

No. 30

**REPORT ON BASIC DESIGN
FOR
FISHERIES DEVELOPMENT PROJECT
IN THE REPUBLIC OF KIRIBATI**

JANUARY 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

The Republic of Kiribati, in view of the depletion of its phosphate resources which had previously formed the mainstay of its economy, focused its attention to the development of fishery resources in the waters surrounding that country and made a Fisheries Development Plan.

In order to implement this Plan, the Government of Kiribati has requested the Government of Japan to provide a grant aid for a fishery training vessel, facilities for the improvement of fish distribution, and fishing equipment and gears.

The Japan International Cooperation Agency was commissioned by the Government of Japan to conduct a necessary survey in connection with the above request and dispatched a 6-man survey team to Kiribati from November 22 to December 15, 1979, headed by Dr. Masatsune Nomura, Director of the Kanagawa International Fisheries Center of JICA.

This report contains the findings of the study team. I hope this report will prove to be useful for the Government of Kiribati in implementing its Fisheries Development Plan and, at the same time, serve to further strengthening the friendly relations between the Republic of Kiribati and Japan.

I should like to express my deep appreciation to the officials concerned of the Government of Kiribati for their valuable assistance and cooperation extended to the survey team.

January 1980



Keisuke Arita, President
Japan International
Cooperation Agency

170°E 180° 170°W 160°W 150°W

PACIFIC OCEAN

GILBERT ISLANDS

- Makin
- Butaritari
- Abaianq
- Tarawa
- Kuria
- Aranuka
- Baraba
- Tabiteuea
- Onotoa
- Tamana
- Arorae
- Marakei
- Miaiana
- Abermama
- Nonouti
- Beru
- Nikunau

NORTHERN LINE ISLANDS

- Tabuaeran (Washington)
- Fanning
- Kiritimati (Christmas)

PHOENIX ISLANDS

- McKean
- Birnie
- Orora
- Nikumaroro (Gardner)
- Canton
- Enderbury
- Phoenix
- Manra (Hull)
- Sydney

SOUTHERN LINE ISLANDS

- Vostok
- Caroline
- Flint

HOWLAND (U.S.A.)
BAKER (U.S.A.)

JARVIS (U.S.A.)

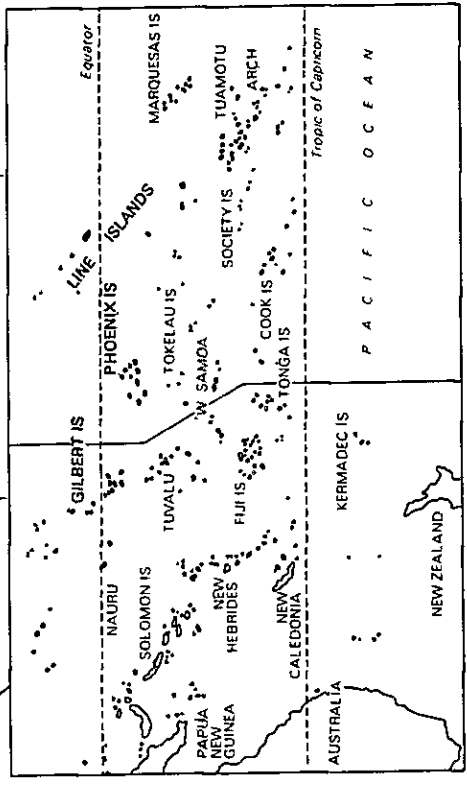
Maiden
Starbuck

TOKELAU IS.

10°S

TUVALU IS.

ROTUMA (Fiji)



