BIBLIOGRAPHIC DATA SHEET	1. CONTROL NUMBER	2. SUBJECT CLASSIFICATION (695)
	PN-AAH-570	AM00-0000-G704

3. TITLE AND SUBTITLE (240)

A survey of the fisheries research program of the Republic of Korea

4. PERSONAL AUTHORS (100)

Roedel, P. M.; Trefethen, P. S.

5. CORPORATE AUTHORS (101)

6. DOCUMENT DATE (110)	7. NUMBER OF PAGES (120)	8. ARC NUMBER (170)
1968	102p.	KS639.3072.R712

9. REFERENCE ORGANIZATION (130)

Korea

10. SUPPLEMENTARY NOTES (500)

11. ABSTRACT (950)

12. DESCRIPTORS (920)

Fisheries
Fishery products
Research
Surveys
Fish
Korea Rep..

13. PROJECT NUMBER (150)

14. CONTRACT NO.(140)	15. CONTRACT TYPE (140)
Korea	

16. TYPE OF DOCUMENT (160)

Short term loan to NAS-OPC

Return to

PHILIP M. ROEDEL
FISHERIES ADVISOR

BUREAU FOR TECHNICAL ASSISTANCE
AGENCY FOR INTERNATIONAL DEVELOPMENT
U. S. DEPARTMENT OF STATE
WASHINGTON, D C. 20523

KS

PN-AAJ-[illegible]

A SURVEY OF THE FISHERIES RESEARCH PROGRAM OF THE REPUBLIC OF KOREA

Philip M. Roedel
and
Parker S. Trefethen

UNITED STATES
DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
AND THE
REPUBLIC OF KOREA
OFFICE OF FISHERIES

SEOUL, KOREA

September 5, 1968

ABSTRACT

A team of biological consultants, requested by the Republic of Korea through the U. S. Department of State Agency for International Development, reviewed the research activities of the Fisheries Resources Development Agency of the Office of Fisheries. The review was concentrated within the Fisheries Resources Section to determine the extent and adequacy of ongoing programs, future plans, and their contribution toward attaining national goals in fishery production, 1967-71, set by the Office of Fisheries. Discussions were held with other sections of the agency, international organizations and representatives of the fishing industry. A summary of research was prepared and recommendations were made to assist the agency in strengthening its research program.

Acknowledgements

We are indebted to Mr. Laverne Wakefield, Chief of the Fisheries Branch of USAID/K in Seoul, and his assistant, Mr. Lee, Kuhn Hong, for making primary arrangements which paved the way for our review. Mr. Hahn Shin Wook, Director of the Fisheries Research Development Agency, showed much interest in our activities and provided office facilities and a typist for our use. Special acknowledgement is made for the cooperation of Mr. Suh Hack Keun, Chief of the Fisheries Resources Section; Mr. Park Byung Ha, Senior Scientist; and scientists and technicians of the Section. These individuals willingly participated in lengthy discussions of their research or administrative responsibilities and gladly spent many hours in preparing special data which we requested. Invaluable assistance was given by Mr. Lee Chun Ku, our guide and interpreter, who made arrangements for special appointments, participated in discussions and helped us in the preparation of this report. We also wish to thank the Chiefs of other sections of FRDA, Branch Station chiefs, Fisheries Cooperative officials and FAO personnel who contributed information which added to the depth and breadth of our review.

CONTENTS

FIGURES

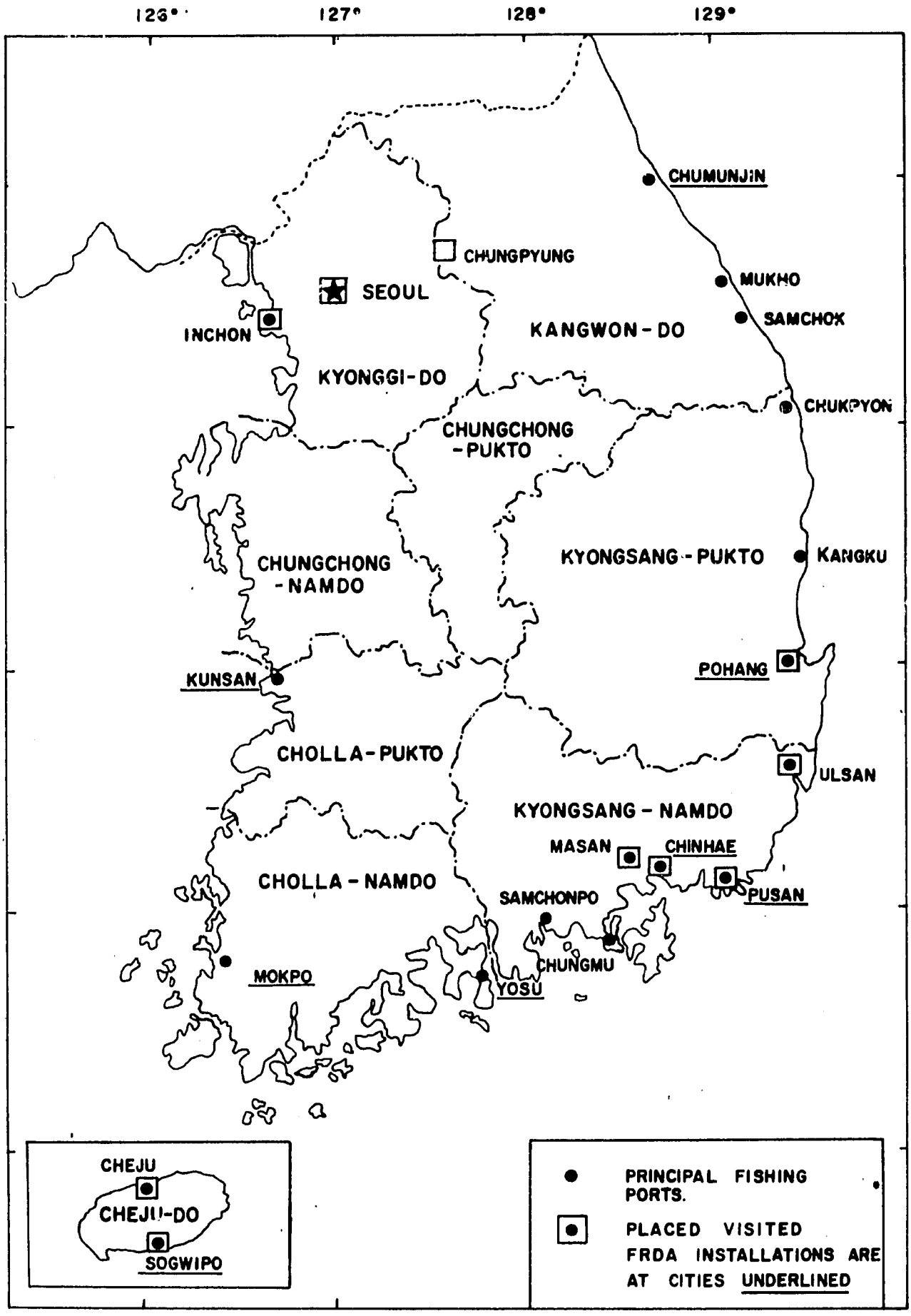

Fig. 1 Map of the Republic of Korea

PURPOSE OF THE SURVEY

During the past several years the U.S. Agency for International Development, as part of its program in cooperation with the Government of the Republic of Korea, has arranged for visits by various specialists in the field of fisheries to assist in the development of the Korean fishing industry. One phase of the program provided for two fisheries scientists from the United States to assist the Korean Government "to improve its planning, programming and implementing procedures to facilitate the expansion and modernization of the fishing industry." The consultants were to evaluate existing programs, suggest modifications where appropriate, and help establish effective programs for:

1. Investigating marine resource potentials.

2. Exploiting marine resources.

3. Providing maximum utilization of domestic marine resources, and

4. Training Korean technicians in marine biology and fisheries resource management under the AID participant program.

In discussing these rather general goals with officials of both USAID and the Korean Office of Fisheries, it became apparent that the review required:

1. A review of the curriculum for fishery students.

2. An evaluation of the fisheries research program in terms of its adequacy and importance as a factor contributing to the Republic's goals in fisheries development, considering such questions as (a) are the present research programs needed in whole or in part? (b) Are areas of importance being overlooked? (c) Would spending the money now allocated for research for some other purpose contribute more toward development of the industry?

3. Looking beyond research per se and considering Korea's needs if it is properly to develop and manage its fisheries.

4. Considering the institutional problems and restraints (social, legal, economic) that might hinder orderly fishery development, insofar as these affect the structure of a management-oriented research program, and

5. Recommending to the Government of Korea a program designed to provide, in a timely fashion, the requisite information that the Republic will need if it is to implement a management program designed to produce a maximum sustained catch for domestic use and for export.

In the time available, about two and one-half months during the period July-September 1968, we found it possible to study in some degree of depth the fishery research and associated programs conducted by the Fisheries Research and Development Agency (FRDA) and to relate these programs to the nation's needs, in the context of these five points. In accomplishing our mission, we discussed the activities of FRDA with administrators within and outside of that organization and reviewed research in progress and future plans with scientists responsible for major programs. We dealt largely with the Fisheries Resources Section but we also talked with scientists of other sections and visited three of the regional stations (Figure 1) to observe and discuss their work. This report summarizes the research activities and provides recommendations which we believe can be helpful in improving the research activities of FRDA.

BACKGROUND INFORMATION

Introduction

An evaluation of the research program on its scientific merit alone would be meaningless. The best research in the world is of small value to administration and management alike unless it relates to national goals, economic needs, and the social and legal structure.

Our purpose in this section is to consider the institutional structure in Korea so that the research work can be viewed in proper perspective. Most of the data presented are taken from official publications of the Office of Fisheries. (Though this title is used on all publications, the Office is commonly referred to as OFA, standing for Office of Fisheries Affairs). Some of the material is from the Fisheries Research and Development Agency (FRDA), a part of OFA, and the balance from various publications and personal communications.

The Place of Fisheries in the Korean Economy

The Office of Fisheries estimated that 1.3 million people were engaged in the fishing industry at the end of 1965. These people represented 4½ per cent of the total population, but they produced only little over one per cent of the total gross national product. This percentage of the GNP rose somewhat during the period 1960-1965, from 0.8 to 1.1 per cent, but the fishery population increased by over one million during the same time interval and from 3.4 to 4.5 per cent of total population. Both GNP and the value of fisheries increased substantially over the five-year period:

	GNP	Fisheries	% Fisheries
1960	₩243 billion	₩2 billion	0.8
1965	₩779 billion	₩8.9 billion	1.1

Thus, fisheries still make a very minor contribution to the total economy even though they show a steady growth. The great bulk of the fisheries are submarginal at best and in general the fishing population occupies a very low position in both the economic and social systems. In comparison, agriculture gives a much higher per capita return than fisheries (in 1965, ₩60,000 for agriculture and ₩41,000 for fishing), but both lag far behind mining and manufacturing.

Despite these factors, fishing is and will continue to be an extremely important component of the Korean economy for two reasons: Only through increased fish consumption can Korea hope to overcome protein deficiencies in the diet, and, second, developed fisheries can contribute significantly to the export market and a favorable balance of trade. The most recent information available to us is that fisheries accounted for between 15 and 20 per cent of the total value of exports in 1965 and 1966.

Recent OFA publications (1967-1971 Five-Year Fisheries Development Plan; Fisheries in Korea, 1966) point out that fishing has traditionally been regarded as an undesirable occupation, that it has remained retarded, and has received little support of a financial nature from the Government.

The fishing fleet is increasing in size, and a number of modern distant-water trawlers and tuna longliners have been acquired in the last few years. Most of the fleet is, however, out-moded and old, consisting of small craft both powered and nonpowered. The OFA plan lists 48,700 vessels of which only 6,400 were powered; 45,300 of the total were 10 gross metric tons or less. Figures for 1967, not compiled in an identical manner, show a substantial increase in the total to 57,300. Of these 46,300 were nonpowered wooden vessels, 10,600 were powered wooden vessels, while 400 had steel hulls.

At the time of the reports cited, coastal fisheries constituted about two-thirds of the total production, inshore fisheries 25 per cent, and deep-sea fisheries, 11 per cent. So far as we know, there has been no significant shift in the last year or two.

The official OFA landing figures do not agree with those appearing in the FAO Yearbook for 1966. FAO credits Korea with 600,000 metric tons in 1964 and 701,000 in 1966 while the OFA figures are 524,000 and 610,000 metric tons respectively. Distant-water tuna and other long-line catches landed at foreign ports appear to account for part of the difference (27,000 metric tons in 1966) but the remainder cannot be explained. Regardless of which set of figures is used, Korea falls far behind the world leaders in fish production; Peru's landings approached 9 million metric tons in 1966, Japan's catch was 7 million, and the United States, in sixth place, caught about 2½ million. According to OFA sources Korea ranked twenty-first in the world (seventh in Asia) in 1964. In 1966, according to FAO publications, Korea was nineteenth in the world (sixth in Asia).

Landings in Korea by species and gear for the period 1956-1967 appear in Table 1-3. The anchovy fishery is now the largest in terms of tonnage. It was followed in 1967 by yellow croaker,

hairtail and saury. The jack mackerel fishery, formerly a leader, has declined significantly in the last two years. The yellow croaker fishery was the most valuable in 1967, followed by anchovy, hairtail and saury.

The Role of Korea in International Affairs

Korea-Japan Fisheries Agreement

While Korea is deeply interested in developing distant-water fisheries as well as those of a more local nature, it has not ratified any of the 1958 Geneva conventions and is party to only one international agreement, that entered into with Japan in 1965.

Table 1. Landings of Leading Species in Korea 1956 - 1959

Species	1956	1957	1958	1959
Anchovy	29,098	34,677	37,864	35,979
Yellow croaker	32,395	29,888	24,585	23,824
Hairtail	47,995	38,611	30,555	33,650
Saury	14,766	22,956	20,651	31,284
Jack mackerel	10,239	14,153	48,361	32,863
Alaska pollack	30,766	38,620	39,336	21,356
Sole	4,858	6,166	9,450	6,755
Spanish mackerel	3,131	2,083	2,171	2,352
Pacific mackerel	15,700	12,783	5,793	1,634
Cod	3,589	1,985	1,459	2,468
Squid	21,271	39,116	33,519	46,695

Source: FRDA

Table 2. Landings and Value of Fishery Products in Korea, 1960-1967

Catch: Metric Ton
Price: ₩1 million
= approx. $2,750

Item	Species	1960 Catch	1960 Price	1961 Catch	1961 Price	1962 Catch	1962 Price	1963 Catch	1963 Price
Fish	Anchovy	34,789	2,878	39,656	2,767	46,955	481	32,428	520
	Yellow croaker	21,687	3,610	22,194	4,444	21,653	530	23,049	645
	Hairtail	41,675	3,028	29,809	3,059	39,307	487	30,451	539
	Saury	10,939	1,723	28,467	2,401	39,972	344	13,652	195
	Jack mackerel	23,452	2,612	23,552	2,417	18,419	298	12,440	273
	Alaska pollack	15,520	2,600	13,726	2,323	27,792	457	22,534	466
	Sole	8,152	816	6,671	785	8,639	115	11,410	182
	Spanish mackerel	3,258	705	3,576	892	7,053	136	2,956	210
	Pacific mackerel	2,175	280	1,762	221	4,058	65	5,451	121
	Cod	1,803	256	1,546	275	1,389	30	853	21
	Others*	78,290	6,980	74,055	8,748	83,001	160	94,851	1,587
	Sub-total	241,738	25,488	245,014	28,342	298,238	4,243	250,075	4,760
Shellfish									
	Sub-total	13,479	1,073	21,534	1,297	19,994	175	17,458	246
Seaweeds									
	Sub-total	27,436	1,427	36,936	2,102	45,611	373	37,819	638
Miscellaneous									
	Squid	37,644	1,760	82,935	3,936	52,935	444	116,874	1,110
	Others	22,174	1,502	26,035	2,110	34,606	329	21,973	437
	Sub-total	59,818	3,262	108,970	6,046	87,541	773	138,847	1,547
GRAND TOTAL		342,471	31,250	412,454	37,787	451,384	5,564	444,199	7,191

* Includes whale, shark, seabream, eel and others.

Source: FRDA

Table 2. (Cont'd)

Catch: Metric Ton
Price: ₩1 million
= approx. $2,750

Item	Species	1964 Catch	1964 Price	1965 Catch	1965 Price	1966 Catch	1966 Price	1967 Catch	1967 Price
Fish	Anchovy	35,592	814	56,735	663	86,349	1,336	78,538	1,830
	Yellow croaker	47,023	1,730	39,604	1,939	44,543	2,447	57,521	2,871
	Hairtail	29,961	878	37,677	1,195	45,384	1,844	48,713	1,881
	Saury	25,360	513	32,273	883	39,404	1,025	28,320	1,162
	Jack mackerel	19,581	526	26,489	833	10,058	627	5,280	327
	Alaska pollack	23,353	626	26,689	820	21,013	936	17,503	1,084
	Sole	10,252	220	13,288	444	12,021	503	16,457	651
	Spanish mackerel	4,465	378	5,599	715	7,590	714	7,581	656
	Pacific mackerel	2,441	87	7,331	234	2,078	117	2,772	194
	Cod	1,465	37	2,245	89	2,211	84	2,286	125
	Others*	121,142	2,663	145,526	4,858	178,229	7,549	175,939	8,128
	Sub-total	320,645	8,472	393,474	12,693	428,880	17,092	440,910	18,909
Shellfish									
	Sub-total	45,030	674	18,628	444	29,718	703	24,927	765
Seaweeds									
	Sub-total	42,980	1,318	48,362	740	50,344	821	61,406	1,370
Miscellaneous									
	Squid	86,628	844	68,392	1,773	75,473	1,398	38,945	1,424
	Others	69,012	774	33,091	966	25,667	1,020	45,373	1,778
	Sub-total	115,640	1,618	101,483	2,739	101,140	2,418	84,318	3,202
GRAND TOTAL		524,295	12,082	561,947	16,616	610,082	21,034	611,561	24,246

* Includes whale, shark, seabream, eel and others.

Table 3. Catch by Principal Fisheries, 1956-1966

Unit: MT

Year	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
Danish seine	37,123	34,481	50,021	33,929	36,914	35,405	42,589	75,908	74,619	93,787	89,678
Purse seine	26,240	26,000	30,815	29,700	27,500	20,300	17,089	14,299	16,609	25,700	12,674
Stow net	76,558	60,589	24,342	51,537	33,173	19,143	32,724	50,217	71,738	72,418	83,147
Saury gill net	14,766	22,957	20,651	31,297	14,884	28,467	39,990	12,580	20,846	31,229	38,046
Yellow croaker gill net	1,557	1,792	6,630	861	2,115	3,820	765	2,278	1,829	8,648	18,803
Spanish mackerel gill net	1,347	487	593	1,084	1,158	510	1,475	521	3,775	3,758	-
Miscellaneous gill net	5,396	7,029	7,991	10,475	6,116	15,706	19,003	29,171	40,949	40,609	17,629
Set net	38,237	38,833	41,745	40,831	49,223	37,645	37,967	31,394	19,496	26,276	30,651
Powered anchovy drag net	-	-	-	19,172	21,476	27,798	32,253	13,624	9,028	17,542	30,160
Small seine	14,764	22,196	27,895	4,256	4,519	2,121	701	13,624	6,798	661	2,202
Alaska pollack long-line	10,467	37,891	35,820	14,792	7,895	3,064	-	-	9,937	13,547	7,836
Squid powered angling	20,195	38,427	32,572	45,600	37,293	49,519	11,501	93,150	72,347	65,148	68,637

Source: FRDA

In 1952, following the lifting of post-war fishing restrictions on Japan, Korea became concerned over Japanese fishing ventures off its coast. To combat this, President Rhee promulgated the Peace (or Rhee) Line which was later given statutory force by the Fishing Resources Protection Law. The Peace Line runs far out to sea, extending at its maximum to 38° N lat; 132°50' E long, nearly 100 miles outside of Ulneung Island and about 170 miles off the nearest mainland point. Korea claimed exclusive fisheries jurisdiction within this line.

Many years of on-and-off negotiations with Japan finally culminated with the Korea-Japan Fisheries Agreement of 1965. This agreement permits Japan to fish inside the Peace Line up to the Korea 12-mile limit that was established concurrently with the implementation of the agreement (Figure 2).

Japanese fishing rights are not unlimited under the terms of the agreement. It provides for a sea zone the inner boundary of which is the 12-mile limit. The outer boundary lies inside the Peace Line except in the northern portion of the Yellow Sea. Within this zone, the two countries have agreed to limit purse seine and trawling operations to 150,000 metric tons each per year for nine species of fish. Trawling is allocated 40,000 metric tons, purse seining 110,000 metric tons. The nine species are: Pacific mackerel, spotted mackerel, jack mackerel, yellow croaker, white croaker, hairtail, red seabream, sharptoothed eel, and Korean shrimp.

There are no quota restrictions in the area between the joint fishing zone and the Peace Line. However, Korea maintains its jurisdiction out to the Peace Line and allows only Japanese and Korean vessels to fish there. We do not know whether any third parties have tested the strength of the Korean position.

The country quotas now in effect were derived from past fishing experience because there were no data available upon which to base scientifically-derived catch limits. The quotas are subject to modification when scientific information indicating the need for a change do become available.

The agreement provides for annual conferences at the scientific level and for the pooling of data. A manual (1967) standardizes techniques for market sampling, measurements, age determinations, egg and larva studies, tagging and oceanographic observations. Data reports for 1966 and 1967 have already been issued. The fishing grounds are zoned for statistical purposes for bottom and pelagic fisheries (Figures 3 and 4).

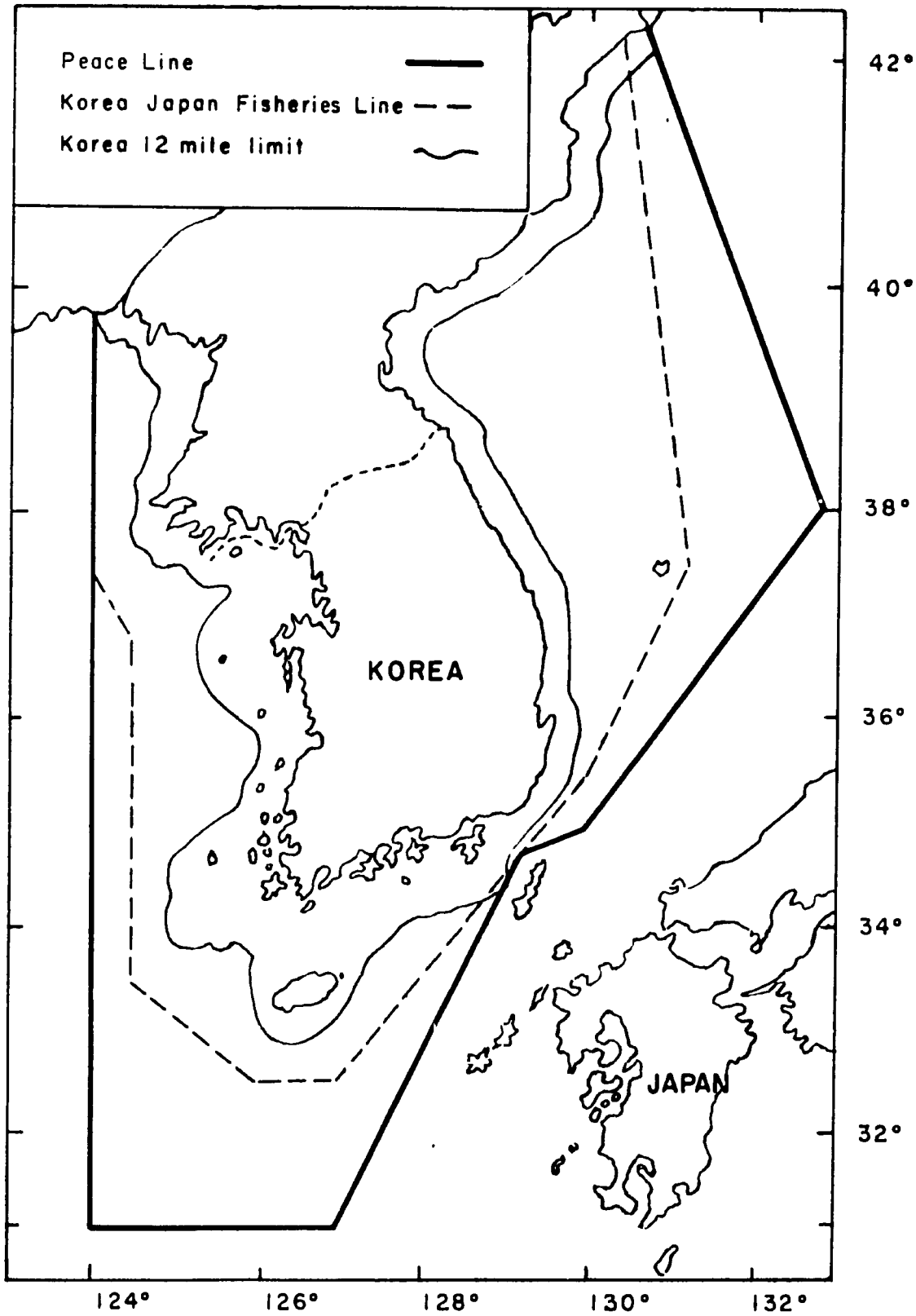

Figure 2 Fishing zones of the Republic of Korea.

