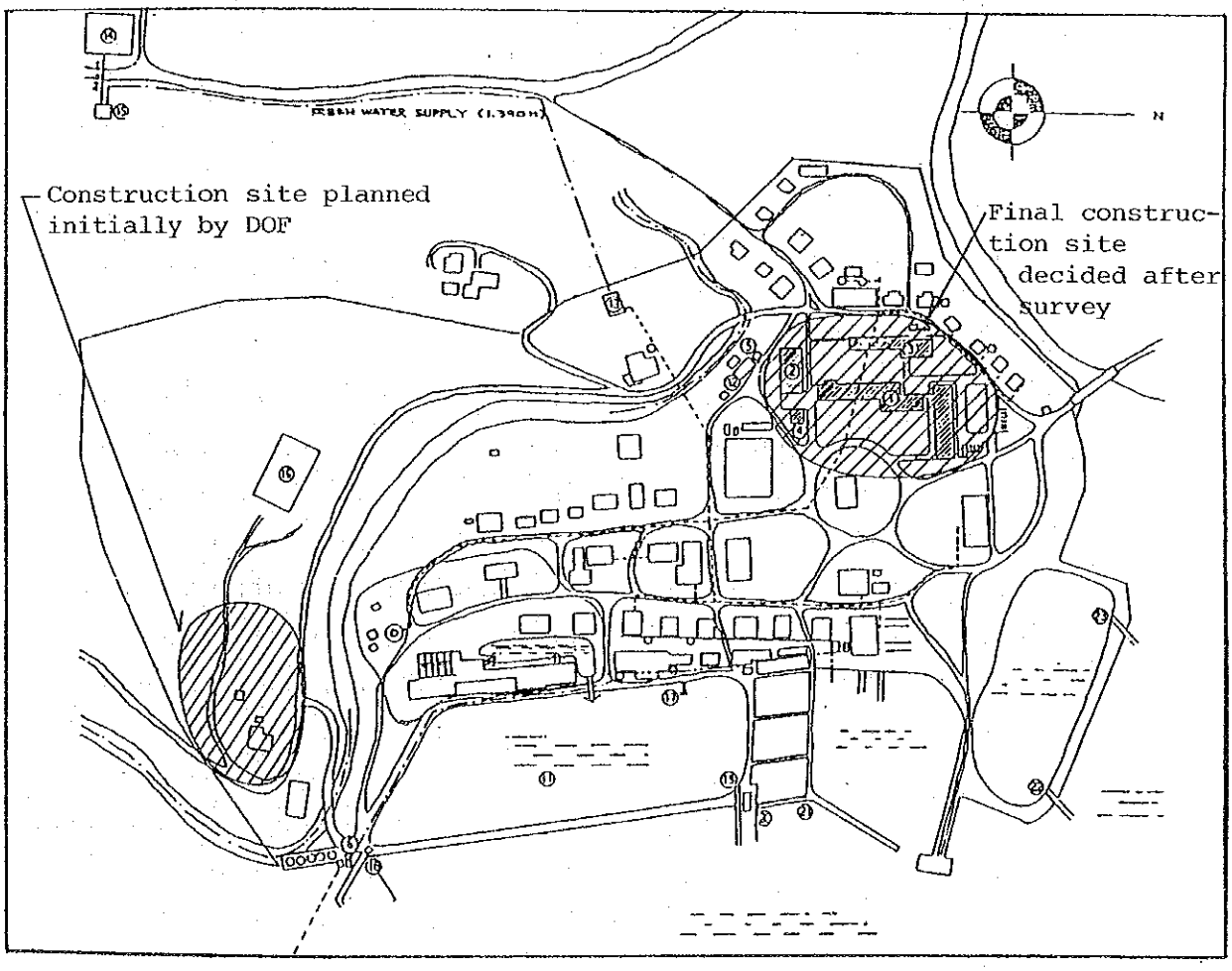
In deciding the scale of the facilities and the scope of the equipment and materials, the efective operation of this Center by Thailand will be taken into consideration in the first place, not to mention the adequate balance between the sufficient possibility of future extension and the simplicity of the facilities to prevent superabundance. Furthermore, the plan will be carried out in such a way to minimize the scope of work to be borne by Thailand.