INTERNATIONAL DATE LINE

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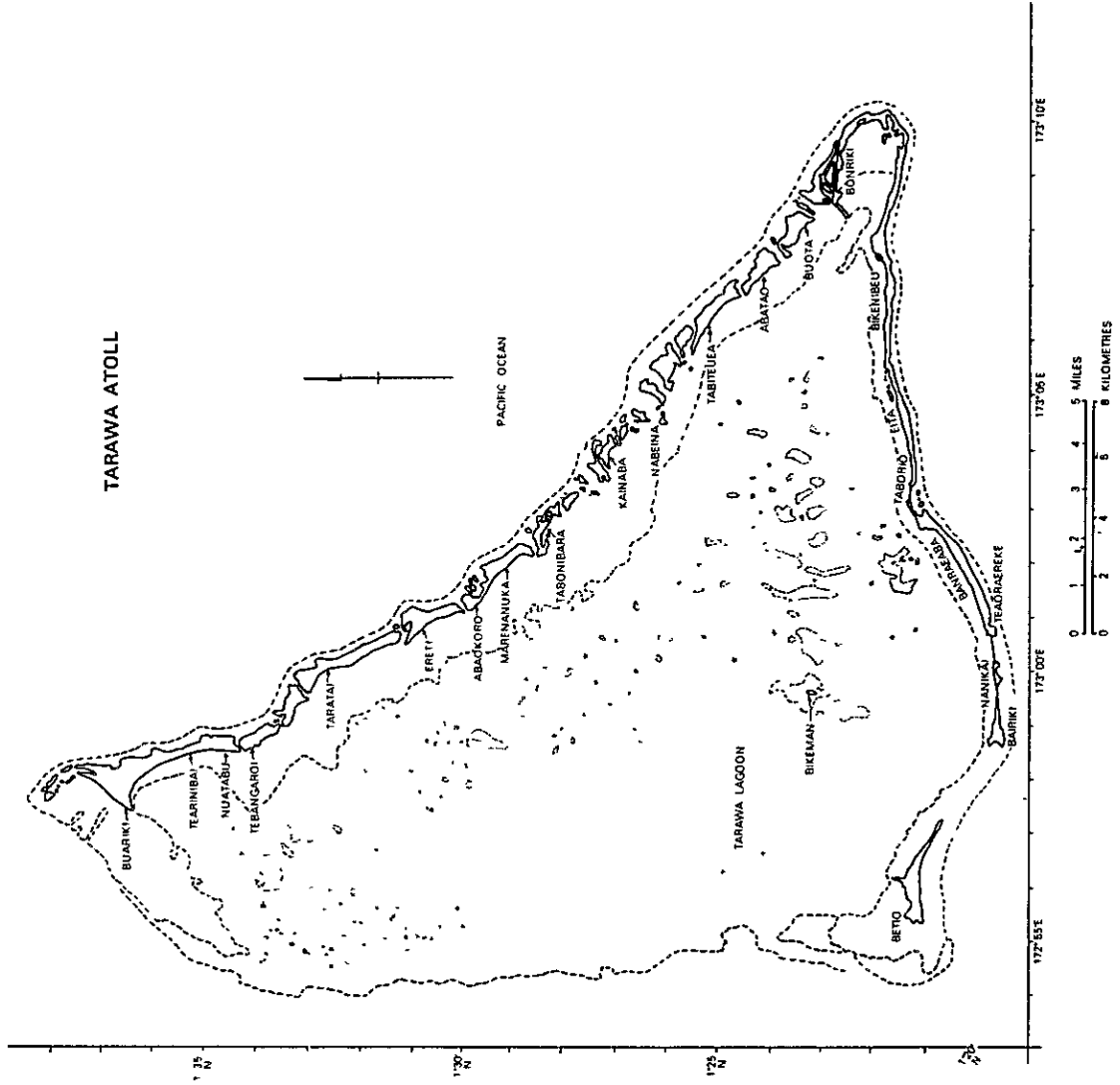
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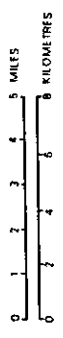
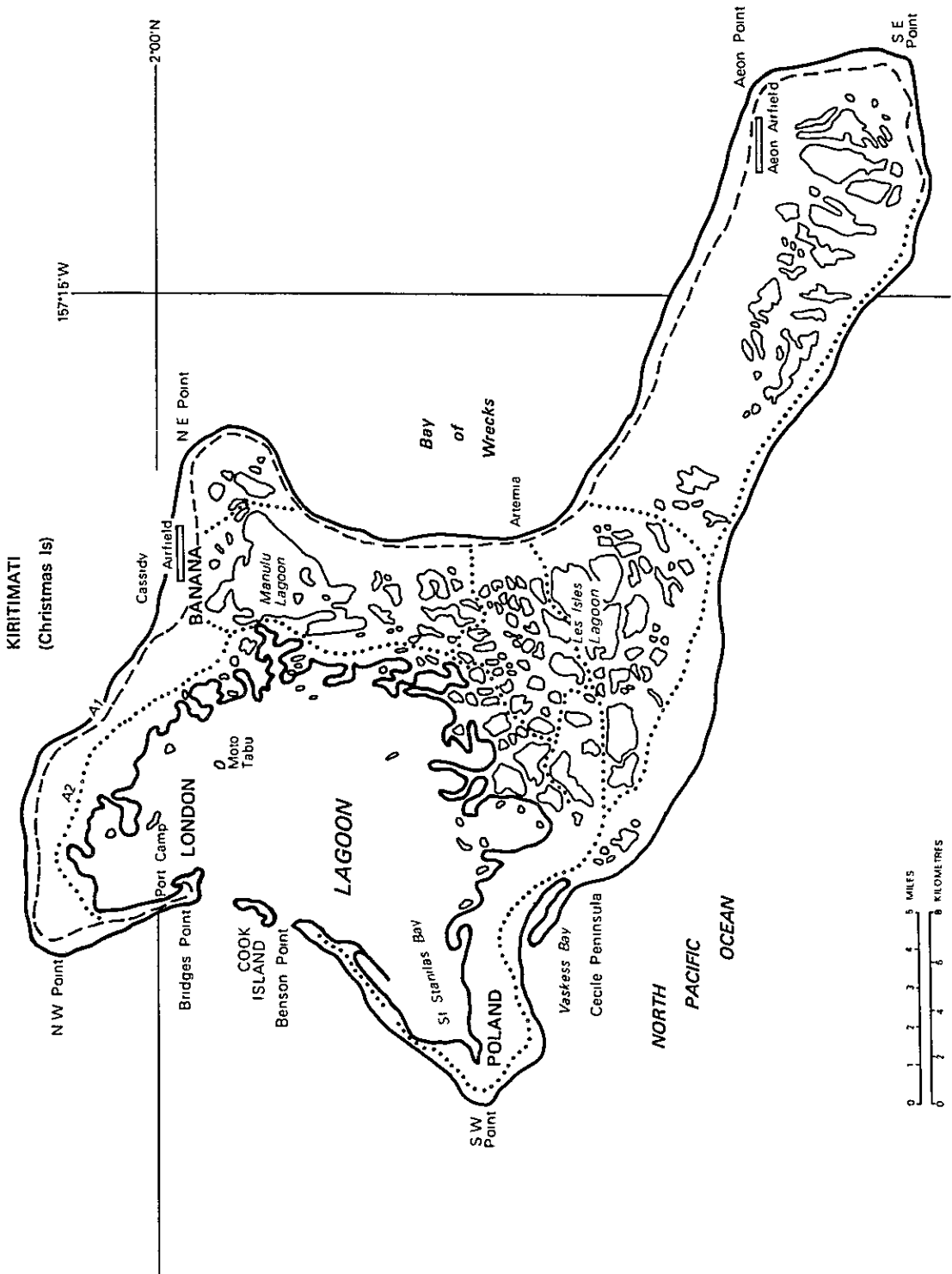
Equator