Administratively, a Korea-Japan Joint Fishery Commission with six members carries out the provisions of the agreement and recommends necessary plans and actions to both governments. The agreement recognizes the need to sustain maximum productivity in waters of mutual interest and the desire for cooperation in developing common fisheries. It calls for management based on the concept of maximum sustainable yield, for rational development and exploitation, for mutual cooperation and for the elimination of causes of dispute.

Our information with respect to the agreement comes from secondary sources, as an English version of the agreement itself was not available.

General Considerations

We found no indication that Korea intends to enter into any other bilateral or multilateral agreements or to adhere to the 1958 Geneva conventions. This latter is not surprising in view of the Republic's claim of exclusive fishery jurisdiction over large areas of the high seas beyond the 12-mile limit.

At the same time, the Republic is actively engaged in expanding its operations both adjacent to its local fishing areas and in distant waters. Further, many of its local fisheries exploit species that are fished by other nations, such as Taiwan and Red China. Unless the Korean stocks prove distinct and are fished by Korea alone or are covered by the Korea-Japan agreement, resource management will be extremely difficult if not impossible in the absence of international agreement. And agreements involving Red China and North Korea appear inconceivable in the present state of world affairs.

The question thus becomes one of whether research directed toward stocks subject to international exploitation can lead to any practical benefit to the Korean industry unless the research is accompanied by negotiations leading toward conservation conventions. Where negotiation is impossible and the other nation or nations are obviously taking a significant portion of the available stock, Korean interests might best be served by fishing as intensively as possible without regard for research or conservation principles.

We bore these considerations in mind while evaluating the research programs.

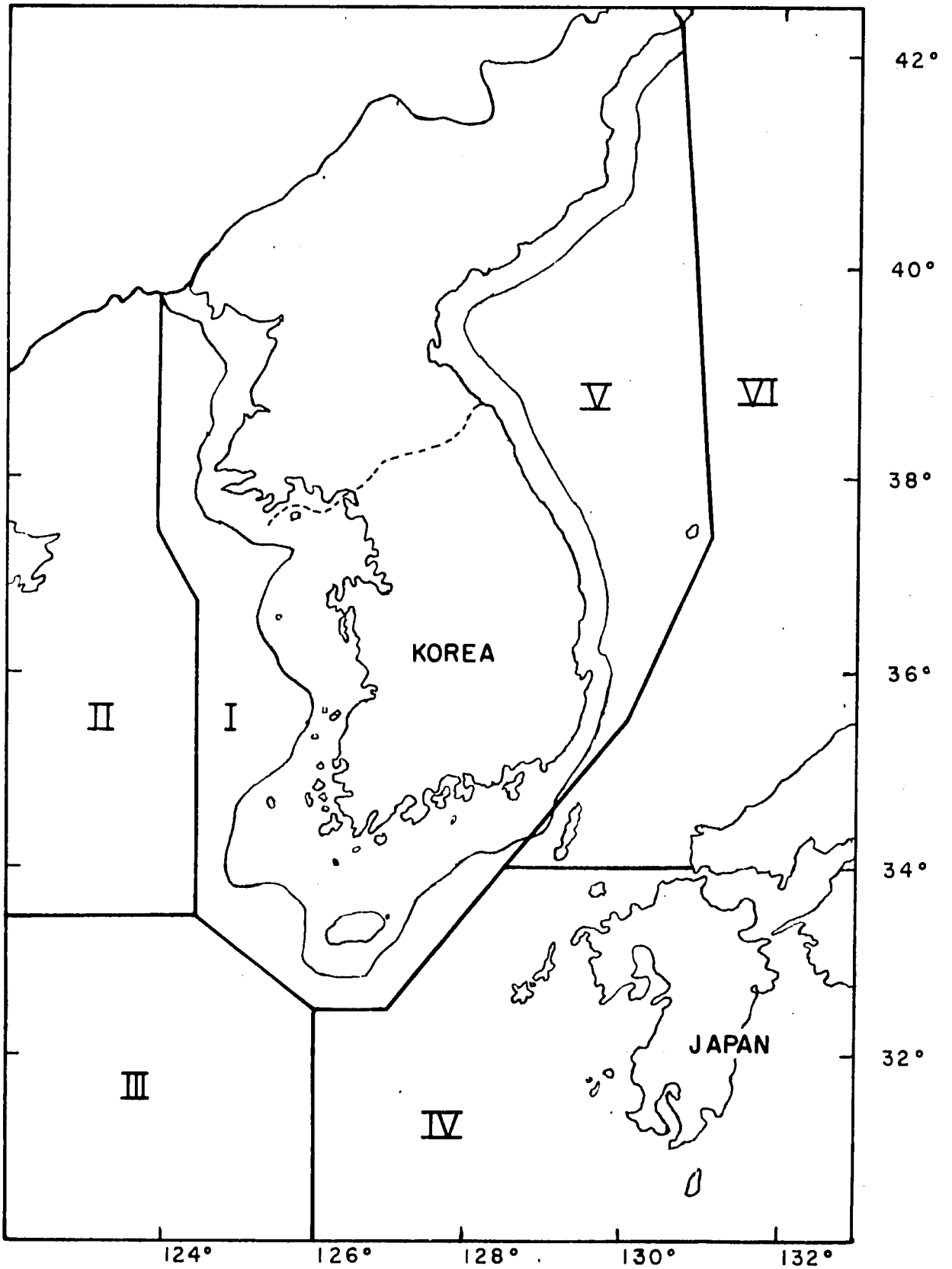

Fig. 3 Korean statistical areas for pelagic fish
Source: Manual of the Korea-Japan Joint Fishery Survey

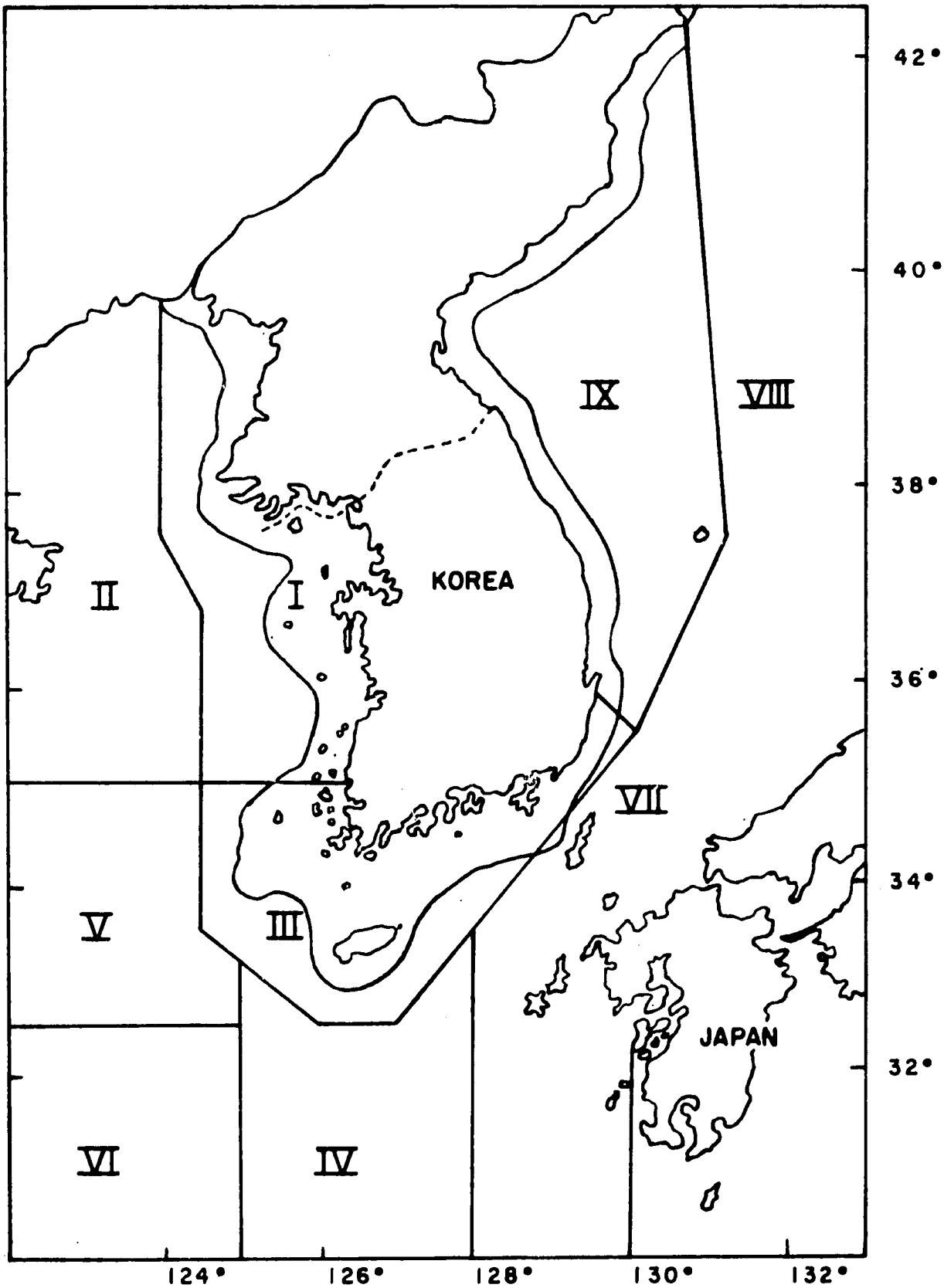

Fig. 4 Korean statistical areas for bottom fish

Source : Manual of the Korea-Japan Joint Fishery Survey

The Five-Year Fisheries Plan

The Office of Fisheries has prepared a development plan for the period 1967-1971 running concurrently with the nation's Second Five-Year Economic Development Plan. As we have noted, the fishing industry has been in severe straights, but its development offers great promise in helping solve problems of economic welfare, nutrition, and foreign exchange. The Five-Year Fisheries Plan is designed to cope with these matters. It attempts to set realistic goals for 1971, but recognizes that the many deficiencies cannot be fully corrected in this period of time.

The OFA prospectus takes note of several priority tasks, including (i) price stabilization, (ii) insuring a steady supply of vessels and gear, (iii) a marine resources survey, and (iv) research coupled with accelerated technical training.

OFA regards the promotion of fisheries as critical because (i) most of the fishermen operate at a submarginal level, (ii) productivity is low, (iii) the climate seems right for fishery development; prospects are bright for deep-sea fisheries and for augmented exports, (iv) fishery development can help solve unemployment problems, (v) Korea must compete with the undeveloped nations that are building their fishing industries, and (vi) Korea must meet Japanese competition.

The plan emphasizes four principal targets: (i) To modernize production, (ii) to increase the income and stabilize the social and economic status of submarginal fishermen, the goal being to double their income by the 1970's, (iii) to enlarge inshore and deep-sea fisheries and to increase the value of exports to over $100 million by 1971, as compared to $37 million in 1965, and (iv) to explore the potential of undeveloped resources with the goal of doubling production by 1971 (the Korean fish catch was 562,000 metric tons in 1965).

To reach these goals, it is proposed to (i) enlarge and renovate shoreside facilities, (ii) encourage and seek to enlarge coastal, offshore, and distant-water fisheries, (iii) enlarge the scope of resource surveys, research, and technical training, (iv) expedite training for fishermen and guidance for fishing villages, (v) promote international technical training, (vi) enlarge and improve facilities for processing, preserving and distributing fishery products both at home and abroad, and (vii) improve the institutional system with special respect to financing and the status of submarginal fishermen.

The program of FRDA reflects this plan, and work in the Fisheries Resources and the Oceanography Sections has, since 1966, been accelerated with special respect to enlarging the scope of resource surveys and research. This activity reflects the impetus given by both the Five-Year Plan and the Korea-Japan Fisheries Agreement. Our survey was directed largely toward these two sections, with special emphasis on the Fisheries Resources Section.

The Governmental Fisheries Establishment

The Office of Fisheries in the Ministry of Agriculture and Forestry was established in 1966 following a series of reorganizations over a period of years. It is headed by an Administrator appointed by the President as is the Deputy Administrator, who, however, holds the top civil service rank, class 1. The Administrator's rank is equivalent to Vice Minister. OFA is organized into a number of sections and four special units. The sections, the heads of which have civil service status and report to the Deputy Director, include Planning and Coordination, Fisheries Administration, Production, Facilities, Fishing Coordination, Fishing Guidance and the Tokyo Resident Officer.

The special units are:

1. Korea Marine Industrial Development Corp., - a quasi-governmental organization. Its president occupies a special position and is appointed by the President of the Republic. He reports to the Administrator of OFA.

2. Central Federation of Fisheries Cooperatives, also quasi-governmental. Its head, appointed by the President, reports to the Administrator.

3. National Fisheries Inspection Office, headed by a director appointed by the Administrator and reporting to the Administrator.

4. National Fisheries Research and Development Agency. Its Director is appointed by the Administrator and reports to him. The FRDA Director is under civil service in class 2.

Civil Service

There are five classes of civil servants, all but the first with two grades within them. Positions in the top three classes are appointive, but the appointees aquire permanent status though they can be transferred to other positions within the class as the appointing power wishes.

The Deputy Director of OFA, for example, is in class 1 and is appointed by the President of the Republic. He has rights to a class 1 position elsewhere if removed from this position. The same holds true for the Director of FRDA, a class 2 position, for Section Chiefs, class 3a, and for Senior Scientists, class 3b.

The scientific staff, except for the positions noted, falls in classes 4 and 5. Candidates, who must have a college degree, are selected from among those who pass a nationwide examination. Promotions within these grades depend on length of service, efficiency reports, and training. People entering through the examination system are eligible for appointment at the top three levels when they are felt qualified. Appointments in FRDA are made by the Director, OFA, on recommendations from FRDA.

Civil service salaries are very low, and this is reflected in the problems related to us respecting recruitment and retention of high-caliber scientists. The data regarding salaries exclusive of bonuses that follow are from a report issued by the American Embassy in 1967 and reflect the pay scale established in April 1967. Grades 4 and 5 have a range of ₩6,690 to ₩9,590; this is from the starting monthly salary of grade 5b to the maximum salary of grade 4a. The grade 3 range is from ₩10,660 to ₩18,740; grade 2, from ₩20,600 to ₩29,700; and, grade 1, from ₩35,100 to ₩48,000.

In 1966, clerical workers in manufacturing industries averaged ₩13,074 per month with a range of from ₩5,466 to ₩18,270. Korean employees of USFK at the GS 7 level (e.g. laboratory technician) received from ₩19,000 to ₩27,200; the scale for GS 12 (e.g. construction engineer supervisor) ranges from ₩32,700 to ₩46,700. Biologists entering in the U.S. Bureau of Commercial Fisheries with an AB or BS degree but no experience are usually recruited at the GS 7 level, and a program leader, comparable to the class 3a positions in FRDA, would be a GS 12 or better.

The problems of recruitment and retention of qualified personnel are in part a reflection of the civil service system. Obviously the Korean governmental scale is not competitive in the field of marine research and it will remain so even with the projected increase in salaries of 30 per cent during 1968-1971.

Law Enforcement and Fishery Guidance

Law enforcement and/or guidance services are provided by four agencies: (i) the Coast Guard, a function of the Ministry of Home Affairs, (ii) the Office of Fisheries, (iii) Provincial Governments, and (iv) the ROK Navy.

The Coast Guard has primary responsibility for enforcement except in the inshore areas subject to the jurisdiction of the provincial governments. OFA has a fleet of 12 boats which offer services designed to give guidance and help to offshore fishermen. If problems arise in the Korea-Japan agreement area, these vessels have police power: they can arrest and investigate but must notify both governments of their actions. A joint committee meets every three months to negotiate damage claims.

Each province has its own fishery guidance and patrol boat that operates in inshore waters. The provinces issue two types of fishing ground licenses, class 1 for seaweed and shellfish and class 2 for diving, and the provincial boats provide enforcement and assistance in these areas of limited entry as well as elsewhere in provincial waters. The ROK Navy joins the Coast Guard and the OFA vessels in patrol near the DMZ, particularly during the yellow croaker season in the summer on the west coast and the Alaska pollack season in the winter and spring on the east coast.

The English version of the Fisheries Code (1967) shows the laws to be extremely complex, particularly with respect to gear, areas, and size limits. The question arises as whether these restrictions are based on scientific fact. If they are not, they cannot help but hinder the orderly development of and maximum sustainable production from the Republic's living marine resources.

Pollution

Korea's rapid industrial development can have a severe adverse effect upon coastal fishery resources unless proper water quality control measures are established and enforced. Neither human nor industrial wastes can be dumped indiscriminately without widespread toxic effects, smothering action, loss of photosynthetic action because of turbidity, and destruction of bottom habitat by sludge accumulation. The immediate and obvious effects are on sessile organisms such as oysters and clams and upon marine plants, but more subtle changes can occur in the distribution and local abundance of fin fish as well. Further, the impact of human waste upon the marine environment is already inhibiting the growth of an export industry based upon raw oysters, at least to such countries as the United States.

FRDA has an extensive and successful program devoted to aquaculture. It would be sad indeed if this work led to little fisheries development because of the lack of adequate water quality standards.

Mr. Richard Dewling (1968) made a survey of the effect of pollution on Korea's fishery resources concurrently with our study. We call attention to his report and to his recommendations with which we agree.

Nutrition

Korea is a protein-deficient country; and, as we have mentioned, the knowledge that this problem must be solved is a prime motivation behind the nation's plan to increase fish production. Land sources of animal protein offer little if any hope for significantly augmenting production. The sea, on the other hand, offers a promise of solution over a period of time. But increased fish production must go hand-in-hand with improved marketing and distributing systems, a fact of which the government is well aware.

Daily protein intake during the period 1962-1964 was 53 grams, well short of the standard of 70 or more. Of this only 7.3 grams came from animal sources, about half of it from fish. In the United States, the daily intake of animal protein was 66 grams in 1962; in Japan the same year it was 22 grams, about the generally recommended minimum level. Korea hopes gradually to close the gap to the minimum level through increasing fisheries production. The target for 1971 is 11 grams per capita per day; this is probably realistic but still far short of the optimum.

Dietary needs are discussed in the OFA Five-Year Plan, in the Korean Economic Development Institute's 1967 report, and by Hee Un Chang (1961).

The Need for Fisheries Research

A question raised within and outside of OFA and FRDA was whether the fisheries research program was contributing or could contribute significantly to attainment of the nation's goals in fisheries development. Would the money now being spent on research be better used if it were applied to some other function, considering the relatively limited amount of money available for the whole fisheries development program?

This is a serious question, and one which has been raised in many places at many times. It is easy to understand why government administrators and fisheries businessmen tend to question the value of research. The scientist speaks a different language, and it is difficult for him to communicate with the layman. The work he does may seem tedious, time-consuming, and not leading in any apparent fashion to solution of immediate or even long-range problems.

One thing is certainly true: research usually does not lead to instant answers. It takes time, perhaps many years, to accumulate enough background information upon which to base reliable estimates of resource conditions. It is also true that the fisheries biologist, like any other scientist, is devoted to adding to man's storehouse of knowledge, and he can be diverted by an exciting lead toward a new discovery that may have great scientific interest but be of little practical value in solving management problems.

The laboratory director and his chief scientists must insure that the research being done is appropriate to the organization's goal. It is important to differentiate between mission-oriented and discipline-oriented research. Agencies with management responsibilities usually cannot afford the latter; these are studies undertaken for the sake of adding to knowledge without regard as to whether they now have -- or ever will have -- a "practical" application. Discipline-oriented research is by-and-large the province of the university and the private foundation, but government agencies have a mission and their activities must be aimed at accomplishing it. This is the case with FRDA.

The question remains as to whether even mission-oriented research is a luxury that Korea cannot afford. Our attitude is that the Republic cannot afford not to support it. Marine resources can be managed at their optimal level only on the basis of scientific fact. Many of the answers will be slow in coming but their value in the long run is great. And many studies are of such a nature that their results can be put to use in a short period of time.

It is worth emphasizing that the international community now recognizes that management of high-seas resources must have a scientific foundation. The 1958 Geneva convention on fishery resources now has sufficient adherents to be an instrument of international law. Although Korea has not adhered, it will find that its position in international fisheries negotiations will be weak indeed if this position is not consistent with scientific fact. And it is to Korea's own self-interest to husband its local resources wisely in order to meet the goals it has set with respect to fisheries and the national economy.

We regard appropriately-directed fisheries research as a capital investment the returns from which will ultimately amortize the cost through increased and more efficient fishing operations. A strong, carefully-channelled research program is an essential part of any long-range plan for fisheries development.

THE FISHERIES RESEARCH AND DEVELOPMENT AGENCY

History and Organization

The Fisheries Research and Development Agency (FRDA), under which the Fisheries Resources Section operates, had its beginning in 1921 when a research station was established in Pusan and designated along with the Chinhae Hatchery as the only research institute managed by the government. In 1936 a branch station was established at Chungjin to aid in the development of the sardine resource on the east coast. At the same time, provincial governments operated their own research stations to benefit the development of local fisheries. A second freshwater hatchery was opened during 1942 at Chungpyong.

Before the end of World War II, in 1944-45, the provincial stations were transferred administratively to the institute which took over all research. This institute was named the Central Fisheries Research Station in 1945 and was placed under the Ministry of Agriculture and Forestry. At that time there were five sections: (1) Exploratory fishing; (2) Utilization and Food Technology; (3) Aquaculture; (4) Oceanography and (5) Administration. Between 1949 and 1961 the Central Fisheries Research Station was transferred to the Ministry of Commerce and Industry, to the Office of Marine Affairs, and back to the Ministry of Agriculture and Forestry.

The Fisheries Resources Section and the Cheju Branch Station were added in 1962 during a reorganization of the research station to increase its contribution to the development of the fishing industry. Also in 1962, the six regional branch stations were combined in 3 regional fisheries research stations -- Eastern Sea at Pohang, Western Sea at Kunsan and Southern Sea at Mokpo.

The research institute was designated the Fisheries Research and Development Agency in 1963 at which time a Technical Management Section was added to provide advice, training and guidance to the fisheries industry. Three years later the Fisherman's Training Center was added to the agency. This organization exists at the present time.

The Fisheries Research and Development Agency is under the direction of Mr. Hahn, Shin Wook. He is responsible for the activities of eight sections, the regional and branch stations and ten vessels (Tables 4 and 5). All research is directed toward helping the commercial fishing industry greatly increase its production so that the national goals set by OFA can be met at the end of the Five-Year Plan in 1971. The goals, among others, are to double production and increase exports by several times over that attained in 1965.

Research Vessels

FRDA has a fleet of ten vessels, one of which is laid up for remodelling this year. Six are relatively new steel-hulled craft; four were built in 1967, one in 1965 and one in 1963. They range in length from 18 to 41 meters and in gross tonnage from 75 to 300. The seventh steel-hulled vessel is older, having been constructed in 1937. The three wooden-hulled vessels are smaller (9-13 meters). One was built in 1939, the other two in 1958. The four vessels constructed in 1967 were built in Japan. The rest of the fleet was fabricated in Korean yards. Characteristics of each vessel and a summary of its operational plans for 1968 appear in Table 5.

Five of the vessels, including the inactive Kalmeki (Seagull), are based at Pusan. The Mokpo, Pohang, Cheju and Kunsan regional stations and the Chumumjin branch station each has a vessel assigned to it. Two of the Pusan vessels are used principally by the Fisheries Resources Section, one by Oceanography and one by Exploratory Fishing.

Cruise schedules are set in advance for each calendar year, are adhered to quite closely, and provide for about 200 operational days on a full schedule. Actual days scheduled for the five newest and largest vessels in 1968 ranged from 171 to 235 days.

We saw several of the boats and toured two of the newest ones, the Taebaksan, assigned to the exploratory fishing section, and the Chrisan, assigned to fisheries resources. Both are basically side-trawlers in their design. These are well-equipped with modern navigating, electronic, scientific, and fishing equipment. They are very well kept up and are a credit to the organization.