5-2-2 Site Planning

At the beginning, Department of Fisheries (DOF) was considering the construction of the facilities in question on the hillock located at the southern extremity of the site. In reality however, the team decided to construct the facilities on the vacant land located at the northern side of the site, in view of the problems such as the increase of

construction cost to be borne by Japan, increase of the construction cost to be borne by Thailand, functional compatibility with the existing facilities, etc. in the case of the former alternataive.

The site in question requires no ground levelling in particular, because it is practically flat. The construction zone is presently a green area which is being used for recreational purposes by the people living in the site (staffs of the Station and their families). Many palm trees aged 10 years, are planted in this area. The felling of these trees will be minimized in order to shade sunlight. From the geological standpoint the site consists of sea sand, and the team asked the Government of Thailand to carry out the required boring test.



5-3 Basic Plan

5-3-1 Basic Plan for New Building

(1) Laboratory

The laboratory building of the Center is designed based on the following principles in consideration of the fnctions and space necessary for carrying out various indoor laboratory work by the three units, namely, Marine Environment Research Unit, Marine Resource Conservation and Management Unit, and Maricullture Development Unit.

1) The functions of the laboratory building is to conduct the following experimental and research activities.

- Physical and chemical analysis of seawater and sediment related to fishery resources and environment

- Physiological and biological research of marine animals related to fishery resources

- Basic research on mariculture technologies including seed production

2) Research activities of all units are co-related so that the cooperation among units are required to obtain an effective achievement. In order to perform cooperative works with other units effectively and to avoid a overlap in equipment having simillar functions, the laboratory is organized according to functional activities, namely, chemical and biological laborarory wings.

3) Number of researchers including assistant researchers is 12 for chemical laboratory and 16 for biological laborarory. The laboratory space is set up based on this staffing plan.

4) Chemical laboratory wing facilitates both inorganic and organic analysis sections.

a) In the inorganic chemical section, various physical and chemical paramaters (temperature, salinity, dissolved oxygen, major inorganic nutrients, etc.) important in relation with fisheries activity, can be measured. All the parameters to be measured are related to fundamental physiology and ecology of marine fishes, and are widely utilized as basic data for marine environment and mariculture researches including seed production as well as for the management of marine environment. Furthermore, the monitoring on heavy metal will be conducted in order to prevent the fishery resource from the environmental pollution which is worried with the industrialization in the eastern seabord of Thailand. In addition, a colon bacillus as an index of coastal water pollution by domestic drainage will be checked. Since satisfactory environmental assessment requires accumulation of field data obtained from long-time investigation, the level of analytical accurancy should be kept at an adequate and constant level throughout the investigation. To satisfy this requirement, the automatic tiltration apperatus is added to the facilities. Main equipment and apperatus necessary for measurment of environmental paramaters in this section are listed as follows;

Equipment/apperatus	Measurment Parameter
pH meter	Hydrogen ion
DO meter	Dissolved oxygen
BOD meter	Biological oxygen demand
COD meter	Chemical oxygen demand
Salinometer	Salinity
Spectrophotometer	Chlorophyll, inorganic nutrients (PO_4-P, NH_3-N, NO_2-N, NO_3-N, etc.)
Mercury analyzer	Mercury

Specific ion meter	cyanide, chlorine, bromide, iodine, algentum, cuprim, etc.
Coli checker	Colon bacillus

b) Basic parameters on feed nutritions such as calory, three major nutrients (protein, fat and carbohydrates) ash content are mainly measured and analyzed in the organic chemical analysis section. Although inorganic nutrients such as nitrogen and phosphate can be measured in the inorganic chemical analysis section, objective parameters to be measurd at this section are those contained in pellet feed and feed materials. By reflecting the results of these feed analysis, feed of known nutrient composition can be produced at the laboratory-scale feed plant. Furthermore, the nutrient requirements for economically important fishes can be studied through experimental fish culture by feeding such pellets. The results of these studies are utilized for development of feed specially of larval feed to be used for seed production. Main analyzing equipment and apparatus to be installed on this unit are as follows;

Equipment/apperatus	Measurment parameters
Protein analyzer with digester	protein
Fiber titration apparatus	Fiber
Fat extractor	Fat
Carolimeter	Caroly
Muffle furnace	Ash
Hot-air oven	Moisture

6) Biolgical laboratory wing consists of a planktonlogy room equiped with a temperature controlled room for plankton culture, an ichthyology room, and a mariculture experimental room.