Tropic of Capricorn

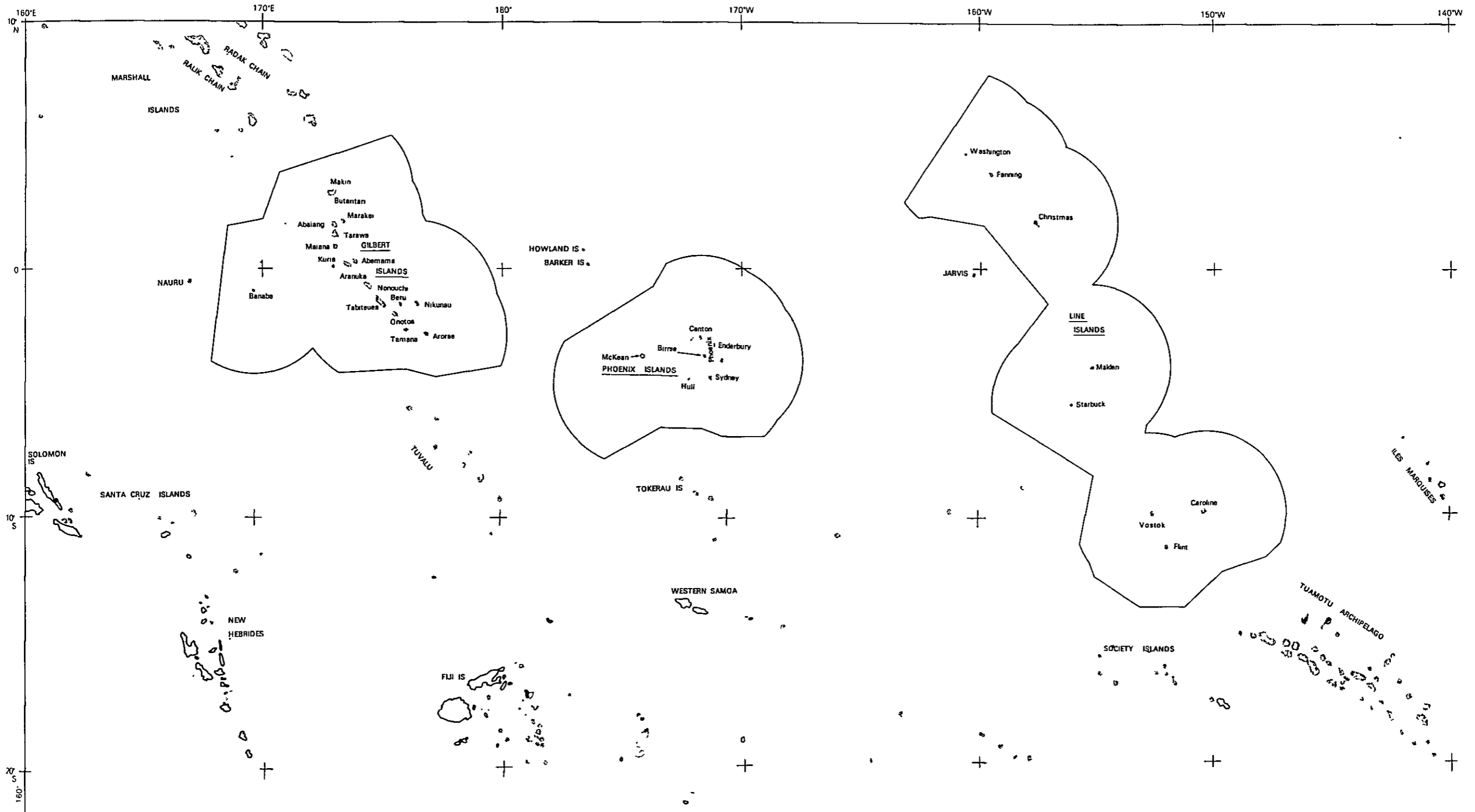
PACIFIC OCEAN

TARAWA ATOLL





KIRIBATI 200 MILE FISHERIES ZONE



SUMMARY

1. The Republic of Kiribati became independent in 1979 but, as a result of the depletion of the phosphate resources which had formed the backbone of the country's economy, has set out to develop in their stead the potential fishery resources of the vast seas surrounding Kiribati.
2. Against this background, the Government of the Republic of Kiribati has requested aid-grants from the Government of Japan to help implement its Fisheries Development Programme. In response to this request, the Japan International Cooperation Agency dispatched a survey team to Kiribati to develop a basic plan for implementing the aid program.
3. The survey team conducted a field study in Kiribati and concluded a Minutes of Discussions with the Ministry of Natural Resource Development, under which the Government of Japan would take steps to donate the following items: one training vessel in the 100-ton class for the pole and line skipjack fishery; facilities to improve the distribution of fishery products to be established in Betio and Christmas Island; and various types of equipment, including a 10-meter fishing research boat, a bulldozer, and a complement of fishing gear including gill nets.
4. The land area of the Republic of Kiribati comprises about 719 square kilometers, but this is composed mainly of coral reefs scattered over a wide expanse of ocean. Other than the cultivation of coconut palm, there are few land-based industries capable of development. On the other hand, the waters around the country are known as excellent fishing grounds for skipjack tuna, and several studies and experiments have already been undertaken for purposes of developing these grounds. There have also been successful experiments in the cultivation of bait species required for the pole and line skipjack fishery.
5. Kiribati's fishing industry is at present limited largely to the supply of fish for the fishermen's own use (i.e., a self-supply

fishery), based on canoes using mainly gill nets and hooks. However, an experimental pole and line skipjack fishery was begun in 1979, utilizing a 100-ton class survey vessel that had been donated by the British Government to help foster the development of the skipjack fishery. A 50-ton freezer has also been established in connection with the Fisheries Agreement between Kiribati and Japan. Thus the country has already taken concrete steps toward the development of a skipjack fishery.

In addition, Kiribati is planning to establish improved distribution facilities for fishery products with a view to providing a source of cash income to its outlying rural population and stabilizing the supply of fish products in urban areas with a relatively high population concentration. The country has clearly launched an effort to move from a self-supply to a small-scale commercial fishery.

6. The Republic of Kiribati has been developing a comprehensive approach to the problem of fishery development, as above described. In order to achieve the objectives of this program, a determination has been made that the following items would be appropriate for a grant-in-aid program:

- 1) One pole and line skipjack fishery training vessel in the 100-ton class, with a main engine of about 600 HP and a regular 24-man crew.
- 2) Construction of fish marketing centers at Betio and Christmas Island, including an ice-making plant, quick freezing facility, freezer/refrigerator, and generator.
- 3) Equipment for fishery use, including a bulldozer, a FRP fishery research boat in the 10-meter class, and a complete complement of fishing gear, including gill nets.
- 4) Detailed design and construction supervision for the above items.

7. The estimated budgetary requirements, as of the end of December, 1979, for the above products and services under a grant-in-aid program would be approximately, 500 million yen.
8. Based on a preliminary financial analysis, in the case of both the training vessel and marketing centers, operating revenues can be expected to cover operating expenses. However, in the case of the training vessel, projected revenues over its assumed 15-year service life are unlikely to cover depreciation costs.

Many of the social benefits accruing from this project will be indirect and incapable of concrete measurement, while many conditions had to be hypothesized in our analysis. Nevertheless, we have come to the conclusion that the subject project will be most meaningful for the economy of Kiribati.

9. In many aspects of project administration, such as fishing and engine operations on the research vessel, it will be necessary to rely on foreign technical assistance. In order to maximize the fruits of this technical cooperation, there must be a careful selection of outstanding indigenous personnel through whom the technology can be successfully absorbed.
10. The Fisheries Development Programme has immense significance for the newly-independent Republic of Kiribati. We have concluded that the extension of grant-aid by the Government of Japan will be most effective in moving this Programme forward.

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SECTION ONE

SURVEY OBJECTIVES, BACKGROUND, AND METHODOLOGY

1.1 Objectives

The Government of the Republic of Kiribati has requested grant-aid, based on its Fisheries Development Programme, for a training vessel, facilities to improve fish distribution, and various items of equipment for fishing use.

To permit the effective implementation of this threefold aid program, it is necessary to prepare a detailed optimum proposal, including administrative aspects, through the medium of a field survey in Kiribati and discussions with responsible officials in Kiribati governmental agencies. The survey mission were to develop a basic plan for implementation under the grant-aid appropriation in the Fiscal 1979 budget of the Government of Japan.

1.2 Background of the Survey

Kiribati became independent in July, 1979. However, as a result of the depletion of the phosphate resources which had hitherto been the mainstay of this country's economy, mining had to be terminated at the end of 1979. An effort is being made to promote, as a substitute resource, the development of marine resources within the country's 200-mile fishery zone.

From the standpoint of resource potential and commercial feasibility, the Government of the Republic of Kiribati has displayed the greatest interest in the skipjack tuna resource. As a matter of fact, from the beginning of the 1970's, there has been a history of experimental skipjack operations, albeit on a small scale. In 1975, the Government of the then Gilbert Islands requested cooperation from the Government of Japan in fisheries development, and the Japan International Cooperation Agency responded by carrying out a two-year resource study during 1977 and 1978, centering on pole and line skipjack fishing and skipjack bait species. This resource study was highly regarded by the Gilbert Islands Government which then expressed a desire to receive aid from Japan in fisheries

development as well as other areas.

With respect to the development of the skipjack fishery, the Government of the Republic of Kiribati, in line with its 1979-1982 National Development Plan, initiated research and training in February 1979 on the basis of technical aid from FAO/UNDP, using a 99-ton pole and line skipjack fishery research vessel built in Japan with aid funds from the British Government.

In order to promote the development of a skipjack fishery geared toward export, the Government of the Republic of Kiribati is planning the construction of a second training vessel which would permit expansion of its training program for the pole and line skipjack fishery. Also, with a view toward decreasing imports of canned fish products and increasing self-sufficiency in animal protein foods, this development plan attaches a high priority to the promotion of both a self-supply and a small-scale commercial fishery. To this end, a detailed study was conducted on fish catch and consumption in the South Tarawa area, which resulted in a plan to establish local distribution facilities.