The Chrisan (named after a mountain) carries a crew of 17 including the master, 3 navigators, 2 radio operators, 3 engineers, 2 oilers, a boatswain, 3 sailors, an electronic technician and a cook. It can accommodate a half-dozen scientists. Its longest cruise so far lasted 3 months; the vessel can stay at sea for a month. The Chrisan usually operates between 30° and 38° N and 123° and 140° E; it has conducted one 2-month saury research cruise off Japan. The vessel is in the shipyard for major overhaul about one month each year, and for temporary maintenance two other times. These stays do not exceed 10 days each. The crew takes care of minor maintenance. As far as we know, the other larger vessels follow this same pattern in crewing and in operation.

Table 4. Organization of FRDA

Shin Wook Han, Director

Sections, Pusan Headquarters	Permanent Staff
Administrative	33
Technical Management	16
Oceanography	33
Fisheries Resources	42
Aquaculture	16
Exploratory Fishing	50
Utilization and Food Technology	18
Fishermen's Training	8
Sub-total	216
Regional Stations	
Eastern Sea, Pohang	23
Chumunjin Branch	9
Western Sea, Kunsan	17
Southern Sea, Mokpo	22
Yosu Branch	6
Cheju Sea	20
Chinhae Fresh-Water Research	10
Chungpyong Branch	7
Sub-total	114
Total Permanent Personnel	330

FRDA Staff by Function

	Number	Percentage
Scientists	136	42
Vessel crews	100	30
Technical assistants	43	13
Administration	27	8
Extension workers	24	7
Total permanent staff	330	100

Table 5. FRDA Research Vessels

Name	Major activity	Home port	Year built hull	Length meters	Gross MT	Cruising speed knots	Scheduled days at sea, 1968	Advance schedule for 1968
Taebaksan	Exploratory	Pusan	1967 steel	41	300	12	205	Six 30-day cruises East China Sea. One 25-day cruise Kurashio current cooperative study.
Chirisan	Marine resources	Pusan	1967 steel	33	150	11.5	171	Three 20-day cruises Korea-Japan joint survey. One 60-day exploratory fishing cruise Japan Sea. One 45-day saury cruise.
Baekdusan	Oceanography	Pusan	1965 steel	33	150	11.5	185	Two 25-day Kuroshio cruises. Two cruises (18 and 20 days) fisheries prediction. Seven oceanographic cruises, 8 to 20 days.
Hanrasan	Regional station	Mokpo	1967 steel	24	80	9	208	One 90-day yellow croaker research cruise. Two Kuroshio current cruises 28-30 days. Two 15-day bottom fish exploratory cruises. Two 15-day oceanographic cruises.
Chounmasan	Regional station	Pohang	1967 steel	24	80	9	235	Two Alaska pollack research cruises, 15 and 30 days. Seven saury and squid research and exploratory cruises, 10 to 25 days. Four 15-day oceanographic cruises.

Source: FRDA

Table 5. (Cont'd)

Name	Major activity	Home port	Year built hull	Length meters	Gross MT	Cruising speed knots	Scheduled days at sea, 1968	Advance schedule for 1968
Pukhansan	Marine resources	Pusan	1937 steel	23½	74½	9	115	Four 15-day off-shore research cruises. One 15-day fishery prediction cruise. One 30-day exploratory trawling cruise. Two 5-day pearl shell cruises (aquaculture section).
Chokyang	Regional station	Cheju	1963 steel	18	75½	9	180	No published schedule Jan.-March. Eight 15-day bongsoo (blanket) net exploratory cruises. Four 15-day oceanographic cruises.
Hwang Kyung	Regional station	Kunsan	1937 wood	13	12½	7	90	No published schedule Jan.-March. Three 15-day shellfish exploratory cruises. Two 15-day crab exploratory cruises. One 15-day saury exploratory cruise.
Donghaeho	Branch station	Chumunjin	1958 wood	12	12	8	60	No published schedule Jan.-May. Four 15-day squid research and exploratory cruises.
Kalmeki	General	Pusan	1958 wood	9	6	5	-	Out of service for remodelling.

Note: When this schedule was devised, FRDA anticipated that the OFA vessel Bukaksan would be transferred to it. This transfer did not take place which required schedule changes for the research fleet. The Bukaksan had been scheduled for 143 operational days in fisheries resources and oceanographic work.

Source: FRDA

Library

The library of FRDA is under the supervision of the Chief, Technical Management Section. The assigned staff includes two permanent and one temporary employees. None of them is a professionally-trained librarian, a deficiency of which FRDA is quite aware. The concensus is that the staff should be enlarged and that it should be headed by a professional, but it has not been possible to obtain the necessary authorization.

The library does not have funds allocated to it for purchases, depending instead upon contributions from the various sections. Library expenditures last year totalled ₩2.3 million; the budget request was for ₩5 million.

The collection includes an estimated 10,000 volumes, mostly Japanese; perhaps 4,000 are in English. A library committee screens requests for purchases. Most foreign publications are received on an exchange basis for the scientific material issued by FRDA, including the Reports of Fisheries Resources and the oceanography and fishery survey data reports.

The foreign exchange list seems reasonably complete. However, there are some publications they should have that are not available on exchange and to which they do not subscribe. An example is "Copeia", the quarterly publication of the Americans Society of Ichthyologists and Herpetologists. The scientific staff was consequently unaware of a recent paper dealing with the classification of mackerel, a subject under study by the Fisheries Resources Section with respect to differentiating Pacific and spotted mackerel.

More serious, we found that publications being sent on exchange frequently do not reach the library, or if they do, are not accessioned or are misfiled. Part of this is caused by the lack of a trained librarian. Another reason is that some material is sent to the attention of the person initially requesting the exchange, and in certain cases this individual has apparently regarded the material as personal. Both the U.S. Bureau of Commercial Fisheries and the California Department of Fish and Game have been sending their scientific publications to FRDA for a number of years, but the library collection contains only broken series of some and none we could find of others.

On the other hand, the FRDA papers are not reaching at least a portion of the exchange addresses abroad. Neither the BCF Seattle laboratory nor the California State Fisheries Laboratory have received

any Korean literature for years even though both appear correctly on the master exchange list and the agency has published rather extensively.

Obviously the library system needs help. At the very least it requires an interested and qualified person assigned to it with authority to reorganize and control its operations. Ideally this person should be a trained librarian, though an administrator or scientist with some familiality with library operations could do the job. The library also needs stronger financial support and should have its own purchasing budget rather than being dependent upon contributions from the sections.

When the library has the qualified leadership it requires it would be extremely valuable to have a professional fisheries librarian from the United States spend a few months at FRDA helping to reorganize the collection and the aquisition and distribution systems. The Government of Mexico used this technique most successfully in 1967, another case in which the fisheries library needed a strong hand to make it productive.

We emphasize the need for a good, well-run library. This is important at any research facility. It is critical in a place like Pusan, isolated as it is geographically from other fisheries institutions and facilities. The relatively small amount of the total budget properly allocated to library operations is repaid many-fold by keeping the scientific staff informed of developments elsewhere. This can save many man-years of effort in studying problems that others have solved.

Finally, the library staff presently assigned is doing the best it can under difficult circumstances. We commend their efforts.

Budget

The Korean fiscal year coincides with the calendar year. Budget preparation on both a program and line item basis commences at FRDA in January of the preceding year, each section preparing its own budget requests for submission to the Director in February. The consolidated FRDA request as approved by the Director goes forward to OFA early in March. After review and approval by OFA, the budget then passes to the Economic Planning Board in April; EPB may in turn modify, cut or augment specific items. The National Assembly receives the budget in November, and normally acts on it by early December, at which time FRDA knows what funds it will have the following year.

Budget controls are strict. The government auditing office conducts a detailed audit each year. Programs and expenditures are subject to constant review by OFA and to internal inspection. Although each technical section chief has full responsibility for expenditures incurred by his section, the Office of Fisheries exerts complete control in planning and programming; it approves each project and its budget and its concurrence is necessary to shift funds to meet unforeseen needs. However, the Director of FRDA has operational control over his sections and can delegate all or part of his responsibilities to subordinate personnel.

In 1968, over 50 per cent of the research funds exclusive of salaries (Table 6) were allocated to the operation of branch stations and research vessels and for the improvement of facilities of FRDA. The Fisheries Resources Section exclusive of prediction services received only about 8 per cent of the total budget. The proposed budget for 1969 shows increases for all items but the largest occurs in the operation of branch stations and research vessels. The increase for the fisheries resources is ₩5.8 million giving it only about 6 per cent of the total 1969 budget.

Meantime oceanography, distant-water explorations, and utilization programs are scheduled for far greater increases than fisheries resources. It seems to us that utilization and food technology is less important at the present time than a knowledge of the factors affecting the availability and abundance of fish stocks. Korea can assimilate increased production with present methods, and the fundamental problem relates to increasing the catch if this can be done without endangering the supply. We also wonder whether the increased distant-water explorations are as vital as an understanding of local conditions. Oceanographic work properly oriented relates directly to fisheries development in conjunction with biological research; the question is not why this activity got more but why fisheries resources got relatively so little.

Table 6. The Budget of the Fisheries Research and Development Agency for Research Operations
(Salaries are not included)

Research item	Tentative budget (FY 69) (₩)	Budget (FY 68) (₩)	Increase (₩)
Oceanography	28,021,000	16,449,500	11,571,500
Fisheries Resources	27,845,700	22,065,800	5,779,900
Fishing Ground Predictions	10,154,300	6,557,400	3,596,900
Aquaculture	30,010,000	24,965,600	5,044,000
Improvements in Fishing Gear and Methods	13,087,700	6,517,400	6,570,300
Exploration of Overseas Fishing Grounds	24,923,500	15,500,800	9,422,700
Utilization and Food Technology	31,011,000	21,325,900	9,685,100
Publications	19,835,000	9,889,900	9,945,100
Branch Stations	94,651,100	36,066,400	58,584,700
Research Vessels	135,444,000	90,296,500	45,147,500
Improvement of Facilities	44,456,000	29,637,500	14,818,500
Total	459,439,300	279,272,700	180,166,600

Approximately ₩275 = $1.00

Source: FRDA

THE FISHERIES RESOURCES SECTION

Organization and Function

The Fisheries Resources Section is responsible for developing the fund of biological knowledge that is required for a rational fisheries management program based on scientific fact. This fund of knowledge must ultimately include a full understanding of the life cycle of each key species, its resilience, its response to measured units of fishing pressure, its impact on its associates in the ecosystem, their impact on it, and the effect of the physical environment on its distribution and survival; all these factors play their role in determining the quantity of fish that can be taken each year without endangering the supply.

This section thus forms the foundation of a research structure such as FRDA. It is under the direction of Mr. Suh, Han Kun, who has been acting chief since spring of this year. His chief assistant is Mr. Park, Byung Ha, senior scientist and scientist-in-charge of the research projects. Both men were promoted to these positions when the former chief, Mr. Kim, Kae Ho left to accept a position with the Deep-Sea Fishing Training Center, a UNDP Special Fund activity in Pusan.

The staff includes 42 permanent employees 22 of whom are fishery scientists (Table 7). Two research vessels, the Chirisan and the Pukhansan are assigned to the section.

Table 7 Organization of the Fisheries Resources Section

Hack Keun Suh, Chief
Byung Ha Park, Chief Scientist

	Total Staff	Fishery Scientists
Administration	3	2
Chief Scientist	1	1
Pelagic Fish Group		
Eggs and Larvae	3	3
Mackerel (3 spp.)	3	2
Anchovy	4	1
Bottomfish Group		
Hairtail, eel and shrimp	4	4
Croaker and sea bream	4	2
Population Dynamics Group		
Fisheries Statistics	8	2
Biological Statistics	6	1
Fisheries Prediction Group	6	4
Total	42	22

The objectives of the section are threefold and involve: (i) Surveys of offshore resources; (ii) surveys under the joint agreement with Japan; and (iii) fisheries prediction and fishing ground surveys. To reach these objectives the section is divided into study groups concerned with pelagic fish, bottom fish, population dynamics and fisheries prediction. In our review we discussed past and present studies and future plans for research with scientists responsible for specific activities. We assessed their work on two points: Is the research scientifically sound? And, how will the results contribute to FRDA objectives?

The operating budget of the section including vessel costs is about 33.6 million won for fiscal year 1968. These funds were distributed as follows:

Offshore resources surveys	----------	₩7.2 million
Korea/Japan joint surveys	----------	7.6 "
Fish prediction	----------	4.9 "
Vessel operations	----------	13.9 "
Total		₩33.6 million

The breakdown is somewhat different from that shown in Table 6; it apparently represents subsequent adjustments. Although the proposed 1969 budget reflects an increased allotment, the section does not anticipate receiving much if anything above the 1968 level.

Pelagic Fish Group

Mackerel

Staff: The mackerel unit has a staff of three, two of whom are fisheries biologists. Both are graduates of Pusan Fisheries College, one in 1964 and the other in 1966.

Species: The term "mackerel" covers two fisheries and three species. The Pacific mackerel (Scomber japonicus) constitutes one fishery that also takes small quantities of spotted mackerel (S. australasicus according to Mitsui, 196[illegible], not S. tapienocephalus as it usually appears). The second fishery is that for jack mackerel (Trachurus japonicus). It is not a true mackerel but a member of the jack family, Carangidae. All three are included in the Korea-Japan Fisheries Agreement.

Fishery: Jack mackerel are widely distributed in the China Sea and they are fished by Japan, Taiwan and Red China as well as by Korea. They are not found off the east coast of Korea. The Korean fishery peaks in the summer with the great bulk of the catch

coming from the Cheju Island area. At one time the fishery extended northward into the Yellow Sea as far as Inchon. Most of the fish are taken with purse seines and most of the catch is landed at Pusan. Stow nets, set nets and gill nets account for the balance of the catch, on the order of five per cent of the total.

There is a major fishing area south of Korea, but Korean vessels do not enter it, presumably because of the distance involved. Japan, Taiwan and Red China all fish extensively there.

Korean landings have fluctuated widely in the period 1956-1967. The catch reached 48,000 metric tons in 1958, but exceeded 30,000 tons in only one other year, 1959. In two years, 1956 and 1966, the catch was only 10,000 tons and in 1967 it dropped to 5,300 tons (Tables 1 and 2). The Japanese catch is far greater, and has increased from 130,000 metric tons in 1956 to 389,000 tons in 1965 (later figures are not available). The increase reflects chiefly the catches made west of 128°E long. This area has produced over half of the total in the last few years; prior to 1958 catches there were negligible (Table 8).

Pacific mackerel are found off the entire coast of Korea, as well as in the China Sea south of Korea and in the Pacific Ocean off Japan. Major fishing grounds lie off Japan and between Japan and Taiwan (Figure 5). Japan, Taiwan and Red China all fish in the latter. The Korean fishery, concentrated around Cheju Island, is essentially a purse seine fishery with the heavist catches in the summer. Spotted mackerel comprise a small percentage of the catch, perhaps as much as five per cent.

The Korean Pacific mackerel catch is at a very low level. Prior to the war, the fishery centered off the northeast coast, but these grounds are lost for the time Landings since have not reached 8,000 metric tons since 1957, when 12,800 tons were landed, a drop from 15,700 tons in 1956. The low years were 1959 and 1961 with less than 2,000 tons; the 1967 catch was only 2,700 tons (Tables 1 and 2).

The Japanese catch in the east China Sea ranged from 40,000 to 80,000 metric tons during this same period and appears to be holding up. About half of the catch has in recent years originated west of 128°E long. In the late 1950's most of the effort was east of this line. Expansion of the fishing grounds may be the best explanation of the relatively stable Japanese catch. The total Japanese catch was about 80,000 metric tons in 1965 (Table 8).

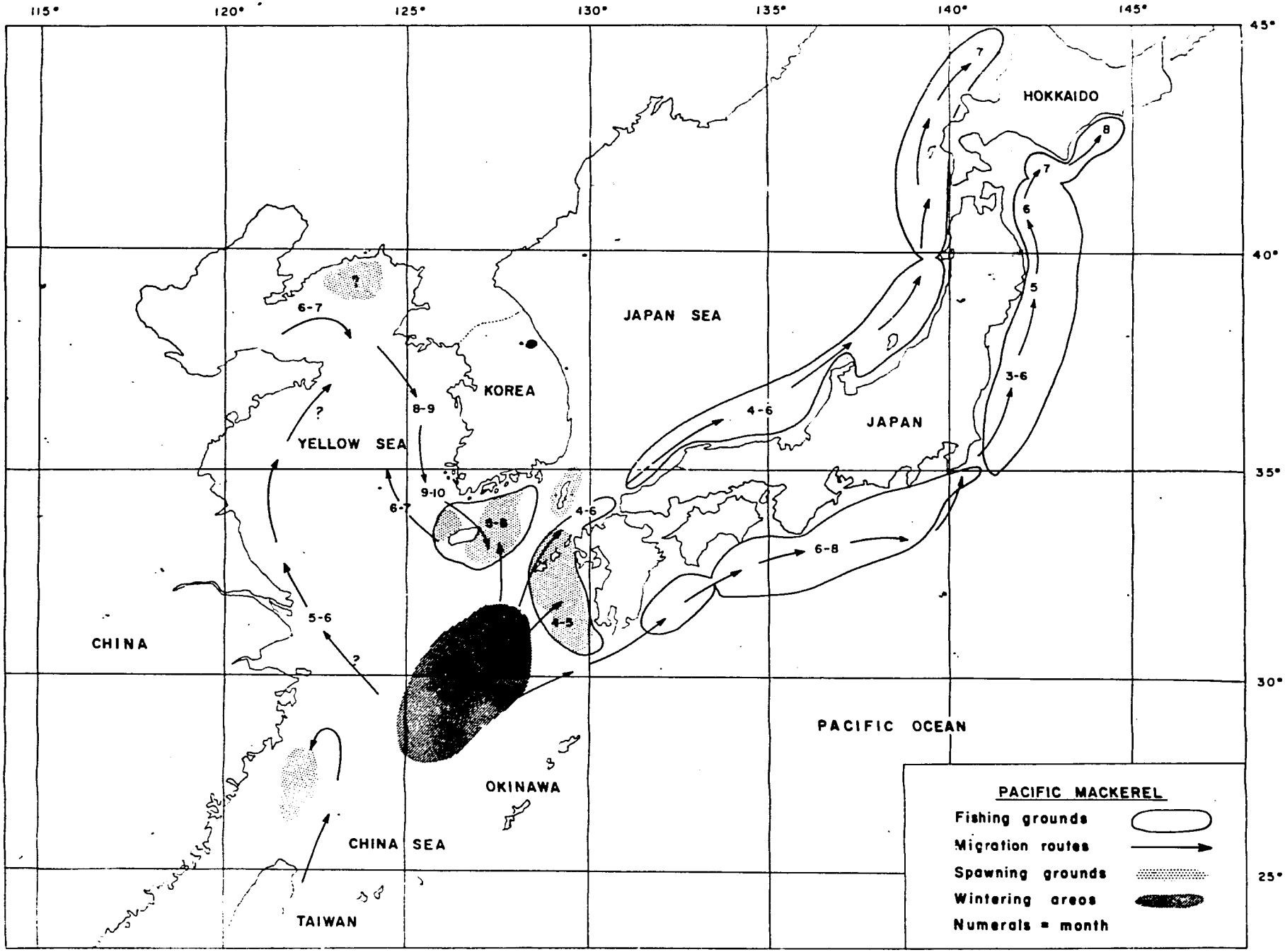

Figure 5 Distribution of Pacific mackerel in the Korea – Japan – Taiwan area.

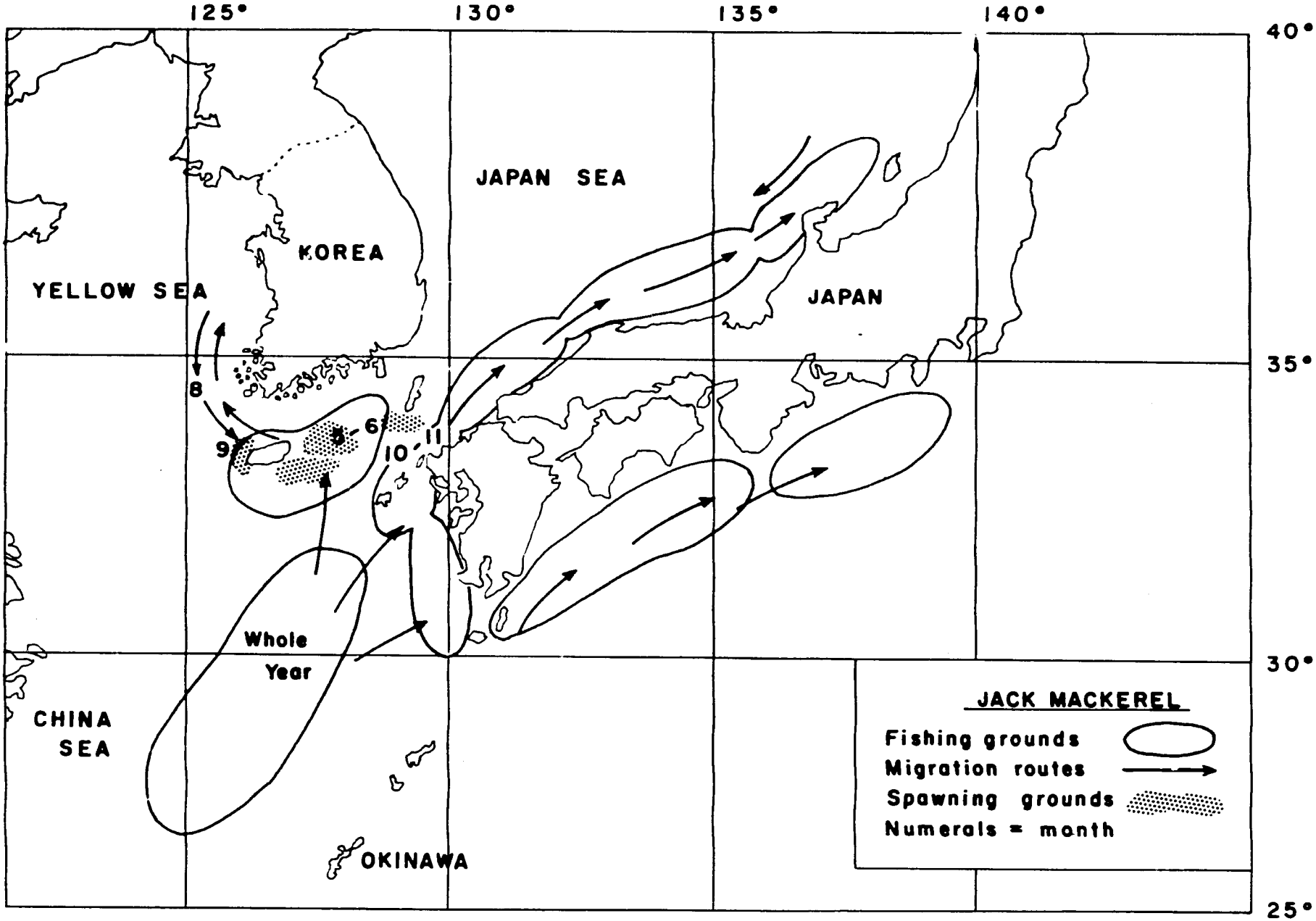

Figure 6 Distribution of Jack Mackerel off Korea and Japan

Catch Statistics: Japanese catch and effort data are available to Korea through the Korea-Japan Agreement. No information is received from Taiwan or, of course, from Red China and North Korea.

Biological data, jack mackerel: Fish appear off the south coast of Korea in the early summer (Figure 6), at which time they are in spawning condition. Eggs and larvae have been collected in the Cheju Island area and south of Tsushima Island, Japan. These fish move up the western Yellow Sea and are off Inchon in August. They move back south in the late summer and fall and are near Cheju in November.

What is believed to be a separate stock spawns midway between Korea and Taiwan in January. The two stocks are thought to mix off South Korea. The southern population seems to be decreasing in abundance, the northern increasing.

Jacks generally occur in cooler water than do Pacifics. Japanese data indicate the greatest concentrations in the China Sea are along the 200-meter contour.

Biological data, Pacific mackerel: Pacific occur in all the waters around Korea. They spawn in June and July, near Cheju Island, and in the vicinity of Tsushima Island, Japan. According to early records, spawning also occurs in the northern portion of the Yellow Sea. The fish are found in the western Yellow Sea south of Inchon from July to October. They move up the west coast at the same time and are north of the 38th parallel in July and August. During the winter, mackerel tend to concentrate south of Korea roughly between 30° and 32°N lat.

The Korean and Japanese scientists postulate three subpopulations; the Korean, one off the east coast of Japan, and the third between Japan and Taiwan. The Japanese have tagged fish in the latter two areas, which represent major fishing grounds. There have been local recaptures but none indicating movement from one area to the other. This has led to the working hypothesis that the two fisheries are exploiting separate stocks and to the feeling that the Korean stock is independent of both.