a) Planktology Room

Samples of plankton, eggs and larvae, which are collected on the research vessel, are analyzed both in quantity and quality to be utilized for estimation of primary productivity, in cooperation with the results of chemical analysis. In order to culture living feed organisms, a temperature controlled room is facilitated since the optimum environment for their propagation should be maintained. Main equipment and apparatus to be required in this room are as follows;

Equipment/apparatus	Function
Zoom stereoscopic microscope	Observation of micro-organisms
Phase microscope	"
Incubator	Culturing micro-organisms
Ozonizer	Sterization of seawater
UV water purifier	"
Shaking machine	Plankton culture

b) Ichthyology Room

This room is used for measurement of body length, body weight and other physical characteristics of fishes caught on the research vessel and reared at the mariculture facilities of the Center. Dissection and examination of fish are also conducted in this unit. The necessary equipment and apparatus for these work will be furnished.

c) Mariculture Experimental Room

This room is used for rearing of economically important marine fishes and for collection of basic data necessary for development of the mariculture technology. In order to perform this activity, about 10 units of polycarbonate tanks (1,000 l and important

marine fishes and for collection of basic data necessary for development of the mariculture technology. In order to perform this activity, about 10 units of polycarbonate tanks (1,000 l and 2,000 l capacity) and about 30 units of small grass tank (50 to 100 l capacity) are furnished. Compairing with the outdoor tanks for seed production, these indoor tanks are capable of obtaining more accurate experimental control with the additional facilities by regulating water volume, filtering and aerating water. This room, which might be called "wet laboratory" is furnished with piping systems for supplying seawater, freshwater, and air to each tank. A concrete drainage system is constructed on the floor to drain autimatically both seawater and freshwater overflowed the tanks.

The laboratory building facilitates a preparation cum training room, a conference cum lecture room, and a laboratory. The preperation cum training room is mainly used by trainees to conduct basic biological experiments on mariculture as well as used for preparation of major experiments in the Center. The room is furnished with a laboratory-use table at the center providing a work space enough for 10 to 13 trainees. A conference cum lecture room is designed to hold a lecture for trainees, a conference for the Center's staffs, and research workshop with universities and other research organizations. The maximum capacity of the room is designed to accommodate 80 persons. This room is also used as small conference rooms when divided by the partition wall. In the library, various books, reports and data related to the activities of the Center are stocked and are utilized by the Center's staffs as well as by trainees and instructors. About 5,000 volume of books can be stocked and the reading space is also provided.

(2) Dormitory

In order to facilitate accommodation for trainees and instructors invited from universities and other research institutions, a dormitory will be provided in relation with the excution of training and education programmes. The capacity of this dormitory is allowed to accomodate 25 trainees, 5 instructors.

(3) Laboratory-scale Feed Plant

The development of feed is one of the most important objectives for the promotion of aquacultural industry. The trash fish has mainly used as the feed in the traditional aquaculture in Thailand. The trash fish, however, has problems on transportation and storage making the constant supply difficult. A cheap artificial feed is expected to be developed to obtain longer storage time and better growth rate. A laboratory-scale feed plant is furnished to Mariculture Development Unit to deal with this matter. Since the analysis of feed ingredients and nutritional requirements for objective fishes will be carried out in the laboratory building, the actual feed production on experimental basis will be a main activity in this plant. In consideration of the extension aspect to the private farmers, the new feed to be developed should be produced by a simple and easy machinery. In this respect, the machinery should be simple but not advanced. The plant is of laboratory-scale to produce feeds for experimental use. The feed produced will be used for the experiments in the Center and at neighboring fish farms. The main equipment and apparatus to be furnished includes a minch chopper, a pulverizer, a pelleting machine, and other related equipment. The building space is designed just enough to place these machinery, a work table, raw marerials, and the produced feeds in the most effective arrangement.

(4) Workshop

This workshop, which is utilized for the activities of both Fishing Gear Development Unit and Small-scale Fisheries Development Unit, is a facility to produce and repair machinery and equipment to be used in the Center.