However, considering the economic conditions prevailing in Kiribati following the exhaustion of its phosphate resources, it will be fiscally difficult to activate these plans. Accordingly, when a Japanese Economic Cooperation Mission visited the country in May, 1979, it received a formal request for aid in carrying out a fisheries development plan incorporating the above aspects. The survey mission was dispatched as a result of this request.

1.3 Composition of the Survey Team

The survey team comprised six members under the leadership of Dr. Masatsune Nomura, Director of the Kanagawa International Fisheries Training Center of the Japan International Cooperation Agency (JICA). The members included:

Dr. Masatsune NOMURA	Team Director	Director, Kanagawa International Fisheries Training Center, JICA
Mr. Susumu MURAKAMI	Planning Coordinator	Senior Official, International Cooperation Division, Ministry of Agriculture, Forestry, and Fishery
Mr. Tetsuya SHIMAMURA	Fishing Vessels	Technical Advisor, Fisheries Engineering Co., Ltd.
Mr. Katsumi IIZUKA	Refrigeration	Technical Advisor, Fisheries Engineering Co., Ltd.
Mr. Naohiko NAKAJIMA	Fishing Equipment	Assistant Director, Fisheries Engineering Co., Ltd.
Mr. Shunichi MIZUOCHI	Project Coordination	Fisheries Technical Cooperation Division, JICA

1.4 Survey Itinerary

The survey was conducted over a 24-day period, extending from November 22 to December 15, 1979 inclusive. A schedule of the activities of the Survey Team is provided at the end of this report.

1.5 Discussants

In an effort to gain an understanding of local conditions, the Survey Team conducted discussions in Kiribati with the widest possible range of respondents, including concerned officials of the Government of the Republic of Kiribati, experts with international agencies and from Japan, and officials of the Embassy of Japan.

A list of discussants is provided at the end of this report.

1.6 Outline of the Survey Plan

Verification of Basic Facts

Following arrival in Kiribati, the Survey Team paid courtesy calls on concerned officials of the Government to explain the objectives of the mission, scheduling, and the nature of the survey and to request cooperation. The Team then sought to obtain and evaluate information on the following matters:

- 1) Background and circumstances of the request
- 2) Relationship of the request to the Master Plan
- 3) Specific nature and scope of the request
- 4) Program priorities
- 5) Operational plans -- including sites for facilities, personnel, and transportation
- 6) Need for technical cooperation

Field Survey

The field survey was conducted in the South Tarawa and Christmas Island areas and covered the following items, as deemed necessary for the preparation of a basic design:

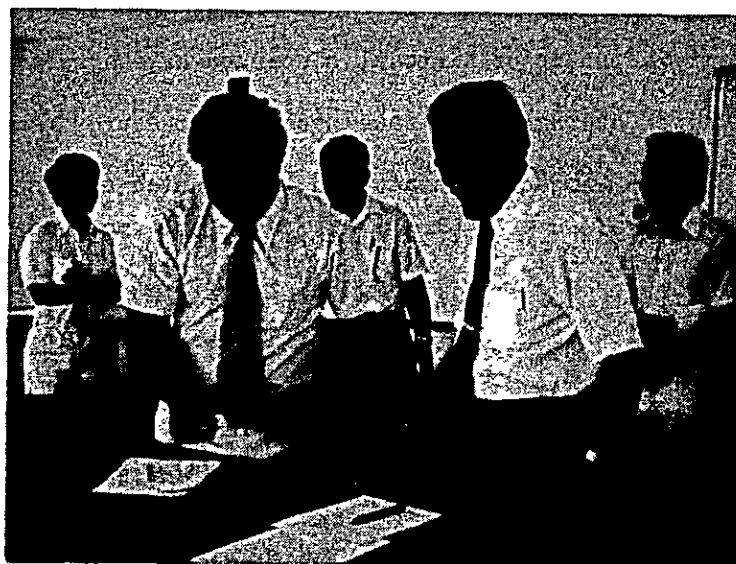
- (1) Conditions in the Fishing Industry:
 - ... Fishing methods
 - ... Size and specie composition of catch
 - ... Number of fishermen
 - ... Structure of distribution and marketing
 - ... Storage and processing technology
- (2) Fishing Port Facilities:
 - ... Wharves, entrance channels
 - ... Ship-building facilities
 - ... Supply facilities
 - ... Navigational aids
 - ... Shore facilities

(3) Construction of Facilities

- ... Natural conditions
- ... Environment and configuration of sites
- ... Roads, water and sewerage, electricity, telephone
- ... Existence of Senior Plan
- ... Materials and equipment procurable locally
- ... Laws and regulations
- ... Unloading and transportation

Discussions

In addition to discussions and a review of survey findings with concerned officials of the Government of the Republic of Kiribati, the Survey Team made a general determination of the intended grant-aid items, verified priorities and the areas of responsibility to be assumed by Kiribati agencies, and explained the procedures for future project implementation. The Team prepared Minutes of Discussions, as shown in the following pages, which was signed by the Team Director and the Minister for Natural Resource Development of the Government of the Republic of Kiribati.



Minister for Natural Resource Development, Hon. Roniti Teiwaki, and Dr. Masatsune Nomura, the Team Director; following signing of the Minutes of Discussions.

MINUTES OF DISCUSSIONS

ON

THE BASIC DESIGN SURVEY FOR THE FISHERIES DEVELOPMENT

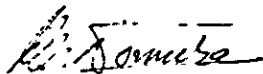
PROJECT IN THE REPUBLIC OF KIRIBATI

At the request of the Government of the Republic of Kiribati for assistance in providing the training vessel, facilities and equipment for the purpose of promoting the Fisheries Development Project (hereinafter referred to as "The Project") in the Republic of Kiribati, the Government of Japan, acting through Japan International Cooperation Agency (JICA), has sent a survey team (hereinafter referred to as "The Team") headed by Dr. Masatsune Nomura to conduct a basic design survey on the Project from November 25th, 1979.

The Team held a series of discussions and exchanged views with the authorities of the Republic of Kiribati concerned in respect of the desirable measures to be taken for the successful implementation of the Project.

As a result of the survey and discussions, the Team and the authorities of the Republic of Kiribati concerned have agreed to recommend to their respective Governments to take necessary measures towards the accomplishment of the Project as stated in the Minutes of Discussions attached herewith.

December 4th, 1979
Tarawa, Republic of
Kiribati



Dr. Masatsune Nomura
Head of the Japanese
Basic Design Survey Team



Hon. Roniti Teiwaki
Minister of Natural
Resource Development

MINUTES OF DISCUSSIONS

1. The Project covers the following two fisheries development areas:
 - (1) Promotion of export oriented commercial fisheries by training I-Kiribati for actual fishing operations;
 - (2) To increase artisanal fish production and supply of locally produced protein.

2. The Fisheries Division of the Ministry of Natural Resource Development will be responsible for the administration of the Project and will be the executing agency for the Project.