Research Program: Both the Pacific and jack mackerel programs call for studies in these areas now and for at least the near future.

1. Collection of fishery and biological data.

2. Determination of how the fish are recruited to the south coast area; migratory routes require delineation. They hope to resolve the problem through tagging, egg and larvae surveys and fishery studies.

Table 8 The Japanese Purse Seine Mackerel Catch, 1955-1965 in Metric Tons

Year	Total Catch All Areas		East China Sea, (East of 128°E)				East China Sea, (West of 128°E)			
	Pacific	Jack	Pacific	Per cent of total	Jack	Per cent of total	Pacific	Per cent of total	Jack	Per cent of total
1955	81,255	114,791	22,550	27.75	57,170	49.80	473	0.58	1,125	0.98
1956	47,400	130,346	17,728	37.40	78,321	60.09	79	0.17	386	0.30
1957	58,256	124,658	42,226	72.48	83,603	67.07	409	0.70	994	0.80
1958	40,617	138,120	28,014	68.97	82,570	59.78	6,172	15.20	9,723	7.04
1959	64,544	199,497	29,877	46.29	92,411	46.33	24,631	38.16	44,687	22.40
1960	62,669	320,712	25,803	41.17	116,837	36.43	23,041	36.75	107,053	33.38
1961	61,033	304,063	28,290	46.35	121,762	40.04	15,727	25.77	111,072	36.53
1962	73,575	316,006	28,372	38.56	115,894	36.67	9,410	12.79	126,178	29.93
1963	65,575	237,523	24,771	37.38	57,775	24.32	25,159	38.37	135,503	57.05
1964	49,249	349,264	11,369	23.08	68,519	19.62	28,603	58.08	196,291	56.20
1965	79,343	389,378	36,098	45.50	105,571	27.11	39,810	50.17	257,153	66.03

Source: FRDA.

3. Delineation of subpopulations through morphometric and meristic work; they now have one man trained in genetic techniques, and hope to send another to the United States later this year.

4. Age studies; they presently use both scales and otoliths and will select one as a standard technique as soon as their evaluation of the two methods is complete.

5. Determination of the role of environmental factors with respect to fluctuations in abundance.

6. Determination of the relationship, competitive and otherwise, between the two species.

Fish samples and catch statistics are obtained by the sampling team which services all Pusan fishery investigations. Egg and larva samples are collected monthly at standard stations off the south coast as part of the routine oceanographic and biological surveys.

A variety of measurements and counts are taken in an attempt to resolve the subpopulation problem. Among those now recorded routinely are total length, fork length, body weight, body height, head length and number of anal rays.

The current tagging program instituted in 1966 has as its goal for 1968 the release of 5,000 fish with emphasis on jacks. They are tagging purse-seine caught fish in the Cheju Island area. The tag is one used on tuna--plastic tubing with a large double-barbed head. The tag is larger than the one now being used on tuna by U.S. investigators in the eastern Pacific but is the only one available to FRDA. We suspect that tagging mortality is high in view of the method of capture and the size of the tag, but no estimates of tagging mortality and tag loss are available nor do they envision a program to measure these factors. Recoveries are dependent on detecting tagged fish in the market. In view of handling methods in the Pusan market, it appears that the chances of detection are poor though FRDA gives a reward -- an inscribed towel -- which would provide incentive to workers to turn in the tags. Last year there were only three recoveries from about 1,300 Pacifics tagged. The hope is ultimately to define migratory routes and to estimate the size of the population off southern Korea.

Work with catch-per-unit effort data is just starting; data are available only since 1966. The unit of effort is the successful set.

The staff puts a good deal of effort into separating spotted mackerel in the samples. While some specimens are obvious, others

can be identified with certainty only by counting the number of interneurals. This requires laborious dissection and processing and raises the question as to whether it is worth the time and effort since spotted mackerel comprise only a small fraction of the total catch.

Comments: The basic program appears sound scientifically, but it is an extremely ambitious undertaking for a staff of three. Pacific mackerel are really a minor fishery in Korea, and jack mackerel have ranked well behind anchovies, yellow croaker and hairtail in the last few years. The Japanese catch data do indicate that Korea could increase its catch of both species by extending its fishing operations farther south. If Korea does not do so, or plan to do so, the research effort directed toward Pacifics particularly seems disproportionate for a relatively minor fishery.

Studies of interspecific relationships are limited to the mackerels themselves. They might profitably be broadened to cover relationships with other possible competitors under a program designed to measure interspecific competition at all stages of the life cycle. Any such study lies well in the future.

The staff did not have available to it many publications on the Pacific mackerel of the United States west coast. There are many parallels between these two stocks, and knowledge of what has been learned elsewhere could save Korean scientists a great deal of time and effort.

Anchovy

Staff: Four people are assigned to the anchovy program, one of them a scientist. He, Mr. Bong An Kim, has been studying genetics in France, and returned during our stay in Pusan.

Fishery: The anchovy catch has been Korea's largest in terms of tonnage since 1965. Landings have increased steadily since 1956, from 29,000 metric tons that year to 78,500 in 1967 (Tables 1 and 2). The fishery is prosecuted by set nets, gill nets and anchovy drag nets These latter, patterned after the Japanese gear, can be used only from July to December, and the number of units is limited. Set nets operate largely during the same period. Gill nets are used during the fall, winter and early spring but not during the summer because very small fish of the year are dominant at that time. Most of the catch is made off the south coast.

We suspect, from discussions with people outside of OFA, that the actual catch is appreciably greater than the recorded. It

seems that large quantities are sold outside of the official marketing system and do not appear in the official statistics.

The substantial Japanese anchovy fishery takes the same species, but anchovies are not included in the Korea-Japan Fisheries Agreement

Biological Knowledge: Anchovies occur in all of Korea's coastal waters and spawn particularly in the inshore waters of the southern coast during the late spring and summer (Figure 7). Park and Lim (1965) have published a paper concerning anchovy ecology on the south coast. The fish are believed to be quite short-lived; large quantities of tiny fish of the year are taken during the summer

Whether the Japanese and Korean inshore fisheries are exploiting a common stock remains to be determined. The feeling prevails that separate stocks exist because of their tendency to concentrate inshore for spawning, but studies of migration and stock composition still lie ahead.

There is some informal interchange of data with Japan at the scientific level even though the species is not covered by the joint fisheries agreement. We believe it would be extremely useful to Korea and Japan to have a more closely integrated program with special respect to stock identification.

Research Program: Because of the absence of the only scientist assigned to anchovy, the project has been relatively inactive recently. The technicians have been processing samples collected at Pohang, Pusan, Yosu and Cheju to obtain length and weight data and vertebral counts. These latter are used in subpopulation studies These studies will now be expanded to cover genetics, Mr. Kim's field of study in France. He will also work on jack mackerel genetics. Age and growth studies will continue. Scales have proved difficult to read and otoliths have not (or are not) being used. Growth data are being obtained by following the incoming year classes that, as we have said, are fished at an extremely small size. The problem of stock differentiation between Korea and Japan remains to be undertaken; work now projected is largely concerned with anchovies in Korea waters.

Comments: It seems to us that the anchovy resource may be one with considerable potential for development that should be explored. Experience elsewhere in the world is that anchovies can support extensive fisheries. Peru is of course the prime example. California and Baja California, Mexico, share a population, now virtually unfished, with a standing stock on the order of five ...

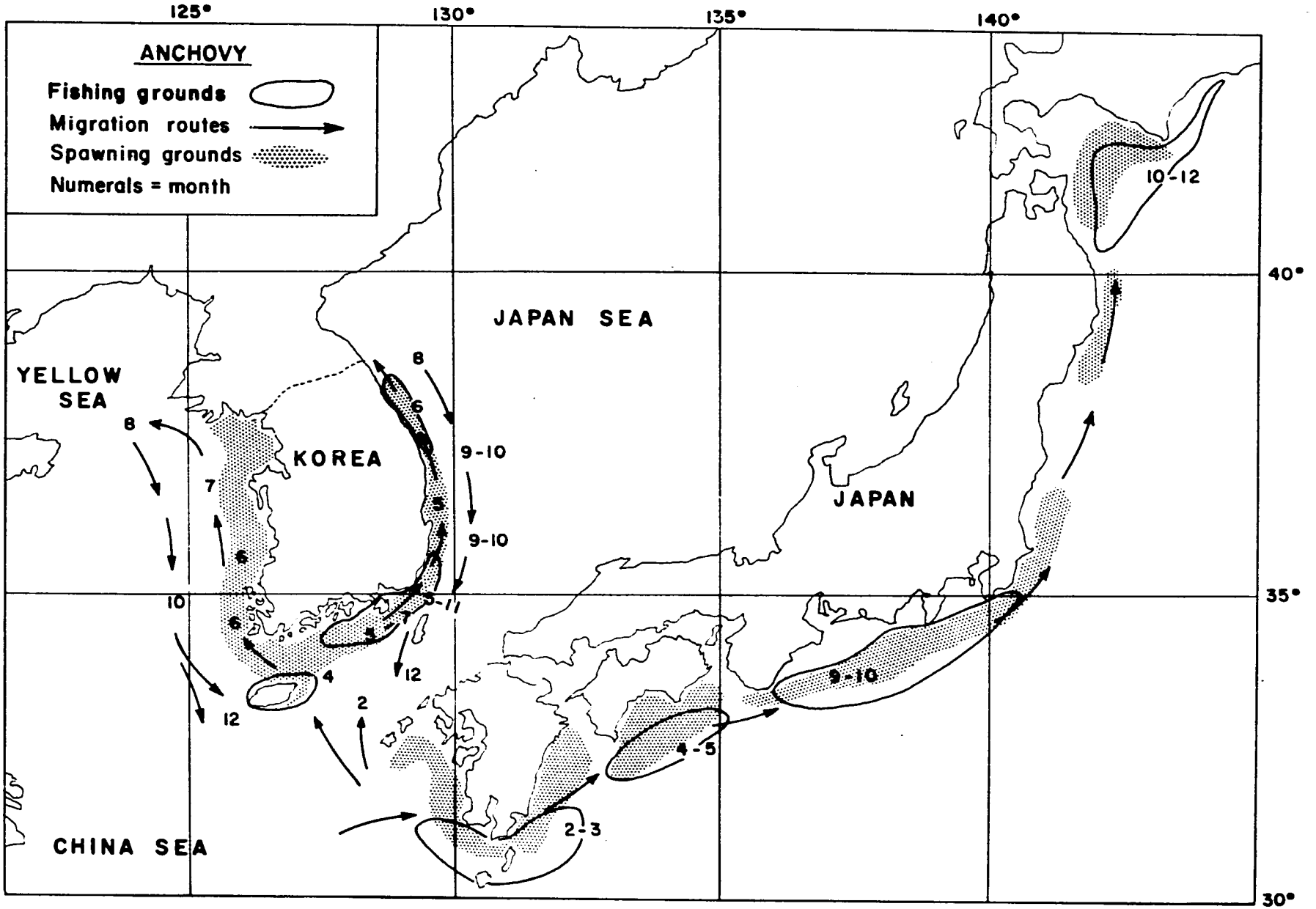

Figure 7 Distribution of anchovies off Korea and Japan

million tons. This population appears to have filled the ecological niche once occupied by the sardine, now at an extremely low level because of overfishing coupled with a series of years of poor spawning success. The South African anchovy population also appears to be rising as sardines become less abundant there. It may well be that Korea and Japan share a resource with great potential. A fully productive investigation requires, however, cooperative research by the two countries, and this is not provided for at present.

Some of the people with whom we talked have reservations about developing the anchovy resource even if it can withstand a higher rate of exploitation. Their fear is that a reduction in the anchovy population would have an adverse effect on valuable predator fishes by cutting their food supply. This is exactly the same fear that has so far prevented any substantial growth of the California anchovy industry despite scientific evidence that a substantial harvestable surplus exists over and above the dietary needs of predators. The factor cannot be ignored, but neither should it be allowed to hinder the acquisition of scientific knowledge and, if the evidence is favorable, the orderly development of a carefully managed fishery.

Eggs and Larvae

This unit has a staff of three, all biologists and all graduates of Pusan Fisheries College. It was organized in 1964 and conducted special sardine studies that year and in 1965. Since 1966, it has occupied the standard station pattern also utilized by the Oceanographic Section (Figure 14). The egg and larva unit conducts its surveys in the odd-numbered months, the oceanographic stations in even-numbered. The same data are collected on all cruises so for practical purposes there is monthly coverage. All eggs and larvae are processed by the egg and larva unit, all physical oceanographic observations and other plankton by the Oceanography Section. However, there is no interchange of personnel on cruises; oceanographers do not participate in egg and larva cruises and vice versa.

The unit is engaged at this time in identifying the material, and in further development of collecting devices. Specific tasks of the unit are to (i) delineate the distribution of eggs and larvae for all species possible, (ii) delineate spawning grounds and nursery areas (iii) delineate spawning seasons, (iv) correlate occurrence with temperature and salinity, and (v) ultimately attempt to measure population size from quantitative data.

In 1966, material was collected at 810 stations, in 1967, at 685. At present, they can identify the eggs of 14 species and the larvae of 48. Large numbers of eggs and many larvae cannot yet be identified. They use two types of collecting gear: A net with a 45-cm diameter opening hauled vertically and a 1.3-m diameter net equipped with a flow meter for oblique hauls. This net is the same as is used by Japan.

The work now under way is regarded as preliminary. They plan to get into the field of population estimation in 1969, emphasizing studies of Pacific mackerel, jack mackerel, anchovy, and yellow croaker. Egg and larva data are published in annual reports.

A problem we see with respect to this unit is one of general organization, a subject on which we shall comment later in the report. For the moment, we point out that egg and larva work is separate from the Oceanography Section. Further the unit is under pelagic fish within Fisheries Resources even though yellow corvina (bottomfish unit) studies are to be emphasized in the future, and bottomfish as well as pelagic fish eggs and larvae are to be identified.

The studies could be enhanced by sending an appropriate scientist to the United States to work with groups using egg and larva surveys as a tool for estimating population size. The U.S. Bureau of Commercial Fisheries has an extremely successful project as part of the California Cooperative Oceanic Fisheries Investigations Program.

Bottomfish Group

The Bottomfish Group is investigating yellow croaker or corvina (Psueduscianena manchurica), hairtail (Trichiurus lepturus), and Korean shrimp (Panaeus orientalis). Other fish for which the group in responsible includes the sharptoothed eel (Muraenos cinerius), white croaker (Argyrosomus argentatus) and the red sea bream (Pagrus major).

Yellow Croaker

Staff: Studies on this species are supervised by Mr. Choo, Woo Il, a 1966 graduate of Seoul University in biology. He is assisted by two technicians who are high school graduates, one of whom majored in fisheries biology.

Fishery: The yellow croaker is a major fishery ranking second to anchovy since 1965. The landings decreased to a low of about 21,000 metric tons in 1962 but when the number of boats and gear

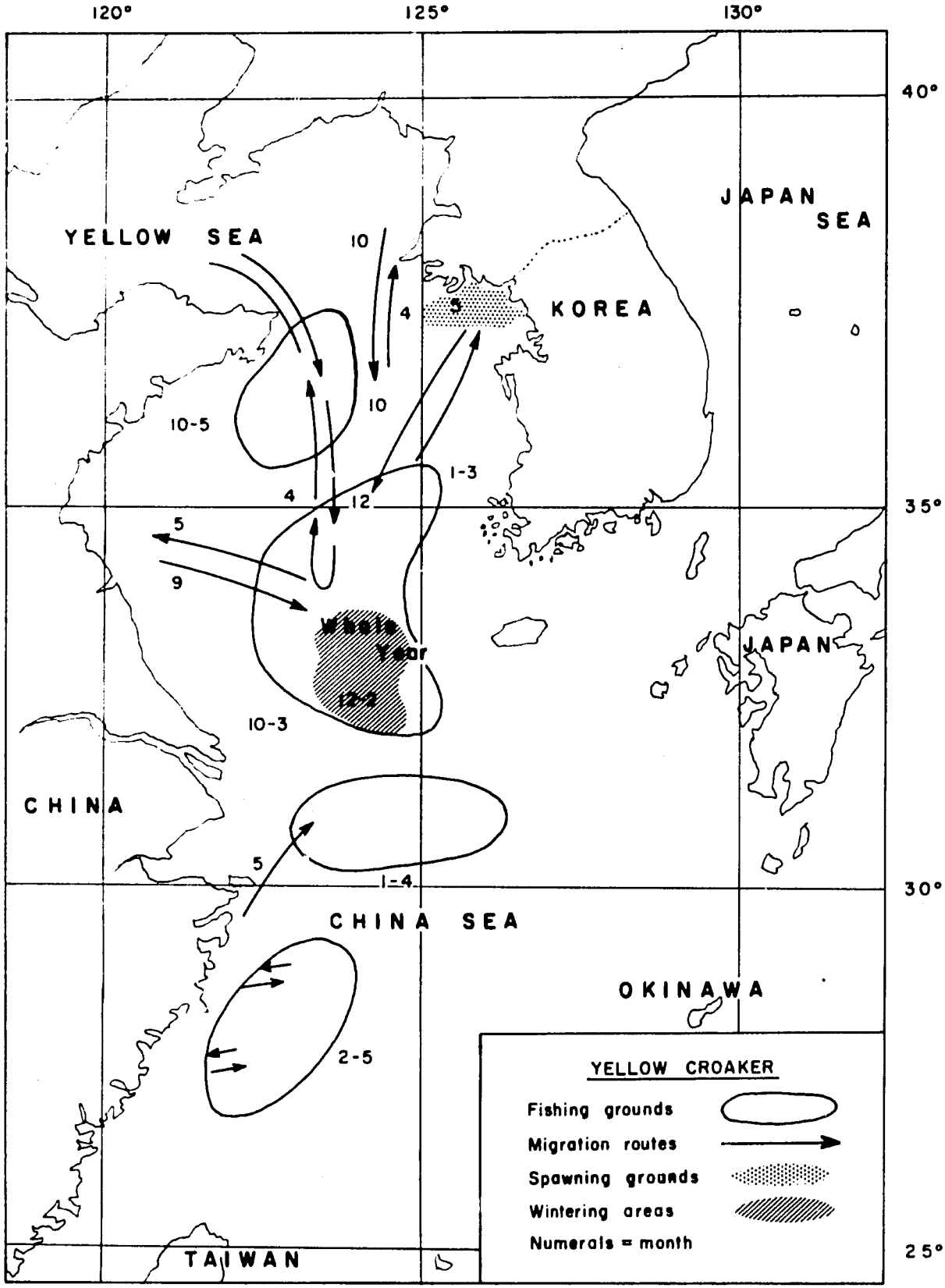

Figure 8 Distribution of yellow croaker (corvina) in the China and Yellow Seas.

increased the landings reached about 57,000 metric tons in 1967. Most of these fish are caught by stow net in relatively shallow water and by trawls in deeper water. They are fished throughout the year but peak landings are made from April to June when over 50 percent of the annual catch is made; over 25 percent is caught in May. The stock exploited by the Republic of Korea is also fished by Japan.

Biological Knowledge: There are believed to be four stocks of yellow croaker in the Yellow and East China Seas (Figure 8). There may be some mixing of the Korean and West Yellow Sea stocks but a cold water barrier along 125°E longitude tends to keep the Korean stock separated from the others.

From December to February the Korean stock is found southwest of Cheju Island but early in the year the fish begin migrating northward. By May they are concentrated near the DMZ for spawning. In June they move into deeper water and start a southward migration in July. It is interesting to note that while in the DMZ area the stock is subject to a North Korean fishery the extent of which is not known.

Research Program: Research on this fish began in 1966 to obtain data to exchange with Japan in accordance with the Korea-Japan Fisheries Agreement. Fish samples of small, medium and large size are obtained from fishing ports twice each month (total about 100 fish) to obtain data on length weight and age. At the same time, other data, collected for use in differentiating stocks or sub-species, include head length, body height, snout to first dorsal, snout to pectoral, eye diameter, sex, maturity, number of eggs, and egg diameter. Starting this year parasites found on yellow croaker are being collected and identified. The staff plans to collect these data until 1970 and use them to define sub-populations, expand knowledge on age, growth, maturity and reproduction, and estimate the size of the population; they also hope to develop a suitable tagging method.

Comments: The collection and processing of these data is time consuming and prompts the question of whether it is practical for such a small staff to delve deeply into the biology of the yellow croaker. This might be accomplished by graduate students at Pusan Fisheries College under staff supervision and allow scientists to emphasize the definition of sub-populations and estimation of population size; these are of utmost importance in the management of the fishery.

There is the question of whether or not morphometric and meristic measurements are providing the necessary data for separating stocks. There are other methods such as genetic studies that might be more productive.

Hairtail

Staff: Mr. Kim, Bong Yul and Mr. Yoo, Sung Hae are assigned to the study of the hairtail. Both are graduates of Pusan Fisheries College.

Fishery: The landings of hairtail were second in importance to anchovy until 1966 when yellow croaker assumed that position. The landings have fluctuated since 1956 but in 1967 nearly 48,000 metric tons were landed in Korea. Most fish are caught in set nets but stow nets and trawls are used to a great extent. Some fish are taken by angling, purse seine and traps. The fishing season extends from April through October while they are migrating to or from their spawning area. Of the total catch of hairtail, it is estimated that the Republic of Korea obtains about ten percent; the remainder is taken by Red China, Taiwan, North Korea and Japan. Some estimates of catch by Red China are obtained from the Japanese Embassy located in that country but there is little information of landings by Taiwan or North Korea.

Biological Knowledge: The hairtail is distributed throughout the Yellow and East China Seas (Figure 9). There are two concentrations of fish in the winter months southwest of Korea, one off Cheju Island and one further south near Taiwan. Some migrate northward early in the year but others are thought to move southward toward Taiwan at depths of 60 to 100 meters. Spawning is suspected to occur near the coast of Red China; from inspection of gonads this appears to take place in July and August.

Research Program: As with other species, part of the studies are directed toward obtaining data to exchange with Japan. Samples of fish from the local market are brought to the laboratory and the necessary information obtained on length, weight and age, etc. Age is determined from otoliths but this is difficult because of the small and indistinct rings. Ages determined from otoliths by Japanese and Korean scientists are only in 70 percent agreement so studies are in progress to narrow this gap.

Basic life history studies are in progress to learn more about age, growth, maturity and reproduction. This is important but there is some question of whether scientists of the research station should be undertaking this activity. Because of the small staff, these studies dilute efforts in a more practical direction.

Morphometric and meristic measurements and counts may point the way to separation of stocks of hairtail. It is important to determine if the stock fished by Korea is separate from those exploited by other countries. If separate, a management program

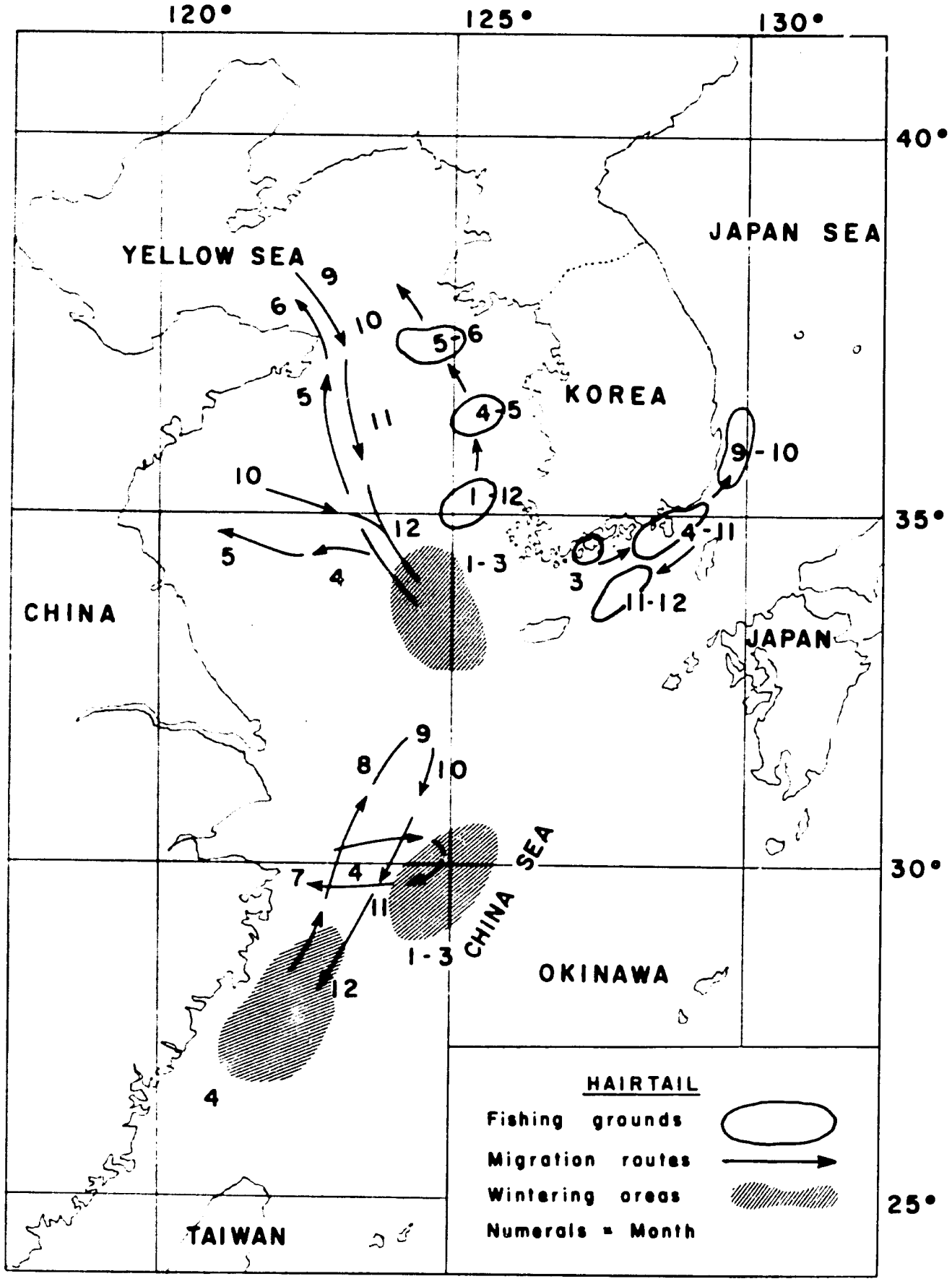

Figure 9 Distribution of hairtail in the Chino, yellow and Japan seas.

for proper utilization can be established. On the other hand, if stocks mingle freely throughout the Yellow and East China Seas, then a different philosophy of exploiting the hairtail seems appropriate.