The major activity in this workshop are as follows;

- Making fishing gears and fish apartments
- Simple repair of small-scale fishing vessels of the neighboring fishermen
- Maintenance of equipment in the Center

The machinery and tools necessary for the above activities will be furnished. Workshop facilitates a work room with storing space for the machinery and tools, an office, and a rest room. The installation of large machinery is avoided, so as to provide a space enough to extend fishing nets. In addition, small hoist (bearing capacity of about 1,000 kg) is furnished for removing heavy things.

5-3-2 Basic Design for New Building

(1) Scale of Facilities

The scales of the laboratory building and laboratory rooms are determined by taking into consideration the number of research staffs and technicians, layout of central experiment bench, work bench at the window side and required equipment as well as layout of the furniture of the accommodated personnel. As for the dormitory, its scale is determined by taking into consideration the capacity, number of persons per rooms and the size of the beds and desks to be used. The scale of the workshop is determined in such a way to reserve sufficient space for making the fishing gear, fish apartment, etc. As for the feed plant, its size is determined by taking into consideration such factors as the

type and layout of the walk-in-cooler and feed production machinery. The scale of each building, including such subsidiary spaces as corridors, lavatories, staircases, stores etc. is as follows.

Name of Building	Indoor part	Outdoor part (Corridor, working space)	Total
Laboratory building	1,714.56m^2	856.80m^2	2,571.36m^2
Dormitory	475.80	377.28	853.08
Workshop	80.00	400.00	480.00
Feed plant	100.00		100.00
Genarator house	20.00		20.00
Pump station	12.00		12.00
Grand total	2,514.04m^2	1,634.08m^2	4,036.44m^2

The necessary area of each principal room is shown in table below, as well as its calculation standard.

Areas of the Principal Rooms and Bases for Their Calculation

		Room Name	Area (m^2)	Bases for Calculation	Remarks
Laboratory building	Biological laboratory	Mariculture experimental room	96.0	ø1,000 tank; 5 units ø1,800 tank; 5 units Work space for 8 research staffs and workers	Work space; 8m^2/person
		Ichthyology room	52.0	Central experiment table; 1 unit Principal equipment; 5 units Work space for 3 research staffs and technicians	Central experiment table; 3.8mx1.3m Principal equipment; 0.8m^2/unit Work space; 8m^2/person
		Planktology room	52.0	Principal equipment; 13 units Work space for 3 research staffs and technicians	Area required by principal equipment; 0.8m^2/unit Work space; 8m^2/person
		Temperature controlled room	24.0	Preparation room (machine room); 12m^2 Temperature controlled room; 12m^2 Research staff; 1-2 persons	Work space; 8m^2
	Chemical laboratory	Inorganic chemical analysis	124.0	Central experiment table; 2 units Sink; 1 unit Experiment & analysis equipment; 25 units Space for 8 research staffs and technicians	Central experiment table; 4.2mx1.2m Sink; 0.9x0.8m Space required by analysis equipment; Approx. 0.8m^2/unit Work space; 8m^2/person
		Organic chemical analysis	76.0	Central experiment table; 1 unit Principal experiment & analysis equipment; 12 units Work space for 5 research staffs and technicians	Ditto
		Chemicals storage	12.0	Chemicals shelf; 4 units	Chemicals' shelf, 0.5mx1.8m/unit
		Balance room	12.0	Balances; 4 units Work space for 2 research staffs	
		Preparation & training room for students	96.0	Central experiment table; 2 units Teacher; 1 person Students; 12 persons	Central experiment table; 3.8mx1.3m

		Room Name	Area (m^2)	Bases for Calculation	Remarks
Laboratory building	Study room	Mariculture development room	80.0	Chief; $12m^2$ (= size of individual booth) Staff (7 + 2 persons); $6m^2$/person Secretary (1 person); $6m^2$/person A desk and chairs, book-shelves	In Thailand a unit chief has normally an individual booth. The area per person is in conformity with the standard adopted in Thailand (approx. $6m^2$). There is additional space for 2 persons more, in order to cope with future increase of personnel.
		Marine environmental research room	80.0	Chief; $12m^2$ (= size of individual booth). Staff (5 + 2 persons); $6m^2$/person Secretary (1 person); $6m^2$/person A desk and chairs, book-shelves	Ditto
		Marine conservation & management room	64.0	Chief; $12m^2$ (= size of individual booth) Staff (4 + 2 persons); $6m^2$/person Secretary (1 person); $6m^2$/person A desk and chairs, book-shelves	Ditto
		Fishing gear & small scale fisheries development room	64.0	Chiefs (2 persons); $12m^2$/person Staff (2 + 2 persons); $6m^2$/person Secretary (1 person); $6m^2$/person A desk and chairs, book-shelves	Ditto
		Teacher's room	64.0	Lockers; $2m^2$ Table and sofer; $12m^2$ 5-8 persons; $6m^2$/person	This room must be rather large because it will be used by teachers invited from universities and other institutions and furthermore it will be used as study room also in the case of technical cooperation.
		Technician's room	88.0	4-$5m^2$/person 14-18 persons	Room to be used in common by the technicians of the center (for data sorting, work preparation, consultations, etc.). This room can be made relatively small because not all technicians are ordinarilly in this room.
		Specimen room	40.0	Specimen shelf; 10 units	Specimen shelf; 0.7mx1.8m/unit