3. The Team agreed that the Japanese Government should take necessary measures to provide the following items for the Project:
 - (1) 100-ton type skipjack pole and line training vessel including pole and line fishing gear;
 - (2) Fish Reception Center to be established in Betio comprising of ice making machine, air blast freezer, cold storage, diesel generator, refrigerator truck, ancillary equipment and a building to house the above mentioned equipment;
 - (3) Fish Reception Center to be established on Kiritimati comprising of ice making machine, cold storage, diesel generator, ancillary equipment and a building to house the above mentioned equipment;
 - (4) 10m fisheries research boat for Kiritimati;
 - (5) Fishery equipment including bulldozer, outboard engines, gill nets, nylon ropes and miscellaneous fishing gear.

4. The Team suggested that, in view of the operation cost and the ease of maintenance, a smaller vessel would be beneficial. The authorities of the Republic of Kiribati explained the need for a longer duration

of training in the light of expanded fisheries development activities and mentioned that the Government of the Republic of Kiribati will be ready to make funds available to cover the operation costs of the training vessel. After studying the operation results of F/V Nei Manganibuka, the 99-ton type skipjack vessel of the Government of the Republic of Kiribati, the Team agreed that the size of the vessel should be around 100 tons. The authorities of the Republic of Kiribati strongly requested the provision of a Masterfisherman and a Chief Engineer for the training vessel as technical co-operation experts from Japan. Considering the importance of effective utilisation of the vessel, the Team promised to convey to the Japanese Government the request of the Government of the Republic of Kiribati for sending (not more than) two experts to the Republic of Kiribati in connection with the training vessel.

5. The authorities of the Republic of Kiribati requested to include a bulldozer for the Project, which did not appear in the list presented to the Japanese Economic Cooperation Mission which visited Tarawa in May, 1979. The Team was informed of the lack of heavy equipment available in the Republic of Kiribati and that the equipment will be solely used for the pond construction for culturing bait fish. The Team, recognising the importance of live bait supply for skipjack pole and line fisheries, agreed that a bulldozer should be provided for the Project.
6. The authorities of the Republic of Kiribati confirmed that specifications and quantities of items of low priority may be deleted, altered or decreased according to the budget allocated by the Government of Japan.

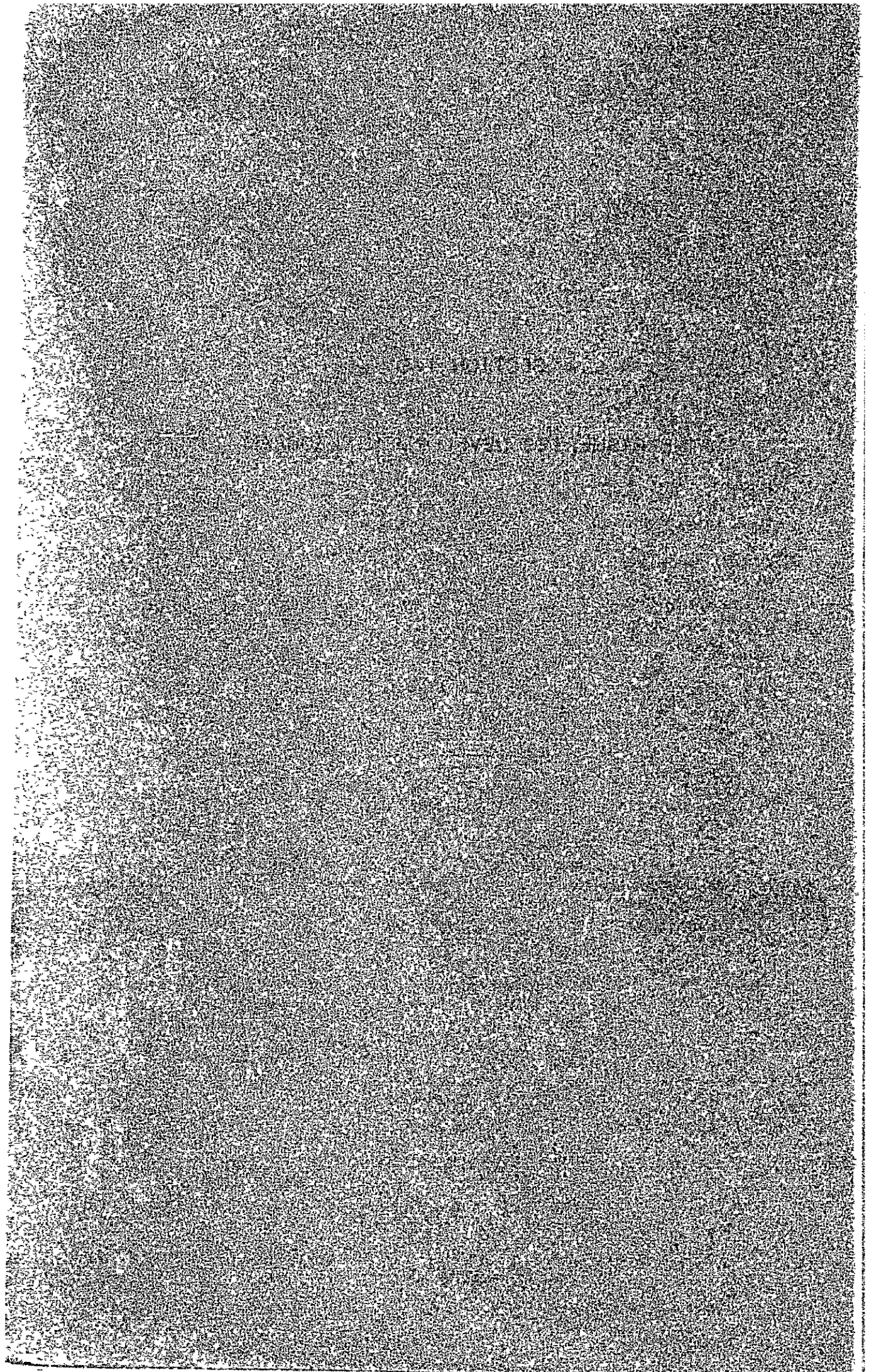
7. The Government of the Republic of Kiribati will take necessary measures -

- (1) to expedite the necessary procedures required for the implementation of grant aid from the Government of Japan;
- (2) to secure land suitable for establishing the facilities and to clear and level the site before the start of the construction of the facilities;
- (3) to distribute electricity, water supply and to provide other incidental facilities to the site; and
- (4) to ensure prompt unloading and customs clearance at the ports of entry in the Republic of Kiribati and internal transportation of materials and equipment to their respective site of installation.

8. The Team expressed its hope that the vessel, facilities and equipment for the Project will be maintained and used properly and effectively for the execution of the Project. The authorities of the Republic of Kiribati undertook to take all necessary measures to achieve the objectives of the Project.

SECTION TWO

THE FISHERIES DEVELOPMENT PROGRAM



2.1 Basic Concept

The Government of the Republic of Kiribati has been devoting strenuous efforts to attaining economic self-sufficiency in the wake of exhaustion of the country's phosphate resources. High hopes and major priority have been placed on the development of oceanic resources, and this area has been continually emphasized in the post-independence 4-Year National Development Plan.