The staff is also investigating different methods for catching hairtail in suitable condition for tagging. Now, most fish when captured are either dead or in too poor shape for tagging. When this is accomplished the unit will be well on its way to define migration patterns and timing.

Comments: Although the small staff is making good headway on a difficult problem, the final results may have little meaning as far as managing the resource is concerned. This is an international fishery that can be only controlled through international agreements unless there are in fact separate stocks. Since Red China and North Korea are involved, agreements seem unlikely. If the results of racial studies indicate a common population, it would be more meaningful to apply the efforts of this staff to a fishery for which rational management practices can be established.

Korean Shrimp

Staff: Mr. Park, Cha Soo, a recent graduate of Pusan Fisheries College is the sole investigator of Korean shrimp.

Fishery: This is not a major fishery at the present time but it appears to have a good potential. Shrimp are caught by trammel net and stow net in shallow water and by shrimp trawl in deeper waters. Peak catches occur in the spring as adults move inshore and again the fall when young shrimp move to their wintering area.

Biological Knowledge: The Korean shrimp are found only in the Yellow and East China Seas. They migrate shoreward in the spring to spawn in one of three areas; two are in the Republic of Korea in the vicinity of Inchon and Kunsan and the third is off the coast of Manchuria and North Korea. Spawning occurs in May and June. The adults spawn in shallow water after which they move offshore and die. The young, which migrate seaward from June to December, are associated with water temperature of 11° to 12°C. In the fall months they grow 20 to 30 cm carapace length in a three-month period but little growth is evident from November on.

Figure 10 shows the distribution of this shrimps as well as that of two other species (genus Pandalus) that are fished on the east coast. The latter are not under biological study at the present time, though they have been in the past. The fisheries statistics unit is keeping complete enumeration data on the Pandalus fishery.

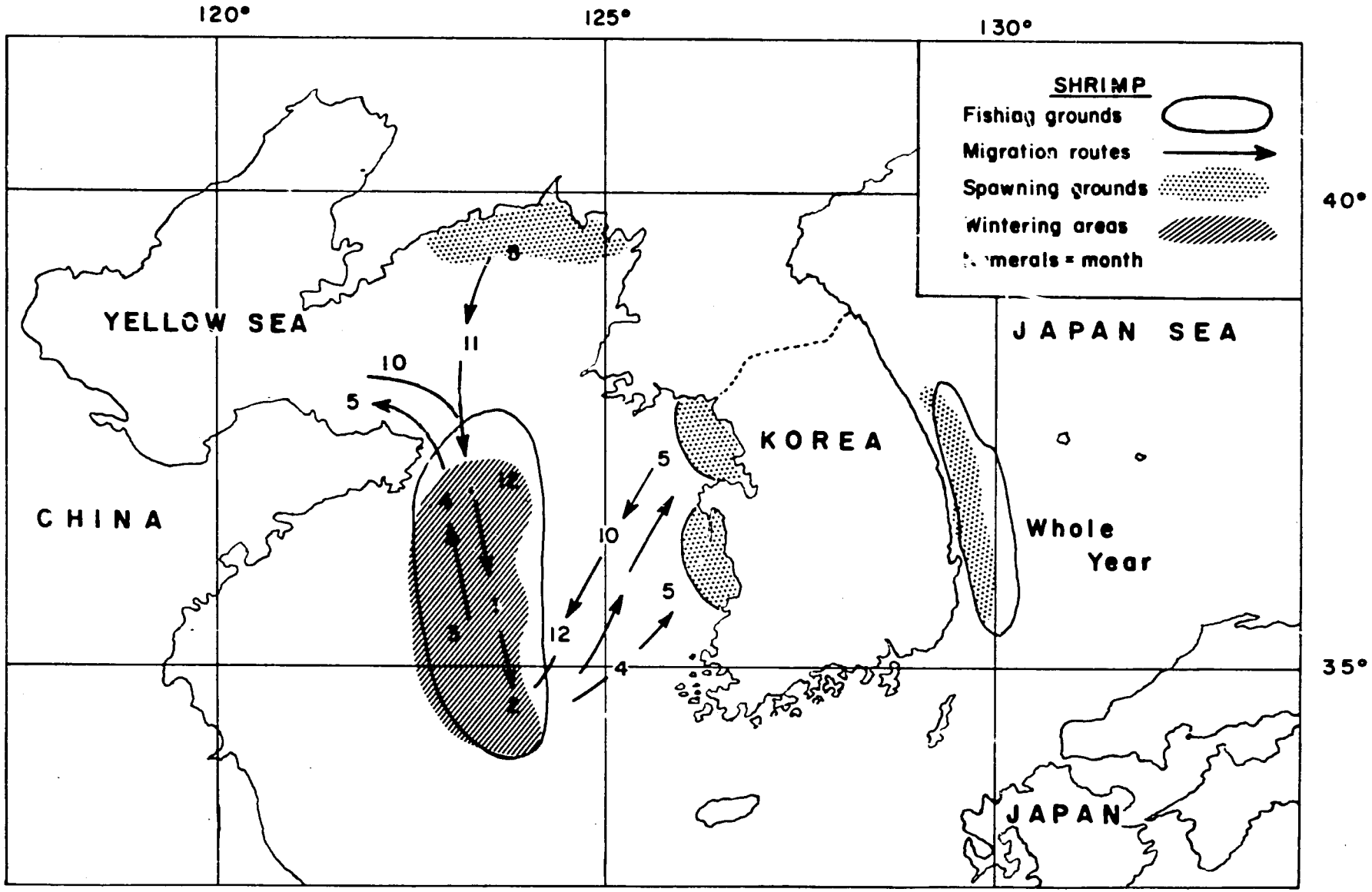

Figure 10 Distribution of Korean, pink and humpback shrimp in waters adjacent to Korea.
Korean shrimp are in the Yellow Sea only;
Pink and Humpback in the Japan Sea only.

Research Program: Research activities began in 1966 to supply data for the Korea-Japan Fisheries Agreement. A tagging program of young shrimp to determine migration patterns and define sub-populations showed that they move seaward in a southwesterly direction, to their wintering area. Japan is also tagging shrimp in the western Yellow Sea for similar information. These programs will continue for another three years.

Studies are underway to determine what relationship exists between environmental factors (temperature, salinity, bottom characteristics) and fluctuation in abundance of year classes. This may help in making forecasts for commercial fishermen but it is of questionable value because this shrimp is subject to an international fishery.

Comments: It would seem that landings of Korean shrimp could be significantly increased by concentrating on the adults in the spring after they spawn and move seaward to die. But, before the fishing pressure can be increased on young shrimp migrating to their wintering ground or mature shrimp moving inshore to spawn it is necessary to determine if the stock is from that fished by China. With this information a practical program for harvesting this species may be established. It is unlikely that a one-man staff will make much of an inroad in answering the question. The importance of this shrimp domestically and internationally, however, suggests that more research effort on this species would be desirable.

Other Species

The sharp toothed eel (Figure 11), white croaker and the red sea breem (Figure 12) are not being actively studied. However they are species that are listed under the Korea-Japan Fisheries Agreement and to fulfil the obligations for exchanging data, information on length age and weight are being collected. Apparently these fish are not considered to be of particular commercial importance at this time.

Comments

The bottom fish group seems to be filling the objectives of the fishery resources section in providing data in accordance with the Korea-Japan Fisheries Agreement. Personnel are efficiently and capably gathering the required information and presenting it in acceptable form. However, it would be desirable to examine the sampling system in detail to determine if technicians could do this without the participation of scientist in charge and if changes would produce the necessary data with less effort. This would allow the scientist to devote more attention to deferentiating stocks and to estimating the size of standing stocks.

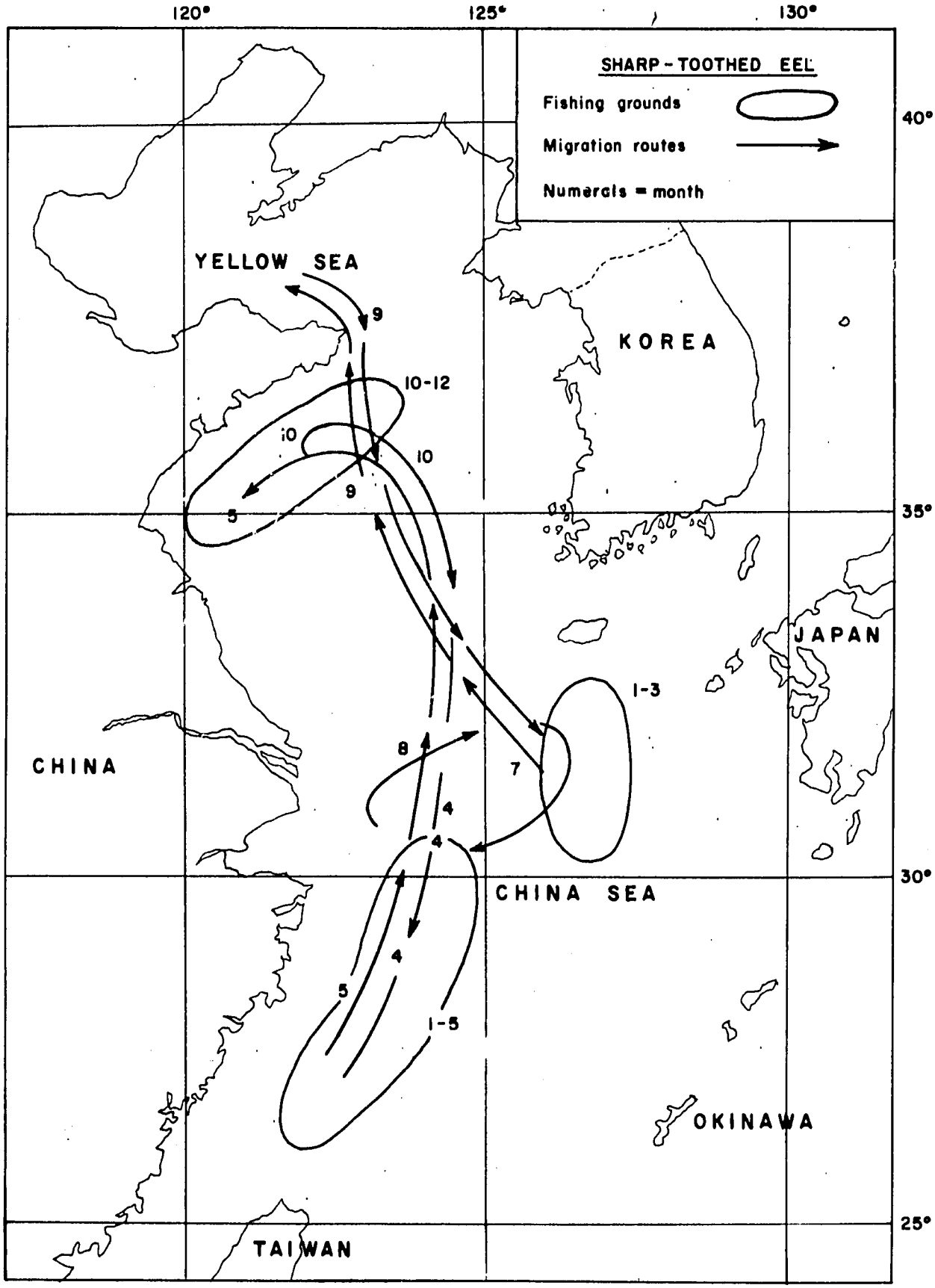

Figure 11 Distribution of sharptoothed eel in the China and Yellow Seas.

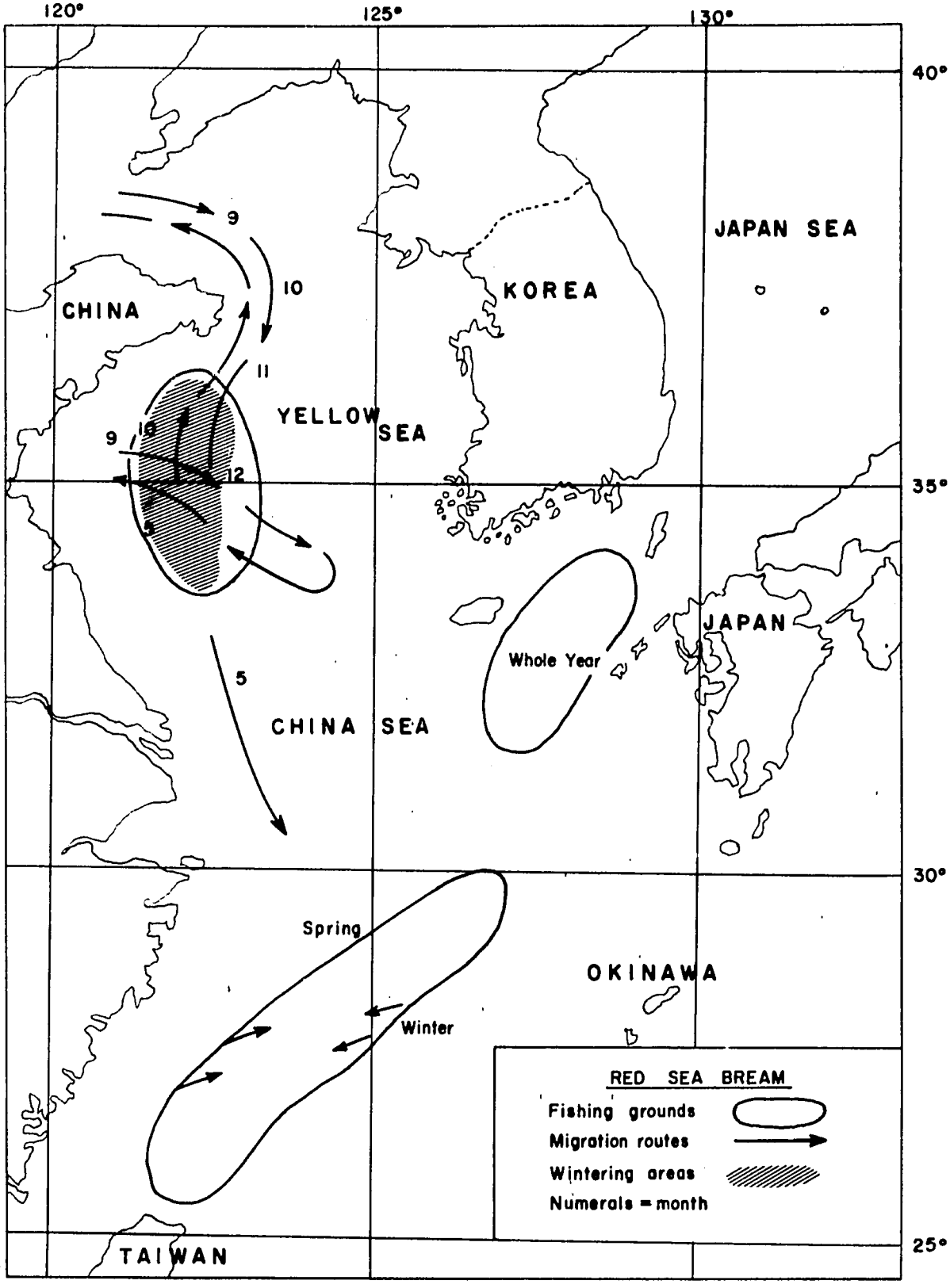

Figure 12 Distribution of red sea bream (porgy) in the China and Yellow seas.

Estimation of the standing stock, survival and maximum sustained yield, is essential as soon as possible for properly managing this valuable fishery. It may be possible to increase the fishing pressure and thus contribute to the production goal of the five-year plan outlined by OFA. On the other hand, if there is evidence that stocks of fish are declining, then immediate management techniques should be initiated to preserve the population An in-depth analysis of the morphological data being collected should be done to determine if they are providing useful information. It may be possible to concentrate on a few measurements and cut down sampling time. If there are no clues that these data are productive, immediate steps should be taken in another direction such as genetic studies using eye lens proteins or serology. This may require special studies in the United States under the AID participant program.

It seems that considerable effort is being expended on fisheries which are subject to international exploitation. Unless international agreements can be formulated for joint management for these fish, research is unlikely to produce practical information. Under these conditions it would prove more valuable in the long-run to concentrate studies on manageable fisheries and develop an economically feasible plan to develop and manage such fisheries to obtain a maximum sustained yield.

Fisheries Prediction Group

The group has a staff of six, four of whom are fisheries biologists. Its task is to intergrate fishery, biological and oceanographic information, and based upon this compedium to predict when, where and in what quantity the principal species will occur. The estimates have been good so far as time and place are concerned, but the unit feels it needs far more data input before it can predict abundance with any reliability.

Prediction reports are issued weekly, monthly and quarterly by the group. It also issues a special mackerel prediction in May and two special yellow croaker predictions; the first appears toward the end of March and the second in mid-April.

The regional stations issue corollary predictions covering their areas of responsibility as follows: Eastern Sea Station (Pohang), 30 weekly predictions during the main local fishing season plus special predictions on squid and saury; Chumungin Branch, 30 weekly predictions; Western Sea Station (Kunsan), 30 weekly and one special yellow croaker predictions; Southern Sea Station (Mokpo), 30 weekly and two yellow croaker predictions.

The group is concerned chiefly with one general and six specific fisheries; trawling, squid angling, Alaska pollack (long line, gill net, trawl), saury drift net, anchovy gill net and drag net, mackerel purse seine, and yellow croaker stow and gill net.

The objective is to get the information to the fishermen as quickly as possible. The publications we have mentioned are issued in a timely fashion and reach the fishermen through OFA and fishing organizations. FRDA also makes good use of public information media, newspapers, radio and television, and appears to get good coverage. Boats at sea receive the forecasts by radio. The Central Federation of Fisheries Cooperatives transmits the reports by radio to its branch office which in turn pass the information to the fishing villages.

The group has a paper in preparation that will present all available data on the yellow croaker and its response to environmental factors It covers the period 1962-1967 and will hopefully be published late in 1968.

We heard nothing but praise for the work of this group from sources outside of FRDA. It is apparently providing a real and valuable service to the fishing industry, which looks forward to the day when the predictions are even more complete and cover abundance as well as time and place.

The success of this group emphasizes the need for sound biological and oceanographic programs, for the predictions are no better than the scientific knowledge upon which they are based. This same success reflects most favorably upon the quality of the work being done elsewhere in Fisheries Resources and in Oceanography.

Population Dynamics Group

This group is responsible for collection of fishery and biological statistics for FRDA. Fishery statistics personnel collect complete enumeration data on catches of three fisheries and sample ten fisheries; these data are used to calculate the catch per unit of effort, estimate population size and ultimately to determine the maximum sustainable yield. The biological statistics unit uses these data plus other vital measurements which they collect for length-age composition studies and measures of survival.

Two entirely separate channels exist though which catch statistics are obtained. One channel is followed by OFA, which publishes the official record of fisheries production for the Republic of Korea. The other channel, followed by the fishery

statistics unit, provides information on effort and precise locality of the catch; this information is not available from OFA. The method used by OFA is as follows:

1. For all fisheries except inshore shellfish and seaweed.

   a. The presidents of the local cooperatives compile catch records for their areas of responsibility.

   b. These are transmitted to the local mayor or gun (county) chief.

   c. The mayor or gun chief submits a consolidated report to the provincial governor.

   d. The governor reports the total catch of the province to the Administrator of OFA.

   e. OFA compiles the nationwide figures.

2. For shellfish and seaweeds.

   Data are first compiled by the chiefs of the many small fishing villages. They then follow the same channel as above. Reports are made monthly and cover catch by gear and species.

Fishery Statistics

This unit collects detailed statistics on gear, species and effort for selected fisheries. Complete enumeration data and sampling data are compiled by field inspection teams which report to the responsible field station which in turn submits consolidated records to FRDA at Pusan for compilation. The station at Pusan has its own team which reports direct.

Field work is done by 40 men who gather information from 27 ports; four are assigned to each of the major ports and one at minor ports. These inspectors are assigned and are controlled outside of Pusan by branch stations; in Pusan they are connected with the research station. All inspectors are either high school or junior college graduates; they receive in-service training before commencing their activities and attend yearly training sessions. As an added insurance for accuracy a permanent scientist makes spot checks of their work and provides special training when necessary.

Complete enumeration data are obtained for the following fisheries:

1. Trawl, subdivided by type of operation (one or two boats) and size (greater than 50 gross metric tons and 30-50 gross tons) at 13 ports on all coasts.

2. Purse seine at five ports on the south coast.

3. Shrimp trawl, 30-100 gross tons, (this is the Pandalus fishery on the east coast only) at six east coast ports.

The ports covered include all those at which vessels with this gear can deliver.

These data are obtained from daily logs of fishing vessels and by interviewing the captains. Since 1966, the captains have been required by law and keep daily logs on forms provided by the FRDA for Danish seine, purse seine, shrimp trawl and whaling vessels. These logs show location and duration of fishing, catch by species, and other data on the vessel and the fishing trip. The data for the purse seine, trawl and shrimp trawl fisheries are estimated by FRDA to be at least 80 percent correct.

The standard block area system for reporting fish catches appears in Figure 13. The blocks, which are 30' on a side, are further divided into 9 sub-blocks each 10' on a side (Figure 13).

Sampling data are compiled for ten fisheries during the peak of the fishing season. Although not as reliable as complete enumeration, they do produce worthwhile data. These fisheries are:

1. Stow nets at three ports (Inchon, Kunsan, Inchon) on the west coast from April through June and October through December.