		Room Name	Area (m^2)	Bases for Calculation		Remarks
Laboratory building	Study room	Dark room	10.0	Sink, work bench Research staff; 2 persons		
		Print room	16.0	Copier; 1 unit Mimeograph; 1 unit Work bench; 1 unit		
	Management wing	Director's room	43.0	Desk, bookshelf, reception furniture set and locker Toilet room; $6m^2$		Standard space of facilities of similar magnitude of Thailand.
		Deputy director's room	25.6	Desk, shelves, reception furniture set and locker Secretary; 1 person		Ditto
		Library	83.2	No. of books; 5,000+3,000 (Open-type bookshelves) Reading desks for 10 persons		Future addition of approximately 3,000 books is taken into consideration. Space will be provided to install 10 reading desks.
		Lecture room	111.8	$1.4m^2$/person (maximum 80 persons)		Normally this room will be divided in 3 parts (by means of movable partitions) that will be used as meeting rooms.
		Canteen	68.8	$1.2m^2$/person (maximum 50 persons)		Used to serve tea and light meal and for conversation.
		Radio room	15.0	Radio equipment; 2 units Desk; 2 units Radio communication staff; 2 persons		
		Computer room	15.0	Computer; 1set Work table; 1 unit		
Dormitory		Bedroom	259.2	Bedrooms for teachers; 6	Bed, locker, desk and chair	Individual rooms for teachers. $14.4m^2$ x 6 rooms
				Bedrooms for students; 8	One double bunk and one single bed, locker and desks for 3 persons	Three-person rooms for students. $21.6m^2$ x 8 rooms

	Room Name	Area (m^2)	Bases for Calculation	Remarks
Dormitory	Dining room	45.0	Dining space for 30 persons (1.5m^2/person)	
	First aid	21.6	Bed; 1 unit Medicine shelf; 1 unit Desk; 1 unit	Bed; 0.9mx1.9m Medicine shelf; 0.4mx1.8m
Workshop	Open space	400.0	Space making possible to unfold fishing gear with 50m length. Furthermore, there should be sufficient space for construction of fish apartments. Workers; 10 persons	
	Working room	40.0	Tool's & parts' shelf Work table; 1 unit	Shelf; 0.5mx0.5mx2 units Work table 2mx3m
	Office	25.0	Technicians; 5 persons 5m^2/person	
Feed plant		100.0	Refrigerator; 1 unit Feed mixer; 1 unit Other machines; 3 units Raw material shelf	Refrigerator; 2.7mx3.6m Feed mixer; 1.7mx1m
Generator house		20.0	Generator 100KVA; 1 unit Automatic voltage regulator 50KVA; 1 unit Switchboard	Generator; 1.2mx2.5m Automatic voltage regulator; 0.8mx1.5m
Pump station		12.0	Pump 11KW; 2 units	0.6mx1.3m/unit

(2) Plot Planning

The buildings to be constructed anew will be provided with open type side corridors, and in principle will be arranged along the N-S axis by taking into consideration the ventilation. Furthermore, the existing facilities will be visible from the principal rooms of the new buildings. Part of the buildings will be arranged along the E-W axis, but in this case their structures and layout will be designed by paying special attention in order to ensure sufficient ventilation.

The disposition of each building is determined by taking into consideration their functional relationship with the existing facilities. Therefore, the feed plant at the sea side, and then the workshop and dormitory are arrenged beside and behid them. The management wing of the laboratory building is designed by taking into consideration the visibility of its doorway from the front gate of the center, as well as the accessibility of the existing main building of the center.