The Fisheries Development Program ties in with the basic objectives of the overall National Development Plan calling for economic independence, the development and strengthening of existing industries, improvement of living standards, creation of cash income opportunities for population in outlying areas, and regional diversification of industrial activity. The specific objectives of the Fishery Program are as follows:

- 1) The establishment of a skipjack tuna export industry, with government participation, to be based in Kiribati.
- 2) Development of a research program for skipjack bait fish, including milkfish cultivation.
- 3) Strengthening of management in the country's exclusive fishery zone.
- 4) Promotion of both a self-supply and a small-scale commercial fishery.
- 5) Brine shrimp production.
- 6) Development of other marine resources, such as sea cucumbers, seaweed, and shark fin.
- 7) Improvement of education and training programs for Fishery Division and extension personnel.

Among the above programs, item (2) has already been brought to the stage of successful implementation on the basis of technical assistance from FAO/UNDP. With respect to milkfish cultivation, there are further plans to develop a 40-hectare production pond.

Item (3) is an item that should be accomplished entirely through local effort.

As to item (5), an initial survey has already been conducted in 1971 in Christmas Island by the Hawaiian Institute of Marine Biology. Since this study, a substantial amount of experimentation has been done, involving a considerable expenditure of funds and manpower. A stage has been reached for finalizing a new program based on the findings to date.

With respect to item (6), other than a small-scale seaweed culture experiment on Christmas Island, no concrete plan has yet been developed.

As to item (7), there is a plan for the establishment of a Fisheries Training Center in Tanaea, with a foreign training officer already scheduled to take up residence for this project.

With regard to item (1)-- the establishment of a skipjack tuna export industry with government participation-- , as already explained, the first steps toward this goal were taken in February, 1979, with the commissioning of a skipjack fishery research vessel, the Neimanganibuka. Looking at the performance of this vessel solely from the standpoint of catch volume, the results cannot be termed entirely satisfactory, with a catch per operating day of only about 0.9 ton. However, one should also consider the indirect benefits from this activity in the form of survey training. Also, during the nine-month period February-October, 1979, the Neimanganibuka recorded an average catch rate of 0.474 fishes per pole per minute, which comes to 63% of the 9-month average of 0.752

fishes recorded in the test operations undertaken by JICA between June, 1977 and February, 1978. This demonstrates conclusively that the I-Kiribati possess a latent talent for absorbing basic fishing techniques. In the future, in addition to the need for providing still broader experience in fishing techniques, it will also be important to conduct a thorough training program in vessel operation and maintenance.

For this purpose, the Government of the Republic of Kiribati intends, in anticipation of a future transition to a true commercial fishery, to launch a pilot operation through the addition of a second vessel of the Neimanganibuka type and the training of a large number of trainees in a minimum period of time.

Item (4) -- the promotion of a self supply and small-scale commercial fishery -- is a natural outgrowth of the importance of fish in the I-Kiribati diet. Based on a recent detailed survey in South Tarawa on fish production and consumption, the annual sale of fish products in the survey area was estimated at between 1200-1300 tons.

The distribution of fish products presently almost totally by-passes the market mechanism, owing to the lack of proper facilities. Moreover, in order to develop a fishing industry in the islands surrounding South Tarawa, a plan is underway to put into service an extension vessel whose personnel would circulate among the various islands to collect fish for landing at Tarawa. For this purpose, starting in January, 1980, an extension/transport vessel of the 15-meter class, built with aid funds from the Australian Government, is expected to inaugurate operations.

There is an urgent need for establishing a distribution center with refrigerated storage facilities to handle this fish, and the Government has already started to prepare a concrete facilities plan for this activity.

Against this background, the Government of the Republic of Kiribati, in line with its Fishery Development Program, has requested assistance centering on the skipjack fishery training vessel and a fish products distribution center.

The results of our survey confirm the feasibility of both of these plans. Accordingly, we have decided to start by developing a basic design in the following three areas, guided by the basic concepts of the master program:

- 1) A training vessel for the pole and line skipjack fishery.
- 2) A fish products marketing center to be established in South Tarawa and Christmas Island.
- 3) Fishing equipment, including a small-size bulldozer and a small FRP boat.

2.2 Basic Performance and Scale Criteria

The Pole and Line Skipjack Training Vessel

Phosphate mining accounted for about 86.4% of total Kiribati export income of Australian \$18,212,000 in 1977. But, with the exhaustion of the resource, this activity ceased at the end of 1979. The Government plans to develop the fishing industry as an export industry to replace phosphate and seeks to make exports of fishery products second only to those of copra by 1982.

The seas surrounding Kiribati are blessed with skipjack tuna resources and is a favorite South Pacific fishing ground for Japanese pole and line skipjack and long-line tuna vessels. However, Kiribati's fisheries are mainly intra-lagoon, self-supply operations using gill and cast nets, while the level of fishing technology is low, so that the skipjack and tuna resources outside the lagoons are scarcely being touched.

It is widely recognized that I-Kiribati are extremely well suited by temperament to work as crew members or fishermen, a fact which has been reconfirmed by the present field survey.

Given the above background, the donation of a pole and line skipjack fishery training vessel along with assistance in raising the technical levels of fishing activity are expected to contribute tangibly to the development of a fishing industry -- which is deemed so vital to the establishment of economic viability and the expansion of employment opportunities. In short, this aid program should produce multiple benefits for I-Kiribati.

Turning to specifications for the skipjack pole and line training vessel, the field survey and discussions with knowledgeable persons in Kiribati produced the following consensus:

- 1) The vessel must be of a size to permit its operation during September-November, when the skipjack schools move offshore, so as to establish a year-round activity. The vessel should be of small size. Also, as the fleet expands, it will be difficult, whatever the vessel size, to locate within Kiribati the necessary experts in fishery training particularly engineers and master fishermen. For this reason, we feel the vessel should be of the same type as the fishery research vessel previously donated by the U.K. (i.e., about 100 tons).
- 2) In order to hold down operating expenses, the main engine horsepower should be kept as low as possible -- viz., 550-600 ps.
- 3) The size of the regular crew should be 24, with a view toward boarding the maximum number of trainees and optimizing training results.
- 4) In order to improve survey accuracy, the vessel should be

equipped with position-fixing equipment.

- 5) Considering the limitations of vessel configuration and budgetary constraints, the other detailed specifications must be carefully planned. These will be finalized at the time of detailed design.

Fish Marketing Centers

South Tarawa

The objective of the Fish Marketing Center to be constructed in South Tarawa is the expansion of domestic demand together with the establishment of sources of cash income for the fishing population in the neighboring islands around South Tarawa. This program will also serve to reduce imports of canned fish products, on which the country now totally depends, and will be the springboard to expanding the fishing population.

Based on the Government's plan, the three cities of Bairiki, Betio, and Bikenibeu will become the biggest market of South Tarawa, with consumption of fish products in this urban area expected eventually to reach some 2.75 tons per day.

Thus, the plan will provide a major fillip to expanding domestic fish demand and developing the fishing industry.

Facilities and equipment for the South Tarawa Marketing Center should be designed for a cumulative handling capacity of 2 tons per day of the various target species. Drinking water is to come from rainwater; well-water will be used for non-drinking water. However, at times of drought, well-water will also have to be used for drinking purposes.

Well-water has an extremely high salinity, which tends to vary considerably by month. (See tables on rainfall, environmental temperature and humidity, and salinity on page 20 through 23.)