2. Spanish mackerel gill net at three south coast ports (Yosu and two islands) in May and June.

3. Non-powered trawlers at two south coast ports from October through March.

4. Croaker dip net at three west coast ports in April and May.

5. Mackerel drift nets (commencing in 1969) during August and September in the Mokpo area.

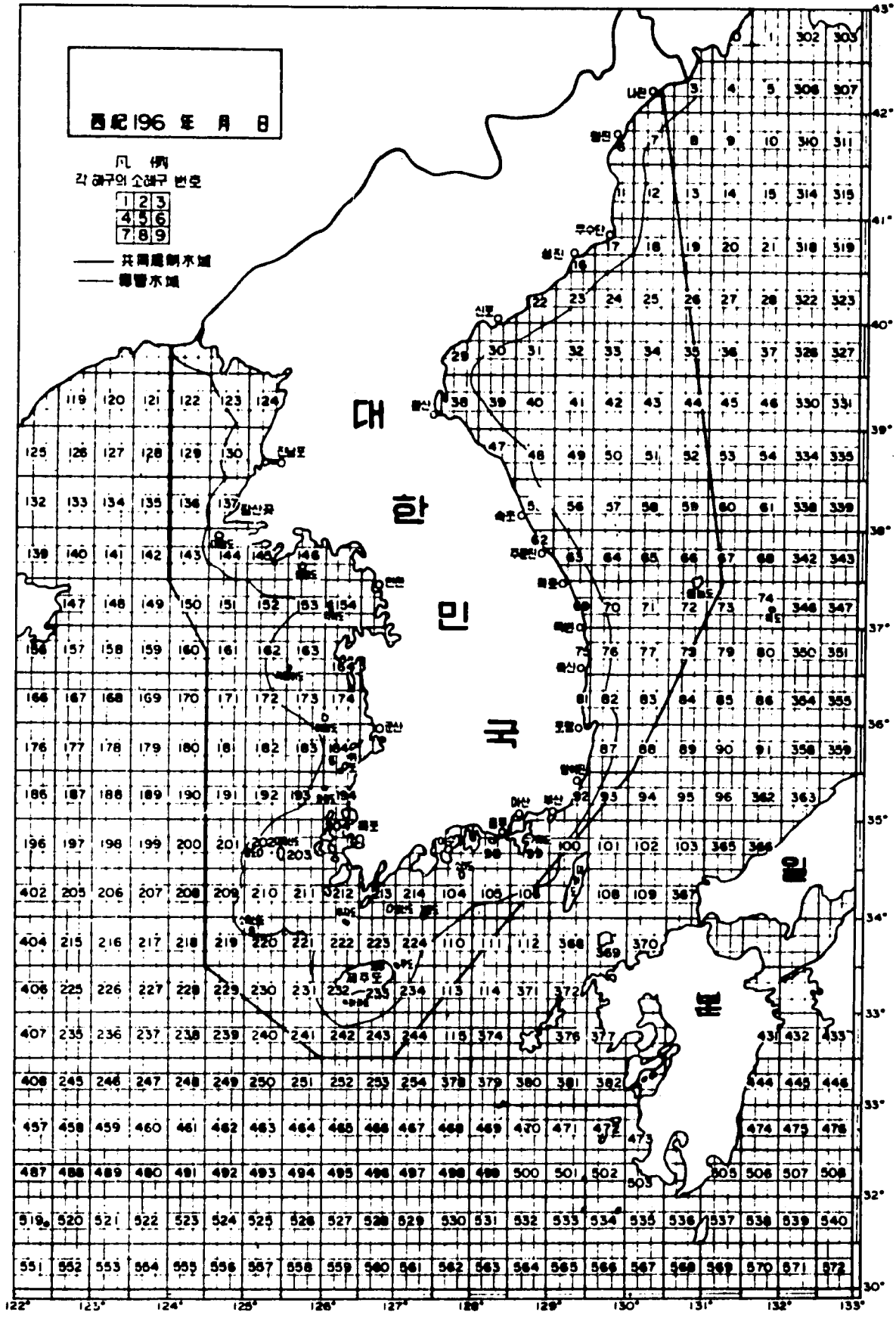

Figure 13. Fisheries statistics block area chart.

6. Squid angling at eight east coast ports south to Pusan from July to December.

7. Alaska pollack gill nets at four east coast ports from November through March.

8. Alaska pollack longlines, same four ports, same time.

9. Saury drift nets at eight east coast ports south to Pusan, March-June and September-December.

10. Anchovy drag net starting in 1969, Pusan to Yosu.

Biological Statistics

The biologic statistical unit develops age-length composition data collected by the fishery statistics unit that are applied to CPUE data for measures of survival. Vital statistics are being collected for 17 species or species groups in eight ports (Table 9).

Table 9 Biological Sampling by Port

Port	Species
Inchon	Cod, yellow croaker, white croaker, hairtail, Red sea bream,eel, sole, shrimp (west coast)
Kunsan	Cod, yellow croaker, hairtail
Mokpo	Yellow croaker, jack mackerel
Yosu	Sole, yellow croaker, red sea bream, hairtail
Cheju	Yellow sea bream
Pusan	Sole, cod, yellow croaker, white croaker, hairtail, red sea bream, eel, shrimp, jack mackerel, Pacific mackerel, yellow sea bream, sea bass
Pohang	Saury, cod, pollack
Chumunchin	Saury, pollack, squid

Biological Sampling System

Biological field samples are collected by the same group that handles fisheries statistics. Two men are responsible for the collection of catch samples in Pusan. They take three samples of 100 fish each month for each of the principal species under investigation, obtaining information as to origin and gear or the same time. The sampling plan is established in advance for all species. The fish are sorted according to size in the market boxes and the samplers take random sub-samples from each size category. Samples are obtained in other major ports in a similar manner. Some routine measurements are made in the market but some of the samples are processed in the laboratory to obtain otoliths, interneural spine sections, stomachs, gonads, and morphometric data.

At present the biological statistics unit has complete data only since mid-1966 and they are not sufficient for analyses of stock condition; data collected previously are not reliable. However, the unit has developed models of age-length composition of the catch of some species and will develop more when age determination of other species become more accurate. Conventional analyses of stock condition using this information in conjunction with catch and effort data must await the accumulation of data over a sufficient period of years. The staff has computed, however, the rate of decline from year class to year class based on 1966-1967 age composition data.

Comments:

The fishery statistics unit, supervised by Mr. Lee, Kon Hee, and the biological statistics unit, under Mr. Jung, Sung Chul, appear to be fulfilling their mission under the Fisheries Resources Section. The technicians in both units appear to be well trained and capable but their efforts are being hampered by the lack of automatic calculating equipment. Although they are at present keeping abreast with computations of incoming data, it will become more difficult if not impossible to do so with increased volumes of data in the future. It would seem politic to obtain more calculators immediately and start planning on the use of electronic computors in the future.

The population dynamics group is light on biometricians. In view of such an important mission, the group should have more scientists well trained in analytical techniques including electronic computation. This would allow the staff more time to aid other groups in the section, devise sampling techniques, analyze data and to put more effort on determining size of fish populations and maximum sustained yield. Additional training of

these scientists is advisable so they can carry out their own duties more effectively and counsel other scientists in the section on sampling techniques.

Data analysis is beset by several problems that FRDA recognizes. Hahn, Jae Yoon, in a report prepared for a Bangkok meeting in June 1968, pointed out (i) the lack of sophisticated data processing equipment, (ii) the shortage of trained statisticians and (iii) the need for improved working conditions for statistical workers.

There are some disadvantages in the FRDA system which are worthwhile to note. The inspectors are non-professionals, their pay scale is low and at times they must work elsewhere to maintain a suitable standard of living. The checking system is not consistent because scientists find it difficult to leave their own work especially in peak fishing seasons so some inspectors may work for long periods without supervision.

The catch statistics of OFA, which are considered official for the Republic of Korea, may not be consistent with the figures compiled and reported by the Population Dynamics Group. There appears to be no system of checking the accuracy of the data compiled below the provincial level. If certain annual increases in catch which is called for in the OFA five-year plan are not actually obtained, the catch statistics may be altered to reflect the desired result. Furthermore, some fishermen by-pass official marketing procedures and sell their fish directly to buyers. Although this action is unlawful the practice is difficult to control since there few enforcement vessels, a long coast line and many islands. There is no way to determine the effect of the interaction of these factors on official OFA catch statistics.

OTHER FRDA SECTIONS

Oceanography Section

The mission of this section is to gather and analyze oceanographic data so that they may be used in conjunction with fishery and other biological data in estimating stock distribution and abundance and in measuring the impact of fishing and environmental factors on the stock. It is active in the fields of physical, chemical and biological oceanography, does some marine geological work and is anxious to increase its endeavors in meteorology. One of its major activities is a study of the Kuroshio Current, a cooperative research venture with Japan.

The section, under the direction of Mr. Hee Soo Han, has a permanent staff of 20, excluding research vessel crews. Scientists number 15, all but two graduated from Pusan Fisheries College. A chemist is a graduate of Pusan University and a meteorologist of Seoul University. The current operating budget is ₩17 million for the Section plus ₩10 million for vessel operations (salaries not included).

The Pusan-based R/V Baekdusan is assigned to the Section. It is one of FRDA's largest craft (33m long, 150 gross tons) and is quite new, being built in 1965. Other vessels assigned to the Pohang, Cheju and Mokpo branch stations carry out portions of the routine oceanographic surveys in their areas. (Research vessel characteristics and 1968 operational plans are detailed in Table 5.)

Besides the Kuroshiro Current cooperative cruises that are conducted in February and August, the section makes four other comprehensive surveys, these in April, June, October and December. The four research vessels occupy all of the station positions indicated in the master station plan (Figure 14) on each of these six cruises. (We understand that the northernmost east coast line is omitted by both the oceanography and egg and larva cruises because of its proximity to the communist-controlled area).

The section made a benthic survey to 1,000 meters from Pusan to Pohang in 1967. This year the survey is covering the area between Pohang and Chukpyan. They are collecting core and dredge samples.

Data obtained routinely during the oceanographic surveys include measurements of temperature, salinity, phosphate, nitrate, silicate and pH plus meteorological observations. Plankton tows

are made at each station, with the section processing all material collected except fish eggs and larvae. These are turned over to the Fisheries Resources Section. The section is working on problems of primary productivity, using chlorophyll-a and carbon-14 techniques.

The section hopes to cover meteorology in a more comprehensive fashion in the future. They feel a need for an oceanographic research institute and have recommended that one be established. They believe that the establishment of an oceanography department at Seoul National University this year will be a great help in providing trained oceanographers, now in very short supply.

The section analyzes its data rapidly so that they are available to the forecasting group in Fisheries Resources with minimal delay. It issues comprehensive data reports annually; that for 1966 was published in December 1967.

Besides wishing to expand its meteorological work, the section would like to make monthly rather than bi-monthly sea surveys. As we have noted, Fisheries Resources makes the same observations at the same stations in alternate months. Coverage is thus nominally complete, though organizationally the system leaves something to be desired.

The section wishes to get more deeply into studies of primary productivity, and hopes to send a staff member to the United States this year for training in this field. The payoff in terms of practical application to the nation's fishery development program seems rather remote, if experience in the United States is any criterion.

Exploratory Fishing Section

This section is concerned with both exploratory fishing and gear development, and its work is complementary to that of the Fisheries Resources and Oceanography Sections. The shoreside staff totals 30, of whom 20 are scientifically-trained college graduates. Most are from Pusan Fisheries College where they specialized in fishery oceanography, boat design or marine engineering. The remaining ten are high school graduates with 3-year's training in a fishing operations course offered by certain high schools.

The R/V Taebaksan with a crew of 20 is assigned to the section. This is one of FRDA's newest (1967) and its largest and fastest vessel (41 meters overall, 300 gross tons, 12-knot cruising speed).

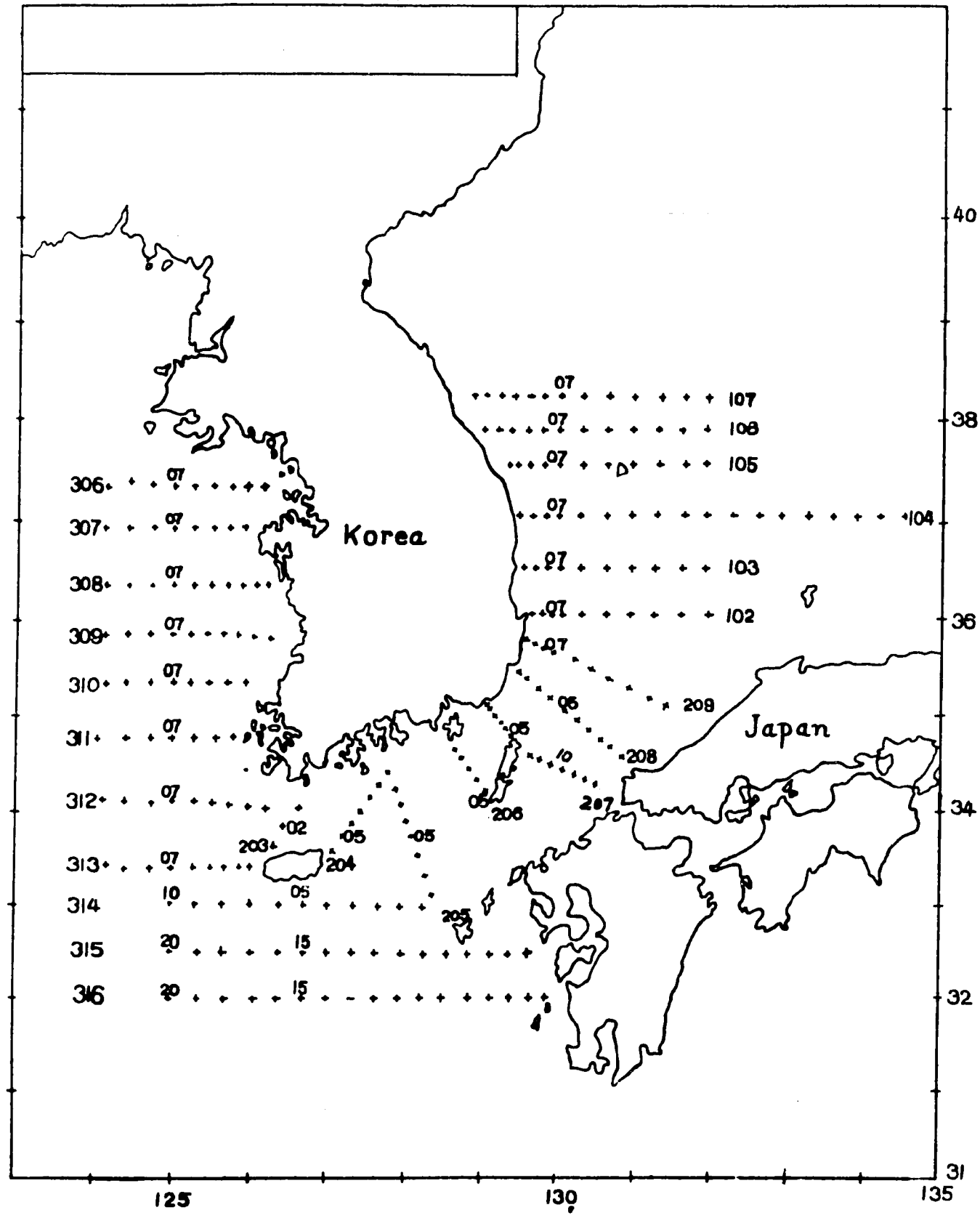

Figure 14. Master oceanographic station plan.

The operating budget of the section, excluding vessel costs, is ₩21 million for 1968. It has requested ₩38 million for both 1969 and 1970.

Two major activities comprise the program: (i) the development of gear and fishing techniques and (ii) exploratory deep-sea fishing.

The gear and technology unit is the smaller of the two, with an operating budget of ₩5 million for 1968. It is (i) testing materials, (ii) working on fishing boat design and construction using fibreglass, (iii) studying east coast saury fishing methods, (iv) studying east coast squid fishing gear, (v) working on west coast crab gear, and (vi) working on the development of lobster fishing grounds and gear at Cheju Island. Some of this work is done in conjunction with the branch stations. It has issued two volumes of a manual of fishing vessels and gear and is completing the third volume.

The work is thus directed toward studies that lead to immediate practical results for the fishermen. Coupled with the generally longer-range programs in oceanography and fisheries, it should make a substantial contribution to local fisheries development over a period of years.

The deep-sea exploratory fishing unit is considerably larger, with a 1968 operating budget of about ₩15 million. Most of the additional funds requested for 1969 and 1970 will go toward its support and expansion directed largely toward distant-water fisheries that are not under investigation by the Fisheries Resources Section. It has already conducted tuna and billfish surveys in the Samoan area and hopes to do similar work in the Indian Ocean next year. It has plans as well for bottomfish surveys in the western North Pacific.

Closer to home, it is conducting a series of five benthic surveys in the East China Sea, two of which have been completed. These are basically exploratory fishing cruises, but they are occupying hydrographic stations, collecting plankton samples, and mapping the bottom topography as well. The unit has recently finished a salmon exploratory gill-netting cruise in the Japan Sea during which it also collected oceanographic data. The cruise extended as far as Hokkaido Island, Japan. Apparently fish were most abundant on Yamoto Bank (approximately 39°N, 135°E).

The cruise objectives and plans are coordinated with Oceanography and Fisheries Resources, and these sections send staff members on appropriate cruises.

Aquaculture Section

This section with a staff of 16 is concerned with (i) shellfish culture, including pearl oyster, oyster seed production, abalone and other molluses, (ii) crustacea culture including lobster, shrimp and crab, (iii) seaweed culture, especially dulse, laver, and agar, and (iv) finfish culture, especially puffer, plus ancillary tasks such as managing the aquarium.

Its work is rather peripheral to our primary task and we did not study the program in depth because of time limitations. The section appears to be doing sound scientific work leading toward increased coastal production, but its staff is very small. The results so far are being put to practical use in the fishing community, and one provincial fisheries officer with whom we talked was especially complimentary and appreciative of the program.

Utilization and Food Technology Section

This section lay outside our purview, but was of especial concern to Mr. Richard Dewling in his concurrent study of pollution problems.

Fisheries Training Center

The center offers basic courses in fishing methods, utilization and aquaculture and more advanced training in exploratory fishing techniques and engineering. It is concerned chiefly with local fishing operations. It complements the program offered by the Deep-Sea Fishing Training Center, a UN Special Fund project, that trains men as captains and chief engineers especially for the distant-water fleet.

Both centers are doing a good job. However, there appears to be little or no contact between them even though the UN center is next door to FRDA. At a minimum there should be informal contact and cooperation in order that each organization can benefit from the work of the other.

Technical Management Section

The function of this section is to offer guidance services to fishing villages, to provide a technical information service, and to run the library.

The library, for reasons beyond the section's control, needs immediate and drastic remedial action to make it productive. We have commented in detail on this subject in an earlier part of this report.

FRDA REGIONAL STATIONS

General

FRDA operates four regional stations, two branch stations, and a fresh-water research station and its branch. The regional stations conduct studies of local fisheries, provide local prediction services and carry out, with research vessels assigned to them, a portion of the standard oceanographic surveys. The fresh-water station is concerned chiefly with developing fish culture techniques.

We visited two of the four regional stations and the fresh-water station, but were not able to see the others because of time limitations.

Eastern Sea Regional Station, Pohang

The Eastern Sea Station, established in 1923 by Japan, is under the direction (acting) of Mr. Kong, Yong who graduated from Pusan Fisheries College in 1961 and received a masters degree in 1963; he majored in oceanography. He is assisted by [illegible], Mr. Chung, Hyun Kyu who graduated from the same school in 1961 after majoring in food processing. Together they are supervising the activities of 10 scientists, 18 technicians and the research vessel Chounmasan. The objectives of this station are (1) to disseminate information on fishing techniques, (2) to provide information for fisheries prediction to help reach national production goals and (3) to promote the income of fishermen by providing technical information on inshore fisheries. Their activities span all of the research sections of FRDA.

To provide information for the Fisheries Resources and Oceanography Sections, oceanographic surveys are made at specific intervals covering a portion of the standard station pattern to obtain physical data and plankton samples. Surveys are also made of offshore marine resources, especially saury and squid, and fishery and biological statistics are gathered from local fishing areas. The major fisheries in the area are for squid, saury, cod and pollack. (Figures 15-18) All pertinent information is radioed to FRDA in Pusan where it is analyzed and issued by the fisheries prediction group. The Pohang Station itself issues 30 weekly fishing forecasts each year plus special squid and saury forecasts.

Research on fishing techniques is concentrated on anchovy and squid. They are attempting to develop a method of catching uninjured anchovies for tuna bait by the use of lights and blanket

nets that are used by Japanese fisherman. The staff is also testing an automatic method of catching squid; this gear which was developed by Japan allows one fisherman to fish four lines of tackle instead of only one. The results so far are very satisfactory.

To improve fishermen's incomes this station is working on the culture of dulse which has a good potential as a product for export. They have set up an exhibition ground to demonstrate culture by a hanging method. In practice, a fishing village could be made self-sustaining by this method.

The R/V Chounmasan is based at Pohang. It is one of the four vessels built in Japan in 1967, is 24 meters long and is rated at 80 gross metric tons. It is engaged in Alaska pollack, saury and squid research and occupies a portion of the oceanographic station grid four times a year.

Cheju Sea Regional Station

This station, located at Sogwipo on the South Coast of Cheju Island, is under the direction of Mr. Park, Kyum Hoe, a very able man with many years of experience especially in shrimp research at FRDA, Pusan. The building is new (built in 1966), modern and well-equipped. The staff, which numbers 20, includes 8 scientists and excludes the crew of the research vessel Chokyang that is based at Sogwipo.

The Chokyang is a modern vessel of 75 gross tons built in 1963. It is 18 meters long and has a cruising speed of 9 knots. It occupies the standard oceanographic stations near Cheju as part of the routine nation-wide coverage. It has scheduled eight 15-day cruises for 1968 to run experiments with the bongsoo net, essentially a blanket net that is used in Japan and China to catch anchovies, which are known to occur near Cheju but are lightly fished.

Ashore, work is centered on lobster, abalone and seaweed. The lobster program is especially interesting. Until recent years people were generally unaware that the resource existed. Local fishermen caught a few, but discarded them as worthless. Then someone recognized their potential value especially as an export item, and a fishery developed at the west end of the island. The Branch Station in conjunction with the Provincial Fisheries Officer is now exploring the rest of the island and has found harvestable quantities in several locations. They are also working on gear development and in interesting the local, essentially conservative, fishermen in branching out into something new.

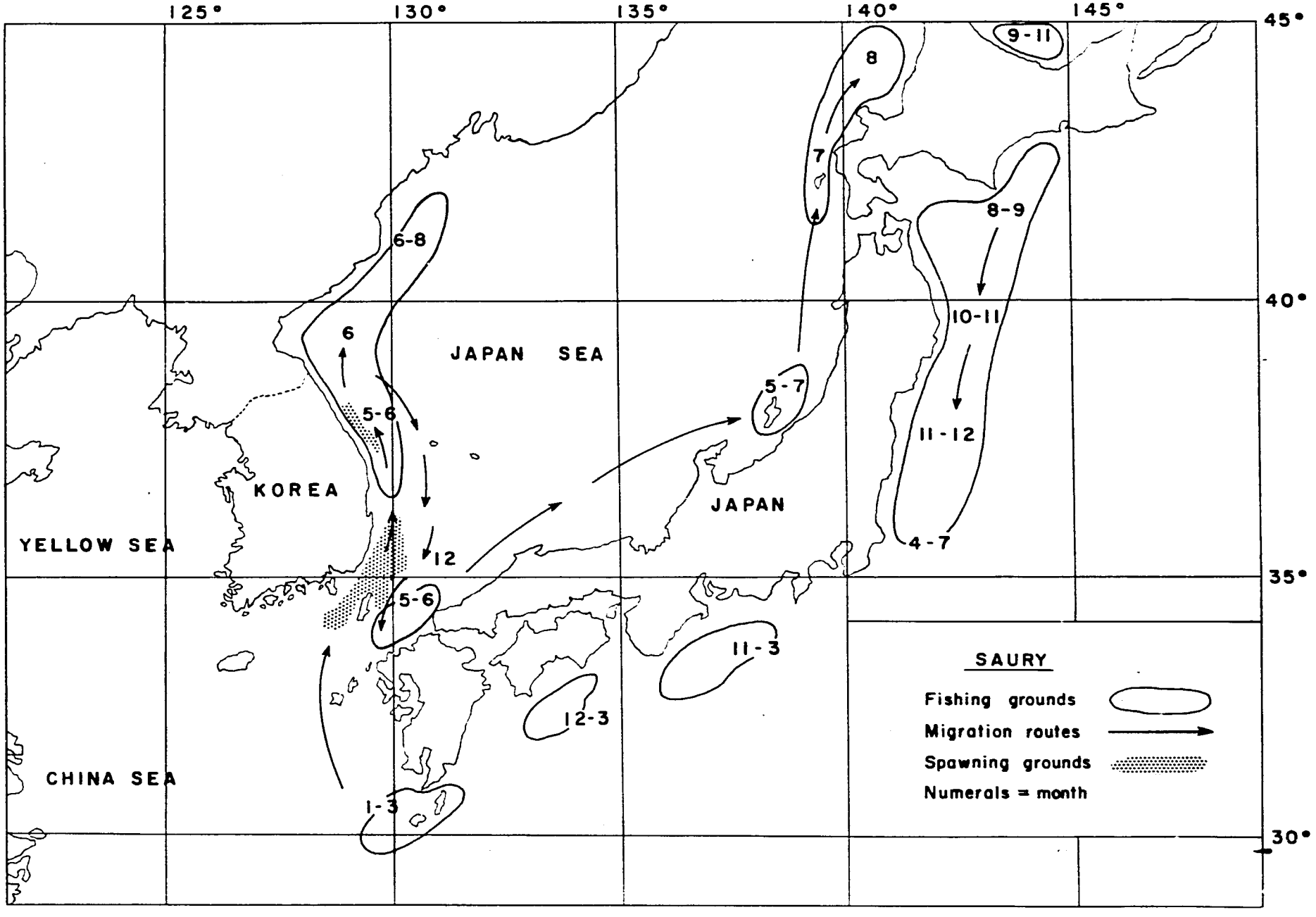

Figure 15 Distribution of Saury in Korean and Japanese Waters.