On the other hand, the workshop is arrenged as distant as possible from the residential complex existing in the site, by taking into consideration the generation of noise. The dormitory is arrenged as close as possible to the existing housing complex.

(3) Element Design

In connection to the design of the elements of the buildings, in the first place it is indispensable to pay special attention to the weather conditions of the site, i.e., strong sunlight and concentration of heavy rainfall in short time. Furthermore, it is also necessary to take into consideration the damages caused by salt because the site is located at the seaside. Next, materials available with ease in Thailand are selected in view of considerations regarding the reduction of cost and ease of maintenance and control,

and furthermore a comfortable and healthy environment with energy-saving characteristics will be designed by paying attention to the ventilation, prevention of humidity, etc.

In principle, the reinforced concrete structure which is generally used also in Thailand will be adopted in this case. The steel structure, which is another alternative, is not advantageous in this case from the standpoints of durability against damages caused by salt and problems related to the maintenance. In view of the aforestated considerations, the principal elements of the buildings are assumed to have the following characteristics in the existing circumstances.

1) Roof

The principal roofs will be inclined-type ones in view of the magnitude and intensity of the rainfall. Cement roofing tile or corrugated colored slate made in Thailand will be used, by taking into consideration the surrounding environment with abundant green. The roof will consist of a sheathing made of excelsior board and the outermost layer made of either roofing tile or slate and furthermore the garret space will be provided with sufficient ventilation in order to guarantee sufficient heat insulation. On the other hand, the projection of the eaves of the open corridors, pilotis, etc., will be made large in order to provide protection against sunlight and rainfall.

2) External wall

In connection with the external walls, it is particularly important to provide sufficient protection against direct sunlight and rain, and on the other hand it is indispensable to improve as much as possible the ventilation. In addition to reinforced concrete, bricks and concrete blocks made in Thailand will be used at the appropriate places. Hollow concrete

blocks will be used in part of the walls in order to improve the ventilation.

3) Windows

The windows will be as large as possible, in order to use natural lightning as effectively as possible. However, sunlight control will be carried out by means of lourvers, eaves, etc., provided as occasion demands in order to cut off direct sunlight. Wooden fittings will be adopted in this case, because aluminum and steel fittings are subject to corrosion in view of the proximity of the site to the seashore. There are some concern about the wather-resistance of wooden fittings, but this problem can be solved by using carefully selected materials. As for termite, the team learned that there was no record of damages caused by this kind of insect at the project site.

4) Ceiling

In the laboratories and other parts of the buildings without air-conditioning, the internal volume of the room will be made as large as possible by using high ceilings, in order to provide comfortable environment under natural condition. As for the types of materials to be used, they will be adequately selected in conformity with the use of each room.

5) Partitioning walls

In principle, reinforced concrete, bricks and concrete blocks made in Thailand will be used to construct the partioning walls, but wooden partitions will be used in the case of rooms requiring future flexibility. As for the finishing materials, they will be selected by taking into consideration such properties as impermeability, resistance to chemicals, etc., in the case of special rooms (e.g. laboratories).

6) Floors

The floor of the first storey of the various buildings will be located approximately 1 meter above the ground, in order to cope with heavy rainfall concentrated within short time. This scheme has two major alternatives, i.e., it is effective to provide space for utility piping and furthermore it prevents the transmission of terrestrial heat by the ventilation under the floor. At places requiring refinement the floor will be coated with synthetic-resin type finishing material, while field polish terrazo, plastic tile and other kinds of finishing materials will be used adequately according to the use of the space in question.