Accordingly, since the use of coolants in the freezing equipment will lead to metal corrosion, this equipment should be of the air-cooled type. Also, all equipment must be tropicalized. Thus, water supply for the Center will involve interchangeable well and rainwater systems. Water for ice-making machine will also be either well or rainwater. Thus, consideration must be given to the use of sea-water in the design of the ice-making equipment.

With regard to power supply, there is a central power plant in Betio with a capacity of about 1,200 KW, but power rates are high, with 1980 rates expected to reach 20 cents/kwh. Furthermore, electricity interruptions are frequent so that, in any event, standby power generators would be required. Accordingly, we have decided that power for both operating and lighting purposes should be supplied from a primary generator built at the Center. With an in-house generating plant, moreover, generating cost can be projected at about 13 cents/kwh.

Moving next to the size of the Center building, after giving due consideration to site configuration, the volume of catch to be handled, the size and number of equipment to house, and the necessary functions of the Center, we have determined that the building should be one-story, prefabricated, steel-frame construction, with a floor area of 400 m². Major space requirements will be for the generating and freezing equipment, maintenance and repair of these installations, processing and handling of incoming fish, retail sales area, warehouse, and administrative offices. Consideration should also be given to ease of access of vehicles delivering fish, fuel oil, and water.

Christmas Island

At present, the total population of Christmas Island is only about 1,300. Thus, the local consumption of fish products, excluding self-supply, is quite negligible. The main use initially of the Center will be to earn foreign exchange from exports of milkfish and lobsters to Hawaii and Nauru. These

products can be shipped out via the weekly scheduled round-trip flight linking Tarawa, Christmas Island, and Honolulu, which is slated to start during 1980. There can be no thought of using the inter-island shipping service, which runs only 2-3 times a year.

The basic design of the freezer facilities should anticipate a catch volume of 3 tons per week. Water supply will be on the same basis as Tarawa but rainfall on Christmas Island is extremely sparse, particularly during the May-December period. Water salinity is also much higher than on Tarawa; during our survey, a well-water sample showed 1.8% salinity. Accordingly, as at Betio, the ice-making equipment should be designed to utilize sea-water.

Power supply in Christmas Island is all based on individual generators for each town and building, since there is no central power plant, as in Betio. In the area of the proposed building site for the Center, there is a large workshop equipped with a 25-HP German generator. As with the South Tarawa Center, power for both equipment operation and lighting will be drawn from an in-house generator.

The size of the Center building should be kept at a minimum, since the facility is to be geared to exports rather than local consumption. Construction should be one-story, steel-frame, with about 120 m² of floor area. Space would be mainly allocated to equipment, product processing, warehousing, and office uses.

Average Environment Temperature and Humidity; Average Rainfall at Betio (1978)

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Average Temperature (C)	27.7	27.7	27.6	27.7	27.9	27.8	27.8	27.9	28.1	28.0	27.9	27.9
Average Humidity (%)	77	75	77	77	76	75	74	74	78	71	69	76
Average Rainfall (mm)	290	203	140	196	142	122	102	198	157	71	58	318

Average Annual Maximum Temperature: 30.4°C
Average Annual Humidity: 75%

Average Environment Temperature and Humidity; Average Rainfall at Christmas (1978)

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Average Temperature (C)	25.0	25.2	25.0	24.9	25.3	25.5	25.3	25.1	24.8	24.6	24.7	25.1
Average Humidity (%)	80	83	82	82	79	79	74	74	74	75	75	78
Average Rainfall (mm)	73	47	150	94	9	4	22	3	4	32	2	4

Average Annual Maximum Temperature: 30.8°C
Average Annual Humidity: 78%

Banaba Island Lat. 0°52'S., Long. 169°35'E.

Month	Pres- sure at M.S.L. Mean mb	Air temperature		Relative humidity %	Average rain fall mm	Wind direction							Percentage of observations from	Mean wind speed m/sec	No. of days with wind speed $\frac{3}{4}$ kts. or more	
		Mean highest in each month °C	Mean lowest in each month °C			N.	N.E.	E.	S.E.	S.	S.W.	W.				N.W.
January	1008	32	23	75	294	8	23	35	4	1	3	8	6	12	25	0
February	1009	32	23	74	205	7	24	42	5	2	3	5	4	8	25	+
March	1009	32	23	74	161	4	26	48	5	1	3	4	2	7	25	0
April	1009	32	23	74	133	3	25	55	5	2	2	1	1	6	25	0
May	1010	32	23	72	104	2	22	55	8	1	3	1	1	7	20	0
June	1010	32	23	71	106	2	20	55	12	5	2	1	1	8	25	0
July	1010	31	23	73	124	3	17	49	11	4	4	3	2	10	25	0
August	1010	32	23	70	117	1	12	46	14	4	5	2	3	9	25	0
September	1010	32	23	70	80	3	15	50	12	5	7	4	2	8	25	0
October	1010	32	23	69	83	3	13	44	12	4	4	6	3	8	25	0
November	1009	32	23	71	133	6	17	47	10	4	7	9	6	7	25	+
December	1008	32	23	74	191	8	19	34	4	3	3	10	9	8	25	+
Means	1009	33*	22**	73	—	4	19	45	9	3	4	5	3	8	25	—
Totals	—	—	—	—	1731	—	—	—	—	—	—	—	—	—	—	+
Observation time	—	—	—	1100	—	—	0800	0800	0800	0800	0800	0800	0800	0800	0800	—
No. of years' observations	29~30	22~25	22~25	10	40~41	21	21	21	21	21	21	21	21	21	12	12

* Mean of highest each year. ** Mean of lowest each year.

Fanning Island Lat. 3°51'N., Long. 159°22'W.

Month	Pressure at M.S.L.		Air temperature		Relative humidity %	Average rain fall mm	Wind direction								Mean wind speed m/sec	No. of days with wind speed \geq 4 kts. or more			
	Mean mb		Mean highest in each month °C	Mean lowest in each month °C			N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.			Calm		
January	1010		30	21	78	181	0	2	84	12	2	0	0	0	0	0	0	40	0
February	1010		30	21	80	197	0	1	79	14	4	0	0	0	0	0	0	35	0
March	1010		31	21	79	215	0	0	82	10	0	0	0	0	0	0	0	30	0
April	1010		31	21	82	286	0	0	80	12	1	0	0	0	0	0	0	25	0
May	1010		31	21	81	289	0	0	64	19	6	0	0	0	0	0	0	25	+
June	1010		31	21	79	264	0	0	75	12	2	0	1	0	0	0	0	25	0
July	1010		31	21	76	181	0	3	69	15	2	0	0	0	0	0	0	25	0
August	1011		31	22	74	109	0	0	69	23	5	0	1	0	0	0	0	35	0
September	1011		31	21	70	82	0	2	62	22	12	0	0	0	0	0	0	30	0
October	1011		31	21	71	81	0	0	63	22	13	0	0	0	0	0	0	35	0
November	1010		30	22	74	83	0	1	55	38	6	0	0	0	0	0	0	35	+
December	1010		30	21	75	156	0	0	64	30	2	0	0	0	0	0	0	35	+
Means	1010		32*	20**	76	—	0	1	70	19	5	0	0	0	0	0	0	30	—
Totals	—		—	—	—	2125	—	—	—	—	—	—	—	—	—	—	—	—	—
Observation time	—		—	—	1400	—	0900	0900	0900	0900	0900	0900	0900	0900	0900	0900	0900	0900	0900
No. of years' observations	20		6	6	4	54~58	4	4	4	4	4	4	4	4	4	4	4	4	18

* Mean of highest each year. ** Mean of lowest each year.