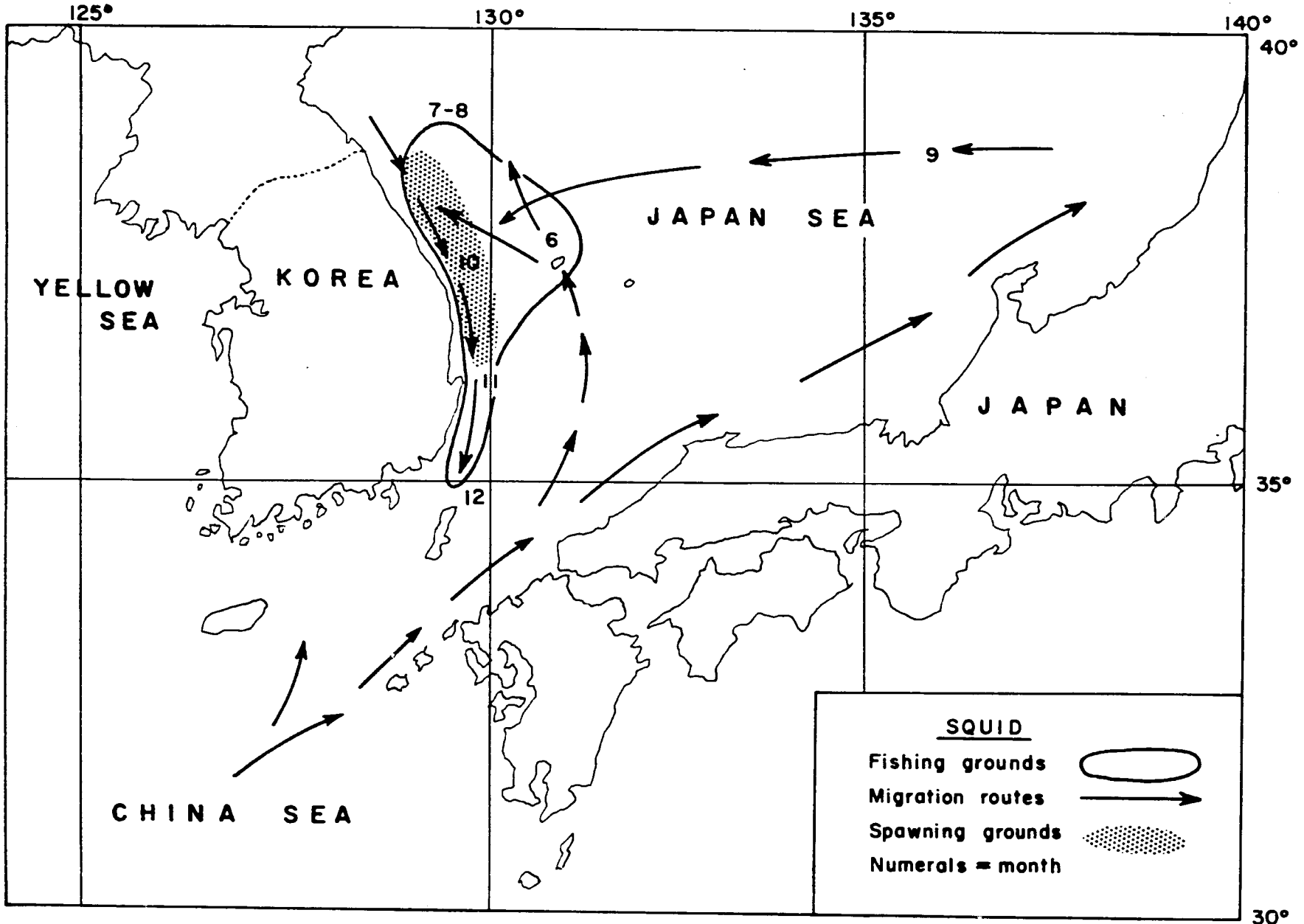

Figure 16 Distribution of common squid in the Japan and China Seas.

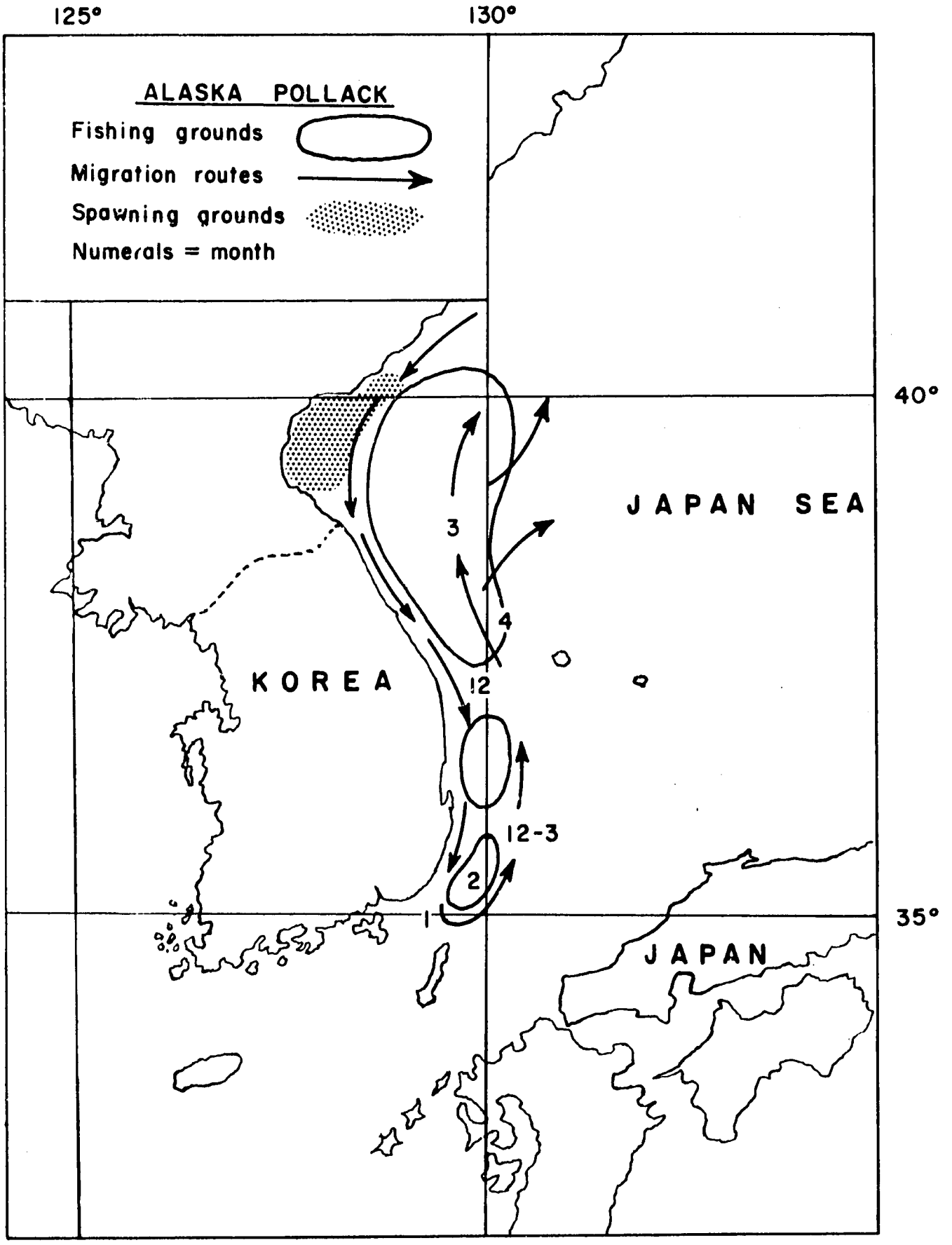

Figure 17 Distribution of Alaska pollack in Korean waters

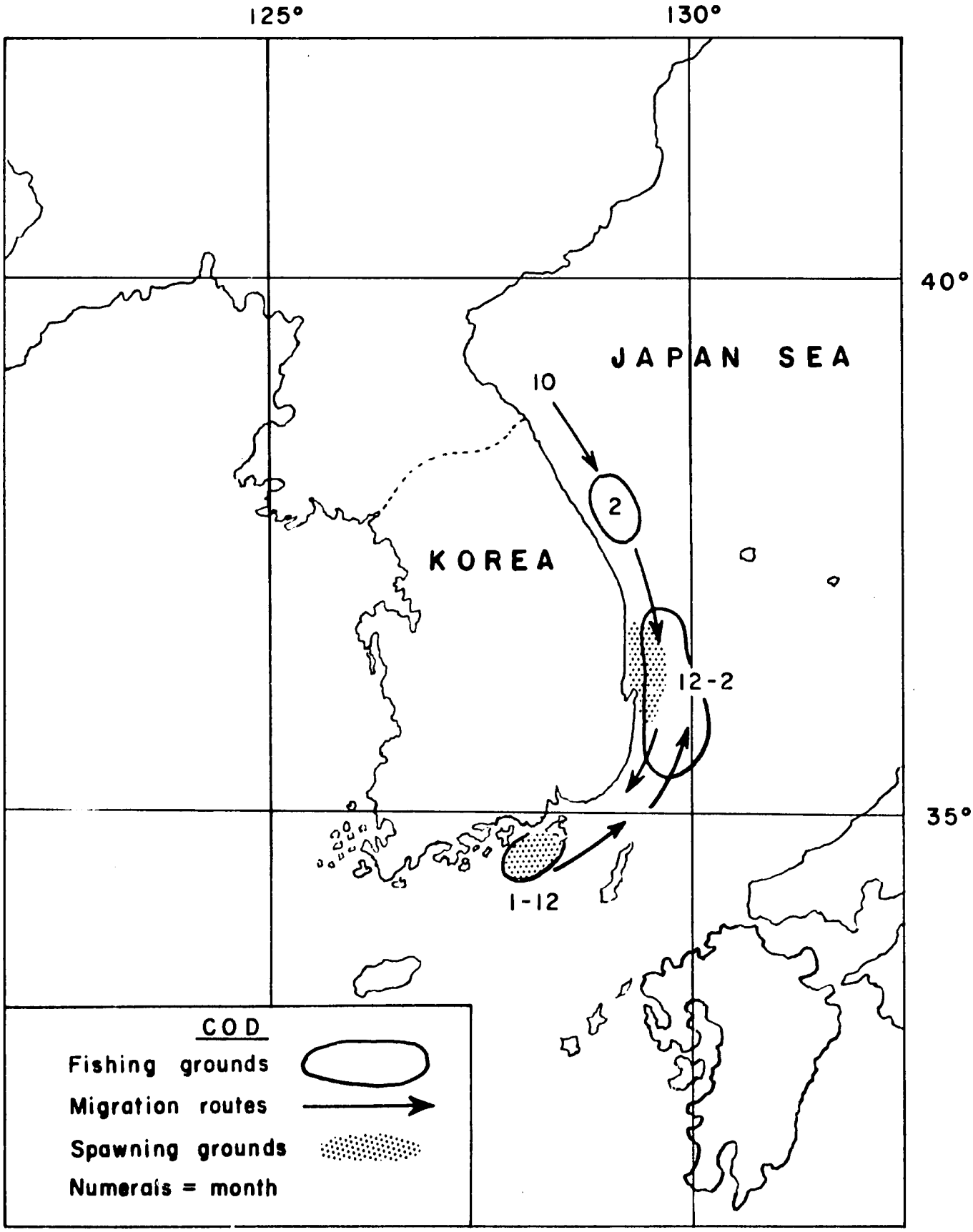

Figure 18 Distribution of Pacific cod in Korean waters.

The fishery depends on two species, Linuparus trigonus, a deep-water form, and a spiny lobster, Panulirus japonicus, that occurs in shallower rocky areas. The former is not susceptable to trapping because of its heavy inflexible antennae. It is the more abundant and is taken in trawls and entangling nets. Spiny lobsters are not trapped either, but it seems that this method might be as effective at Cheju as it is elsewhere.

The catch is still small and may never be great, but as a high-priced export item it can be of significant help to the economy. Lobster landings totalled 25 metric tons in 1967. The catch had reached 38 metric tons by the end of June 1968 and brought $58,000 on the export market. Lobsters apparently do not occur elsewhere in Korean waters. Experimental fishing along the south coast has produced negative results but the Station is showing great vigor in pursuing the opportunity.

The Station is also working out the life history of local abalone, and feels the problem is 90 per cent solved. They hope to develop culture methods, and are now devising artificial substrate for both abalone and the seaweed, dulse, by utilizing local materials for which these species show a preference.

We were very much impressed with the manner in which this station is using scientific knowledge and research to enhance the fisheries in its area of responsibility.

Chinhae Fresh-water Research Station

The Chinhae Fresh-water Research Station, established in 1921, is under the direction of Mr. Rim, Gap Tee who was graduated from Pusan Fisheries College. He is assisted by Mr. Kim, Jong Doo and Mr. Kwang, Yun Ju also graduates of the college. The staff consists of four technicians and one temporary employee.

The station covers about 75,000 square meter (18.5 acres) most of which is in raceways and ponds. Water to the ponds is supplied from a reservoir through open ditches. A small hatchery and experimental laboratory is located in the main building where feeding and culturing experiments are conducted.

This station, along with its branch at Chungpyong on the Han River, is responsible for experimental work and for production of fresh-water fishes in the Republic of Korea. In view of the increasing interest in developing the Han River Basin for fresh-water fisheries (Kangwon Provincial Government 1965) and in salmon and trout culture, this station will play an important role in the future in increasing fisheries production. At Chinhae, personnel are

are experimenting with natural and artificial reproduction and the techniques of feeding and caring of two species of carp, mudfish, sweetfish, eel and tortoise. Recently they became involved with hatching and rearing salmon to a suitable size for release at the mouths of selected streams. Last spring about 3,000 marked fingerling salmon (Onchorynchus keta) were released in the Oship Chun (Samchok) River in Kangwon-Do.

The interest in salmon was stimulated by a survey of salmon and trout resources of Korea (Atkinson et al, 1967) and they expect a large number of eggs for hatching to be shipped from the Northwest U.S. in the fall of 1968. In preparation for the increase in salmon production, Mr. Kim, Yun Ju participated in the AID program in 1968 during which time he worked with Mr. Richard Pressey a salmon expert of the Bureau of Commercial Fisheries.

It is interesting to note that the Provincial Government of Kyongsang-Namdo is constructing a salmon hatchery for use this fall. The hatchery will be constructed on the Milyang River which is a branch of the Nam River that flows into the ocean along the west boundary of Pusan; it is about 40 kilometers from the ocean. The Provincial Government of Kangwon-Do also plans to enlarge the hatchery facilities on the Oship Chun (Samchok) for use this fall. The Chinhae Station and its branch at Chungpyong are responsible for providing technical assistance for these hatcheries.

EDUCATION AND TRAINING

College Level

Most fishery scientists in the Republic of Korea obtain their formal education at Pusan Fisheries College in Pusan where they can obtain a B.S. or M.S. degree in a variety of specialties. However, Seoul National University offers courses leading to a Ph. D. degree in zoology, oceanography, or biology. In addition, some high schools offer a fishery biology course which prepares students to be technicians.

Pusan Fisheries College

The Pusan Fisheries College aims "to produce well informed fisheries scientists ... strong emphasis is placed on the instruction of profound scientific theories along the practical exercises necessary for future career" (Pusan Fisheries College, 1967 Processed information). To this end there are five major departments: Fishing Technology, Food Technology, Fisheries Biology, Fisheries Administration and Fisheries Education.

The curriculum leading to a degree in fisheries biology appears sound, and the graduates with whom we worked at FRDA appeared to have a sound grasp of fundamentals. We talked to the President of the College and to a number of professors and were impressed with their capabilities. The physical plant is old and rather run down, but a building and renovating program is under way.

Upon graduation scientists are employed by the government or by private industry. Most elect to enter private industry because here they are better paid and have a better opportunity for advancement. Those that enter the employ of the government, however, find a great challenge to help their country attain an important position in international fisheries.

A total of 160 credit hours including at least 42 hours of humanities courses are required for graduation with a B.S. Degree. Students are allowed to elect 32 credit hours and the remainder are allocated in their major course of study.

Attached to the College is a marine biological laboratory at Haewundoe. This was established in 1965 for graduate students and as a focal point for academic fisheries research. A 50-foot shrimp trawler (Ċha San Ho) is assigned the laboratory for inshore fisheries research; for offshore research arrangements are made with Pusan

Fisheries College for use of a larger boat. Although the laboratory is new and well-constructed and has a good potential, it is poorly equipped and understaffed. It has a highly-qualified Director, Lee, Byung Don, who obtained his doctorate at the University of Texas.

In-Service Training

The FRDA conducts a special training center in Pusan for officials and employees of various organizations involved with fisheries work Here the chiefs of fishery villages, and managers of local co-ops and their employees receive instruction on how to improve methods and techniques of culturing products such as shellfish, dulse, and laver. Courses in fisheries administration, accounting and law are given to officials of the city, county(Gun), and province, employees of CFFC and OFA, and grade 5 employees hired by OFA. Until 1967, employees of FRDA took special courses at the center but this training was discontinued in 1968.

Participant Program

On the job training is offered to scientists and administrators through the AID program sponsored by the United States. Participants in the program receive practical training in their specialty to improve methods and techniques of their operation in Korea. The training which extends for a 6-month period at locations in America does not usually include academic studies. This program has far greater value to scientists than to administrators because they can observe different methods and techniques being successfully employed and upon return can apply pertinent knowledge to their problems. The program is wasted on those who will not be actively engaged in research.

The candidates for participant training with whom we talked included four men from FRDA and five from OFA, Seoul. Of those from FRDA, two were from the Fisheries Resources Section, one from the Oceanography Section, and one from the Yosu Branch Station who was formerly with Fisheries Resources. Their interests lay in diverse fields: genetics; bottomfish stock assessment and exploratory fishing; comprehensive sea surveys with special respect to egg and larva studies as a means of estimating population size; and primary productivity studies with special respect to C-14 techniques. The candidates from OFA in Seoul expressed interest in tuna fishing techniques and management, fish disease control, trout and salmon culture (two men) and food technology. All nine are personally well-qualified to benefit from the training.

We believe that genetic studies are badly needed because most of Korea's fisheries are prosecuted by other nations as well. Genetics offers a means of stock separation, and determining whether or not Korea is fishing relatively local discrete subpopulations or populations that are subject to international exploitation. The type of management required obviously hinges on the answer to this question. FRDA has one man trained in genetic techniques who has just returned from studies in France. To have another man trained in U.S. laboratories using various approaches to genetic problems appears highly desirable.

The fisheries and oceanography studies would be greatly enhanced by having a man work actively with a program such as the California Cooperative Oceanic Fisheries Investigations, a joint venture sponsored by the California Marine Research Committee in which the major participants are the U.S. Bureau of Commercial Fisheries, the University of California, and the California Department of Fish and Game. Techniques have been developed through which estimates of the population size are obtained from egg and larva surveys and adult fish surveys CalCOFI plans an intensive monthly coverage in 1969, and it would be particularly valuable to FRDA to have a Korean participant present during the first six months of the year when anchovy and mackerel spawning is at its peak. Unfortunately, FRDA feels it cannot spare the man best qualified for this assignment because of his key role as a senior scientist. We believe that it is just such people who can benefit most and contribute the most to Korea on their return. The time "lost" from their present assignments will be more than offset by the long-range benefits to the FRDA program.

Bottomfish resources are most significant to Korea, and we concur with the proposal that a man study exploratory fishing and stock assessment techniques in the United States. West Coast problems and programs seem to parallel those in Korea, and a participant would profit greatly by working with federal and state research units in California, Oregon and Washington.

Because of Korea's interest in developing its distant-water tuna fishery, we feel it would be valuable to have a scientist work with a tuna research and management organization. The Inter-American Tropical Tuna Commission laboratory, La Jolla, California seems an ideal place because of its program and its proximity to the U.S. Bureau of Commercial Fisheries La Jolla laboratory and the Scripps Institution of Oceanography.

Fish disease studies also appear desirable as there are indications of problems both in natural conditions and in holding and transporting live fish.

Salmon and trout culture studies seem less important at this time as there is already a trained cadre in the Republic.

We see little practical application to Korea's fisheries development plan from an academic study of carbon-14 as a technique for measuring primary productivity. The proposal can be expanded to a useful extent by broadening the scope to a consideration of the role of plankton studies in fisheries research; their purpose, types, results, and methodologies. The participant should work largely with a mission-oriented research establishment, not an academic institution.

Similarly, food technology studies appear to offer relatively little return at this time because other problems are more pressing, but would probably be valuable later when fisheries production has significantly increased.

There were no applicants in the field of fishery or biological statistics, two fields in which expert personnel are vitally important. The participant program offers opportunities for a biological scientist who has a basic statistical background to study sampling techniques.

SUMMARY COMMENTS

WITH RESPECT TO GOALS AND PROGRAMS

1. The national goal of the Republic of Korea with respect to fisheries is to increase production and facilities for these purposes: to aid the domestic economy, to provide a more adequate animal protein diet for its citizens, and to contribute to a favorable balance of trade by increasing exports. The task of OFA is to translate these objectives into realities.

2. The function of FRDA as an arm of OFA is to further the development of Korea's fisheries through research and extension services.

3. FRDA channels its activities into six primary areas in its endeavor to fulfil its mission. These are: oceanography, fisheries resources, exploratory fishing, aquaculture, utilization and food technology, and fishermen's training. Its headquarters and major laboratories are at Pusan. It operates four regional stations, a freshwater research station, and has a fleet of ten research vessels. However, it does not have the freedom to act within the framework of approved programs that it requires for maximum efficiency.

4. Facilities and equipment of FRDA are generally good. Four of the research vessels are very new and only two are over ten years old. Laboratories are modern and seem to have all necessary basic equipment The only supporting function that is weak is the library, which requires a great deal of attention and support. A strong library is essential to an organization such as FRDA.

5. The purpose of the research sections within FRDA is to carry out studies that will help management meet its goals with respect to fishery development. These sections, to be fully effective, must conduct applied research that will provide timely answers.

6. The nature of much of the necessary research is such that considerable periods of time must elapse before the beneficial results of the work become apparent.

7. These studies are essential if Korea wishes to manage its marine resources on a scientific basis within the concept of maximum sustainable yield and to occupy a tenable position when and if negotiations at an international level become necessary to insure conservation of the stocks. FRDA is operating on minimum funds (over 279 million won in 1968) but proposes to increase

its budget by about 60 per cent to over 459 million won in 1969. This increase is necessary if the agency is to assume a major role in attaining the national goals outlined by OFA. However, the increase for the Fisheries Resources Section, about 6 million won, hardly seems adequate in view of their responsibilities of research on major fisheries.

WITH RESPECT TO STATUS OF THE STOCKS

8. The ocean adjacent to Korea has been reasonably well surveyed, and it is most unlikely that any significant unexploited stocks are present, though there may be small undiscovered populations with a high market value similar to the recently exploited Cheju Island lobster. It appears that no stocks exist in the waters adjacent to the Republic capable of supporting a large-scale reduction fishery, be it for fish meal or fish protein concentrate. The only major species that appears to be in any trouble is the Pacific mackerel; the China Sea catch is holding up but the local Korean fishery is at a low ebb. The local jack mackerel catch is also down significantly, though the total China Sea catch is increasing. The anchovy fishery may be capable of considerable expansion. The tonnage yield could be raised significantly by harvesting both anchovy and other fish at a larger size. Data are available for too few years to assess the effect of the Korea fishery on the stocks but they may be sufficient to analyze some joint Korea-Japan fisheries. Perhaps the major task at hand in Korea is to determine whether or not Korea is fishing genetically distinct populations. The type of management program required hinges on this factor.

WITH RESPECT TO INSTITUTIONAL PROBLEMS

9. Fisheries cannot develop rapidly, if at all, if institutional problems exist and cannot be rectified. The economic and social position of fishermen must, as the government recognizes, be improved if the goals of the Five-Year Plan are to be realized. This is outside the realm of fisheries research, but the research results will be of little use if the ancillary problems are not solved. This includes matters of law and law enforcement. Improvements in fishing vessels, fishing gear and fishing strategy are essential to fulfillment of the national goals. Many of these cannot take place without changing or modifying traditional thinking. Existing wholesale and retail channels and the planned improvements in the system should absorb any increased fish production leading to the goal of an improved animal protein diet. We do not believe that production of fish meal or fish protein concentrate for domestic use is either

necessary or economically feasible in view of the price and availability of fish. These same factors work against a reduction fishery directed toward the export market.