5-3-3 Design standards

(1) Laboratory building, (2) Workshop, (3) Dormitory, (4) Others

Work Item	Examined Aspect	Material, Specifications & Construction Method				Cause of Adoption
		A	B	C	D	
Roof		Urethan water-proofing concrete backing	Cement roofing tile	Corrugated slate		Inclined-type roof is adopted in most of the cases in view of the heavy rainfall. Furthermore, B and C are adopted in view of salt-resistance requirements.
	Water-resistance	○	○	○		
	Salt-resistance	○	○	○		
	Heat-resistance	△	○	○		
	Heat-insulation	△	×	×		
	Local material	○	○	○		
	Adoption		(1) (3)	(2) (4)		
External walls		Exposed concrete, paint-finished	Bricks, mortar backing, paint-finished	Hollow concrete block facing, paint-finished	Brick facing	B, whichiis the most common and economical type in Thailand, will be adopted in the main. A will be adopted in transverse walls where architectural concrete is indispensable from the structural reason, C will be adopted in the transoms of the dormitory and in the walls of such rooms as feed plant, workshop, etc., that require ventilation and do not require airtightness.
	Water-resistance	○	○	○	△	
	Salt-resistance	○	○	○	○	
	Heat-insulation	△	△	○	△	
	Workability	△	○	○	○	
	Local material	○	○	○	○	
	Adoption	(1)	(1) (2) (3) (4)	(1) (2) (3) (4)		
Windows		Aluminum sash (made in Japan)	Aluminum sash (made in Thailand)	Wooden sash	Steel sash	C is adopted in this case, because salt-resistance is given top priority in view of the proximity of the site to the seashore.
	Watertightness	○	△	×	×	
	Water-resistance	○	○	△	△	
	Salt-resistance	△	△	○	×	
	Local material	×	○	○	○	
	Adoption			(1) (2) (3) (4)		
Ceiling		Rock woolsound-absorbing board	Asbestos board, paint-finishied	Gypsum board, paint-finished	Exposed concrete, paint-finished	D will be used in the laboratory rooms of the laboratory building, because they use abundant water and require cleanliness. A will be used in such rooms as lecture room, radio room, etc., that require sound absorption. B will be used in the external corridor and in the feed plant because the former one requires humidity-resistance and the latter one requires cleanliness. C will be used in the dormitory in view of the appearance.
	Appearance	○	○	○	○	
	Moisture-resistance	×	○	△	○	
	Durability	○	△	△	○	
	Sound absorption	○	×	△	△	
	Cleanliness	×	○	△	○	
	Local material	○	○	○	○	
	Adoption	(1)	(1) (2) (3) (4)	(3)	(1)	

Work Item	Examined Aspect	Material, Specifications & Construction Method				Cause of Adoption
		A	B	C	D	
Partitioning wall		Exposed concrete, paint-finished	Bricks, mortar backing, paint-finished	Wooden frame-work, board backing, paint-fininished	Concrete block facing, paint-finished	B, which is the most common material used in Thailand, is adopted in this case. C is adopted between the laboratories, B is adopted only in facilities made of concrete blocks.
	External appearance	Δ	O	O	Δ	
	Water-resistance	O	O	O	O	
	Durability	O	O	Δ	O	
	Impact-resistance	O	O	Δ	Δ	
	Sound-insulation	O	O	Δ	O	
	Cleanliness	Δ	O	O	X	
	Local material	O	O	O	O	
	Adoption		(1) (3)	(1) (3)	(2) (4)	

Floors		Field polish; terrazzo	Synthetic resin coated floor (epoxy type)	Plastic tile	Mortar hardner finishing	A will be used in the management wing of the laboratory building. B will be used in the laboratory rooms and the like in view of requirements of cleanliness and resistance against chemicals. C will be used in other rooms and D will be used in the external corridors. Furthermore, D will be used in the workshop and in the feed plant.
	External appearance	O	O	O	Δ	
	Water-resistance	O	O	Δ	O	
	Abrasion-resistance	O	O	Δ	Δ	
	Impact-resistance	Δ	O	O	O	
	Chemicals-resistance	X	O	X	Δ	
	Cleanliness	Δ	O	Δ	X	
	Local material	O	O	O	O	
	Adoption	(1) (3)	(1)	(1) (3)	(1) (2) (3) (4)	

Air-conditioning equipment		Centralized-type package + ducts	Individual type			C (ceiling type) is adopted in this case, in order to make possible control of the running cost through the individual operation in each room.
			Window-type	Separate type		
	External appearance	O	Δ	Δ		
	Interchangeability	X	O	O		
	Noise	O	X	Δ		
	Temperature distribution	O	Δ	Δ		
	Individual operation by room	X	O	O		
	Maintenance	Δ	O	O		
	Running cost	Δ	O	O		
	Popularity in Thailand	Δ	O	Δ		
	Adoption			(1)		

Note: (1) Laboratory building, (2) Workshop, (3) Dormitory, (4) Others