Results of Sampled Water Analysis

	Christmas Pond	Christmas Well-Water (Research Station)	Christmas Well-Water (Workshop)	Betio Well-Water	Tokyo Bay (For reference)
PH	7.2(18.0°C)	7.2(18.0°C)	7.2(18.0°C)	7.2(18.0°C)	7.5(17.0°C)
Organic Material	103 mg/l	19 mg/l	22 mg/l	18 mg/l	10 mg/l
Chlorinity	3.4 %	0.58 %	1.82 %	0.03 %	2.0 %
Calcium	1480 mg/l	80 mg/l	190 mg/l	148 mg/l	390 mg/l

Fishing Equipment

The fishing equipment will, in general, be divided among three categories: 1) the bulldozer for building a skipjack bait-production pond. This pond will support the operations of the fisheries training vessel and also help in the future establish a self-sustaining skipjack bait supply operation. This project, as already noted, has been developed on the basis of technical assistance from FAO/UNDP.

The bulldozer should be of a low-ground pressure type in line with its intended use in pond construction. Considering transportation problems within and outside Tarawa Island, its total weight should not exceed 7000-7500 kilograms. The fly-wheel horsepower should be about 60-65HP, with back-hoe and shovel attachments and an ample supply of spare parts.

2) A small-size FRP boat for a fishery development survey in the waters around Christmas Island. The marine resources in the area of this island have not yet been surveyed to any extent; thus, no reference data are available.

At the time of the 1978 Census, Christmas Island had a permanent population of only 1,265. Thus, there is no problem at present regarding local supply of marine products. However,

since the Government is considering the possibility of moving population to Christmas Island, it is clearly essential that a basic study be undertaken to determine the future direction of coastal fishery development. The development of Christmas Island is being programmed along the lines of the National Development Plan, which calls for a dispersion of population on the basis of industrial development in outlying areas.

The small-size FRP boat should have a total length of about 10 meters and should be selected, on the basis of its major intended use, from among catalog models available. Maximum speed should be about 10 knots. In addition to a diesel engine of 40-50 HP, the vessel should be equipped with a drum, located on the vessel's side and coupled to the main engine, which would be used to operate the fishing gear.

3) Equipment for extension activities. For purposes of implementing of the extension program, the primary application of the equipment will be for demonstrations in the islands around Tarawa. Thus, the equipment will not be distributed among the general fishing population. The fishing gear and equipment should be procured in the maximum possible variety and should be compatible with whatever fishing method is being demonstrated.

The most important item of fishing gear will be gill nets, which are widely used in Kiribati. The material for these nets should be nylon monofilament in two sizes: 100 mm mesh of 0.47 mm diameter and 130 mm mesh of 0.62 mm diameter. In addition, the gear should include trolling lines, cast nets minnow nets, lures, floats, sinkers, and nylon rope, etc. Consideration should also be given to providing 25 HP and 40 HP outboard motors and a FRP work boat.

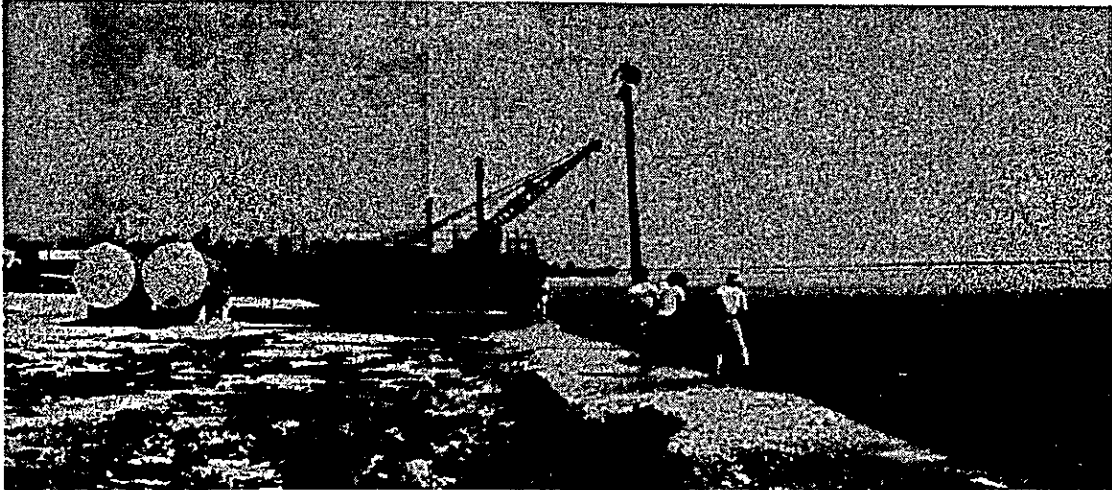
The types and volume of equipment to be supplied should be set conservatively with due consideration for local technical and economic conditions. A final determination will be made at the stage of preparing a detail design.

2.3 Vessel Functions ; Port and Site Selection

In this section, we shall take up the matter of the functions and size of the vessel and facilities outlined in the previous section along with the selection of a base port for the training vessel and building sites for the distribution facilities.

With respect to the skipjack fishery training vessel, the home port, as in the case of the Neimanganibuka, should be Betio. This port has wharves with an average depth of 2.5 meters. However, there is one shallow section in the entry-channel, so that vessels with a draft of over 2 meters cannot berth. Accordingly, this vessel will be required to moor offshore, and employ an auxiliary unloading vessel; in this sense, the facilities cannot be termed complete. Nevertheless, Betio is the only port with reasonably adequate facilities. Also, given the existence of a freezer there for storing the catch, no other port would be appropriate as a base for the subject vessel.

The small FRP boat to be assigned to Christmas Island will have a draft of less than 0.5 meter. Thus, although large vessels will find it difficult to enter the port of London (as in Betio), there will be no such problems with the FRP boat for which there are ample mooring positions.



Wharf at London Port, Christmas Island

Careful consideration must be given to site selection for the Marketing Centers at South Tarawa and Christmas Island. Two channels may be anticipated for receiving fish at the South Tarawa Center: one would be direct unloading at the Center by powered crafts operating within the lagoons and by canoes based close to the Center; the other via the collection at sea of catches from the surrounding islands by means of the extension vessel provided by the Australian Government.

The distribution area to be covered by the Tarawa Center will be the entire South Tarawa region: i.e., from Betio to Tanaea. However, about 53% of the area's population is concentrated in Betio and adjacent Bairiki. The latter is also the center of governmental agencies, while Betio contains a branch of the Fisheries Division.

As already noted, the port of Betio is the only one with adequate facilities. A freezer is already located there, while the city offers convenient facilities for unloading of catches and delivery to consumption areas, thereby facilitating operational control. From these vantagepoints, Betio is,