10. Pollution from both domestic and industrial sources represents a real threat to the development of coastal fisheries, especially shellfish. National water quality standards that are adequate and that are enforced constitute a primary need.

11. Some of the species on which FRDA is working are subject to international fisheries, and, assuming the stocks are common, there is little Korea can do toward managing them in the absence of international agreements. At present, the only agreement to which Korea is a party is that with Japan. Agreements with such nations as Red China are inconceivable at this time. Korea's interests might, in such cases, best be served by fishing such stocks as heavily as possible and not spending time and effort on research. Research is necessary, however, to determine whether or not the stocks near Korea are, or are not, the same as those fished in more distant waters by other nations. These comments do not apply to common resources of Korea and Japan that are included in the fisheries agreement. The agreement does not cover at least one species of mutual interest, the anchovy, apparently on the grounds that the Korean fish represent a distinct subpopulation. We found no evidence to substantiate this belief.

WITH RESPECT TO PERSONNEL

12. The research staff appears to have a sound academic background. Most of the staff are graduates of Pusan Fisheries College, which seems to be doing a good job of preparing its students.

13. The fact that Pusan Fisheries College does provide most of the recruits to FRDA has its dangers. Any staff tends to become inbred and to have a narrow perspective when it is tied closely to one institution by geography and college ties. Some outsiders feel that this is the case here, that PFC exerts a strong though indirect influence over the programs at FRDA and that some of the work tends as a result to be academically oriented rather than mission-oriented. We found some examples of what appeared to be discipline-oriented research and research desires that may stem from this association.

14. Recruitment and retention of highly-qualified scientists is difficult because of the low governmental pay scale. As a result, the best people tend to go into private industry or

into an entirely different field of science. Further, promotional opportunities lead here as elsewhere into administration and highly qualified scientists may leave research in order to attain better economic status. Those who remain in research may have to work part time at other jobs in order to provide for their families, an untenable situation.

15. FRDA recognizes the need for additional training, both academic and on-the-job at other institutions. Practical experience elsewhere in such areas as comprehensive sea surveys, the development of statistically sound sampling procedures, techniques of data compilation and analysis (not computer-based until a computer facility is likely to be available in Korea), and fish genetics seem particularly appropriate at this time.

16. The participant program offers great promise; but the subjects to be studied must have a practical application if future trainees are to make significant contributions to the goals of research on their return. The program is of particular value to scientists actively engaged in research. Some problems have occurred in the past after training was completed. Some participants have been assigned research activities not of the specialty, have assumed administrative duties or have been reluctant to return to the Republic of Korea. A method whereby a returning scientist is retained by his parent organization for a specific period seems necessary for the government to obtain full benefit from his training.

17. Candidates at FRDA for the participant program expressed interest in, respectively, genetic techniques for separation of fish subpopulations; sea surveys for stock assessment based on physical and biological oceanographic factors, egg and larva surveys, and adult fish population assessments; exploratory fishing for and studies of the effect of fishing on bottomfish stocks; and primary productivity studies based on C-14 techniques. All but the latter relate well to current program needs, and it can be expanded to an extent where it can be useful. The candidates from OFA, Seoul, wished to study tuna fishing and management techniques, fish disease control methods, trout and salmon culture and food technology. The first two appear quite appropriate; the latter two are of relatively low priority at this time.

WITH RESPECT TO RESEARCH PROGRAMS

18. The biological and oceanographic programs conducted by the Fishery Resources and Oceanography Sections appear to be

basically sound. They are already producing information of immediate use in fish forecasting and they are accumulating the backlog of knowledge essential to future assessments of stock condition.

19. Some of the routine life history work could be accomplished by graduate students working on projects approved by FRDA. This would free the small permanent staff for more sophisticated studies.

20. Some of the biological data being collected seem of academic interest but not necessary to the organization's accomplishment of its mission. Certain morphometric measurements and meristic counts, for example, could be dropped without affecting the overall program. The effort spent on identifying the small percentage of spotted mackerel in the Pacific mackerel catch can be stopped without adverse effect on the Pacific mackerel program.

21. The biological sampling system can perhaps be streamlined to produce results giving equal or better confidence limits with less effort. This requires an in-depth study by a qualified fisheries statistician on the scene, or by training a FRDA staff member abroad under the participant program.

22. A dual system exists for the collection of physical and biological oceanographic data. The Oceanography Section occupies the standard stations at two-month intervals. The Fisheries Resources Section covers the same stations in essentially the same manner in the alternate months. Oceanography processes all material except for eggs and larvae for all cruises. Fisheries Resources processes all eggs and larvae. The efforts of the two sections do not seem well-coordinated, and joint planning appears to be inadequate. Fisheries people do not participate in Oceanography cruises and vice versa.

23. The fishery forecasting unit of Fisheries Resources is promulgating useful information in a timely manner to the fishing community. They presently cover time and place of occurrence quite accurately, but cannot yet predict abundance. This remains their goal. The forecasts are no better than the information given them by other Fisheries Resources units and by Oceanography, so their success reflects most favorably upon the quality of the work being done elsewhere. It also provides a case history pointing out the value of and the need for a sound scientific body in organization such as FRDA.

24. The Exploratory Fishing Section is doing commendable work in the area of vessel design and gear development. These activities

form an essential ingredient of the required well-rounded program and appear to be contributing good information of value to the industry. The major activity of the section, is providing useful information on stocks in nearby waters, working with the Fisheries Resources Section. Distant-water explorations constitute a major activity, leading toward augmented distant-water fishing activities that can ultimately contribute to the goal of a favorable balance of trade. The importance of this work must be evaluated with respect to the returns that might be attained by spending the money on problems closer to home that, if solved, might be of greater benefit to the total fishing community and to the local economy and health.

25. Findings in aquaculture research have led to direct application and the economic betterment of many coastal fishermen. Seaweed and oyster culture are particularly noteworthy.

26. The regional stations function well in the total program, providing fishery and oceanographic data for projects in the Pusan headquarters, providing local forecasting services, and working on problems of a local nature. A particularly commendable activity is the lobster work being done by the Cheju station.

27. A portion of the research being done is directed toward species of relatively minor importance (e.g. Pacific mackerel) while significant resources such as the anchovy are receiving relatively little attention.

28. The research programs suffer what are reported to be numerous interruptions to provide special information requested by higher headquarters; such interruptions can seriously delay and disrupt carefully planned long-range studies.

WITH RESPECT TO STATISTICS

29. FRDA expends a great deal of effort in gathering catch statistics on key fisheries on either a complete enumeration or a sampling basis. The sampling system needs analysis together with the biological sampling system. More fundamentally, a dual system of catch statistic collection exists; the official OFA system upon which the nation's published fish catch figures are based, and the FRDA system. The two sets of numbers do not necessarilly coincide. FRDA feels its system is essential, not only to get accurate catch data but to obtain effort data as well. Somehow a means must be devised to establish a single, accurate catch reporting system complemented by a log system

for key fisheries. There is also evidence that substantial quantities of certain species (e.g. anchovy) are not recorded under either system. Obtaining full and accurate records from a country with as many fishermen and fishing villages as Korea is a formidable if not impossible task. However, obtaining such records for principal fisheries should not be overly difficult. FRDA has no recourse but to continue its present efforts until a single satisfactory system can be instituted. Meantime the duplication of effort and the dual statistics are regrettable but necessary for FRDA's studies.

30. The official Korea fish catch statistics are lower than those published by FAO, at least through 1966. Part of the difference lies in distant-water catches delivered to foreign ports that are include by FAO but not by OFA. The balance remains unexplained.

31. A weakness in the FRDA sampling system, both biological and fishery, is its reliance on paraprofessionals for field data collection. These men, largely high school graduates, are trained by FRDA before they are sent in the field, but it seems unlikely that they would have either the interest in or the understanding of scientific methodology to do a fully adequate job. Further their pay is low and there is no great incentive for them to perform up to a high standard. Yet they form the backbone of FRDA's system, for the data they collect are fundamental to all future analytical work. They receive some direct supervision in the field, but many, particularly those in outlying ports, are checked on relatively infrequently.

WITH RESPECT TO OUTSIDE VIEWS:

32. Views expressed to us by persons outside of FRDA were generally most complimentary of FRDA's research efforts. The forecasting service and aquaculture research were especially singled out. People were appreciative of the ways in which FRDA gets its message to the industry. The periodic seminars presented for industry by FRDA serve a very useful purpose. Those to whom we talked were from cooperatives, provincial offices, and FAO. We got the strong impression that FRDA has come a long way in the last few years and that it can render even more significant services in the future if certain problems are overcome and it receives the necessary governmental support.

33. Our view is that FRDA, especially the Fisheries Resources Section with which we were most closely associated, is doing a very competent job with the funds available to it and within

the administrative framework that exists. There are weaknesses as we have noted, many of which require action at a high governmental level if they are to be corrected. The staff is, by and large, young and inexperienced though well-trained in fundamentals. The scope of the research program is excessively broad in view of the size and relative inexperience of the staff. Despite these limitations, the research work is producing useful information. Its effectiveness can be improved, as we suggest in the recommendations that follow.

RECOMMENDATIONS

These recommendations are listed under five general areas. We realize that few of them can be acted on by the Fisheries Resources Section itself which actually conducts most of the biological research, but those that are applicable should be given prompt attention. Those that are within the province of the administration of OFA and FRDA should be considered immediately with the view of improving the climate to obtain the best results possible from research efforts. These latter are the most critical to a viable research structure.

General Policy Matters

1. With respect to authority

We recommend that the Director, FRDA, be given full authority to act within the framework of established policies and budgets. He should be able to distribute manpower and money within this framework without consultation with or further clearance from higher headquarters. He should be free of interference, and judged solely on the basis of results attained over predetermined period of time.

2. With respect to fisheries research

We recommend that the fisheries research program not only be continued, but that it be augmented and accelerated. Only through properly-channelled research can the Republic gain the knowledge it needs to gain the maximum benefit from its marine resources. Budgetary and personnel action are required to enhance the program.

3. With respect to the budget

We recommend that the operating budget of the Fisheries Resources Section be increased in stages so that it will reach double the 1968 level by 1971 and that the scientific staff also be doubled in the same period. This will make it possible to adequately staff existing

projects. The increases recommended for FRS and those already proposed by FRDA for Oceanography should be granted even if this means cutting the allotment for utilization and food technology studies and distant-water exploitations. The immediate need is for an understanding of the magnitude and potential of local resources.

We recommend that projects concerning minor fisheries be eliminated if budget increases are not forthcoming and that the available staff and funds be assigned to key investigations of fisheries over which Korea can implement effective management practices either alone or in conjunction with other nations.

4. With respect to personnel

The salary structure and bonus system applicable to working scientists must be upgraded to the degree that good men can be recruited and retained without the need for them to work part time elsewhere. Salaries should be increased in relation to technical, scientific or administrative positions and skills. This would provide an incentive for technical personnel to become more alert and accurate than is now suspected in reporting catch and biological statistics. This is of vital importance because the reporting system is the backbone of the research activities.

5. With respect to fisheries statistics

We recommend that a single system be devised for the collection of accurate catch statistics and effort data at least for the key fisheries under investigation by FRDA. The dual system now in effect is wasteful of money and manpower and produces results that may or may not be compatible. We further recommend that OFA work with FAO to determine the reason for the discrepancy between official statistics of the Republic of Korea and those promulgated by FAO. A reliable statistical system is essential to studies of the effect of fishing.

6. With respect to international fisheries

We recommend that the research programs be reevaluated in terms of whether or not effort devoted to species fished by other nations can be fruitful. Unless Korea is fishing a stock exclusively, or in conjunction with Japan under the terms of their fishery agreement, there is little Korea can do to conserve it in the absence of international agreement. Research on species where a significant portion of the catch is taken by other countries should be dropped if the scientific evidence points toward a common stock and if international control is not likely in the foreseeable future.

FRDA Generally

7. With respect to program interruptions

We recommend that interruption of research programs to fill special requests that are often of minor or transitory importance be minimized, and only undertaken with the approval of the Director when the need is overriding and the only source of information lies within FRDA. A means of coping with the inevitable short-term problems and requests is to assign one man as "special projects" officer entirely outside of any established long-range program.

8. With respect to communications

Communications need to be improved between sections of FRDA and other governmental offices and international organizations working in the Republic of Korea. In some areas such as fisherman training and pollution studies, there is a great chance for duplicating ongoing programs or devoting efforts to obtain information that is already available; this is wasteful in time and money - two commodities which FRDA can ill-afford to use unwisely. Each responsible administrator and scientist must make himself aware of activities in the different ministries and organizations and keep abreast of new developments.

9. With respect to planning

Scientists at all levels should define their objectives and goals specifically and set target dates for completion of phases of the work. This will give points against which scientists and administrators can check progress toward completion of the research. Activities that are not contributing directly toward attaining the objective can be more easily recognized and eliminated from the schedule. Every effort must be made to insure that research projects are mission-oriented, leading to attainment of the nation's goals and not discipline oriented or of academic interest only.

10. With respect to sea survey work

We recommend that the surveys now conducted separately by Oceanography and Fisheries Resources be closely coordinated both in the planning stages and, by exchange of personnel on cruises. This would insure that adequate and reliable data are obtained and that these units become better aquainted with each other's methods and needs. The agency should consider whether these routine monthly cruises might not best be operated under a single head.

11. With respect to the library

We recommend that the library be completely reorganized and placed under full-time direction of a professional librarian, or, if a librarian cannot be obtained, a scientist with some training in and aptitude for library work. A good, well-organized, properly financed library is essential to a research establishment. The FRDA library needs professional guidance, an augmented budget under its direct control, and an overhaul of the acquisition, exchange and cataloging functions to make it effective. We further recommend that when a responsible person is placed in charge, a highly-qualified fisheries librarian from the United States spend two or three months in Pusan to help establish an appropriate system. This will provide the basis for scientists to make more complete surveys of the literature than is now possible to be sure that all or part of the work has not been done elsewhere.

Fishery Research Programs

12. With respect to research generally

We recommend that existing programs be carefully scrutinized to insure that the data being collected serve a useful purpose so far as reaching the nation's fishery goals are concerned. Data may be collected through sheer force of habit long after enough is at hand to solve the initial problem; they may be collected simply because other workers elsewhere have done so without regard to their value in the local situation; they may be collected because they are of academic interest though they serve no useful purpose so far as the mission of the organization is concerned. This is particularly true of measurements of body proportions, counts of fin rays, and the like. Routine biological studies could be done by graduate students under FRDA's supervision rather than by the scientific staff. This would free the staff for more sophisticated studies and at the same time channel graduate studies into areas of immediate concern.

The priority task now is to define what populations of important species can be managed effectively by Korea, and to estimate the standing stocks and the sustainable yield. This information is needed to determine where further research is appropriate, where fishing pressure could be altered and what affect increased or decreased fishing pressure would have on the populations.

13. With respect to sampling procedures

We recommend that far stronger controls be instituted over the activities of the non-professional, lowly-paid people who collect

the basic biological and fishery field data. This information must be accurate to be useful. At least some of the key field samplers should be professional biologists.

The sampling program requires careful examination with assistance of biometricians to determine the minimum amount of data required for the desired results. Fewer samples each month or smaller samples taken more often than at present might be more adequate; this would allow scientists and technicians to increase their efforts in differentiating stocks and estimating the size of fish populations.

14. With respect to equipment

Calculating equipment and adding machines should be provided to increase accuracy and speed of analysis. Long-range plans should include the use of electronic computers as an aid in data analysis. The timing of their use would be contingent upon the establishment of a computer center in the Republic, but planning should start now. FRDA need not obtain its own facility; it should rely on part-time use of other facilities.

15. With respect to anchovies

We recommend that research efforts to deliniate the size of the anchovy population be augmented, that the program be coordinated with that of Japan, and that efforts be made to include the anchovy in the formal Korea-Japan Fisheries Agreement. The species may provide the basis for a major fishery and deserves more attention.

16. With respect to mackerel

We recommend that research effort on Pacific mackerel be minimized in view of its negligible contribution to the Korean catch unless Korea plans to extend its fishing operations into the grounds lying south of the Republic; and that efforts to distinguish spotted mackerel by other than external appearance be discontinued in view of its small contribution to the total catch.

17. With respect to hairtail

Research on the biology and life history of the hairtail should be decreased and morphometic and genetics studies increased to delineate sub-populations and determine if the stock fished by the Republic of Korea is separate from those exploited by China and North Korea. If separate stocks exist, then efforts need to be immediately directed toward estimating the size of the Korean stock and its potential yield. If not separate, research activities should be severely curtailed.

18. With respect to yellow croaker

Studies on yellow croaker need to be concentrated on estimating the size of the population and its potential yield. Scientists now working on species of much less importance could be diverted to this task to provide a scientific basis for increasing the fishing pressure and landings or for decreasing it to prevent overfishing and loss of the second most important domestic fishery of the Republic. Studies on biology could become the responsibility of the Fisheries College and trained technicians now assigned to these studies could obtain the necessary data on this and other species.

19. With respect to Korean shrimp

We recommend that the research effort be increased to determine whether or not the Korean shrimp stock exploited by Korea is separate from those that migrate elsewhere in the Yellow Sea. It appears that this fishery could be expanded but the extent would depend on studies that would define the size of the population and whether the same stock is being harvested by China and North Korea. Guidelines for such research could be obtained from state and federal agencies working on different species of shrimp in the U.S.

Training

20. With respect to the participant program

We recommend that selectees be qualified scientists and that they be required to remain in or be assigned to research in their special fields for a period of at least three years upon their return. The program is largely wasted upon people who cannot apply the results of their training.

Those selected should receive meaningful compensation as an incentive for the 3-year contract and for the practical application of knowledge gained during their training. Particular training needs lie in the fields of genetics, population estimation and sampling methods and techniques.

Peripheral Matters

21. With respect to fisheries law

We recommend that the fisheries code of the Republic be reviewed with respect to the need for the many and complex regulations, and that all possible restrictions be removed. Unnecessary regulations hamper or prevent economical fisheries development and can negate the results of the finest research program.

22. With respect to utilization

We recommend that priorities in research and development be directed toward species that can be utilized domestically and contribute the most toward overcoming the animal protein deficiency in the diet. Existing technology is sufficient to handle augmented catches and we recommend against instituting a fish meal or fish protein concentrate industry on the grounds that the industry would not have available to it the requisite large stocks at a low price.

23. With respect to pollution

We call attention to the report prepared by Mr. Richard Dewling and endorse his recommendations.

24. With respect to size of fish

We recommend that a careful review of fishery practices be made with respect to the intensive harvest of small fish, especially anchovies and yellow croaker. The tonnage yield could be far greater if the system could be modified to minimize the take of juveniles.

25. With respect to freshwater research

The freshwater research should reduce its activities in the production of small carp and eels for sale to commercial growers, increase their efforts on specific problems of culturing those species by industry and examine the possibility of producing other species of warm water fish which would be commercially important.

REFERENCES

American Embassy, Labor Attache
1967 The labor situation in Korea, Seoul, 24 p.

Atkinson, Clinton E. and others
1967 A survey of the salmon and trout resources of the Republic of Korea. U. S. Department of State, Agency for International Development, and Republic of Korea, Office of Fisheries, Seoul, 103 p.

Bae, Jae Kyung
1965 Progress report of the sardine resources investigations No. 1, 1964. Fish. Res. and Develop. Agency, Pusan, 39 p (Korean).

1967 Progress report of the sardine resources investigations, No. 2, 1965. Fish. Res. and Develop. Agency, Pusan, 21 p (English summary).

Chang, Hee Un
1961 The role of fisheries in Korean nutrition. Central Fisheries Experiment Station (now FRDA), Pusan, 28 p (English).

Cheju Province
1968 Status of Fisheries. 18 p (Korean).

Chung, Moon Ki
1961 Illustrated encyclopedia. The fauna of Korea. (2) Fishes. Dept. of Commerce and Industry, Republic of Korea, 861 p, 72 pl., 239 illus. (Korean).

Chung, Kwan, and Seong Jae Yoo
1965 Observations on shrimp fishery and its fishery biology in the eastern Korean waters. Rept. Fish. Resources, Fish. Res. and Develop. Agency, Pusan, vol. 6, p 1-12 (English summary).

Chung, Kwan, Yong Mun Kim and Yong Sool Kim
1967 Zoogeographical studies on the bottom fishes of the Korean coast in the Yellow Sea. Rept. Fish. Resources, Fish. Res. and Develop. Agency, Pusan, vol. 7, p 5-27 (English summary).

Deep-sea Fishing Training Center
N.D. UNSF project, deep-sea fishing training center. 15 p (Korean and English).

Dewling, Richard
1968 Effect of pollution on Korea's fisheries resources. U. S. Dept. of State, Agency for Int. Dev., and Rep. of Korea, Office of Fisheries, Seoul, in press.

East Coast Sector Research Station
1968 Weekly fishing forecast, No. 29, 1968, 7, 24. Pohang, 19 p (Korean).

1968 Squid fishing forecast (special) No. 1. Pohang, 17 p (Korean).

Fisheries Research and Development Agency
N.D. Annual report of Fisheries Research and Development Agency, No. 6, 1966. 119 p (Korean).

1964 Oceanographic handbook of the neighbouring seas of Korea. Pusan, 214 p (Korean and English).

1967 Korean fishing gear and illustrations, vol. 2. Pusan, 433 p (Korean and English).

1967 Bulletin of the fisheries resources sampling yearbook, vol. 1-4 for 1962-1966. Pusan, 424 p (English)

1967 Present status of Fisheries Research and Development Agency. Pusan, 24 p (English).

1967 Annual report of oceanographic observations, vol. 15, 1966. Pusan, 459 p (Korean and English).

1968 Weekly fishing forecast.
Monthly fishing forecast.
Quarterly fishing forecast.
Issued as indicated. Pusan (Korean).

Han, Hi Soo, and Yeong Gong
1965 On the fishing condition of saury in the waters of eastern Korea. Rept. Fish. Resources. Fish. Res. and Develop. Agency, Pusan, vol. 6, p 13-35 (English summary).

Kangwon Provincial Government
1965 A development plan for fresh-water fisheries in the Han River Basin. Chunchon, Korea, 23 p (English).

Korean Economic Development Institute
1967 Development of modern fishery in Korea. xiii + 745 p (English).

Lim, Joo Youl
1967 Ecological studies of the common squids, Ommastrephes sloani pacificus Steenstrup, in the eastern water of Korea. Repts. Fish. Resources, Fish. Res. and Develop. Agency, Pusan, vol. 7, p 41-49 (English summary).

Matsui, Tetsuo
1967 Review of the mackerel genera Scomber and Rastrelliger with description of a new species of Rastrelliger. Copeia, 1967, No. 1, p 71-83.

Office of Fisheries, Republic of Korea
1966 Fisheries in Korea. 257 p (English).

1967 Fisheries code. 296 p(English).

1967 Five-year fisheries development plan, 1967-1971. 98 p (English).

1967 Yearbook of fisheries statistics, 1966. 483 p (English and Korean).

Park, Byung Ha
1965 On the race of cods (Gadus macrocephalus Linnaeus) between Yellow Sea and Chinhae Bay of Korea. Repts. Fish. Resources, Fish. Res. and Develop. Agency, Pusan, vol. 6, p 107-115 (English summary).

Park, Byung Ha, and Joo Youl Lim
1965 Fisheries biology of anchovy (Engraulis japonica Houttuyn) in the waters around Korea. 1. On the ecology of anchovy in the southern waters of Korea. Rept. Fish. Resources, Fish. Res. and Develop. Agency, Pusan, vol. 6, p 37-49 (English summary).

Park, Joo Suck, and Joo Youl Lim
1967 On the results of the tagging experiment on squids in the Korean Waters. Repts. Fish. Resources, Fish. Res. and Develop. Agency, Pusan, vol. 7, p 29-40 (English summary).

Pusan Fisheries College
1967 General information. 9 p (English).

Ree, Chang Ki, and Seong Taek Jeun
1965 Reports of horse mackerel (Trachurus japonicus) distributed in adjacent waters to Korea. Repts. Fish. Resources, Fish. Res. and Develop. Agency, Pusan, vol. 6, p 69-105 (English summary).

Republic of Korea
1967 Manual of Korea-Japan joint fishery survey. 32 p (Korean).

A P P E N D I X

Names of Principal Species

Common Name

English	Korean	Scientific Name
Fish		
Anchovy	Myul-chi	Engraulis japonica
Cod	Dae-gu	Gadus macrocephlus
Croaker, white	Bo-gu-tchi	Argyrosomus argentatus
Croaker, yellow (corvina)	Tcham-cho-gi	Pseudosciaena manchurica
Eel, sharptoothed	Get-jang-eo	Muraenesox cinerius
Hairtail	Kal-tchi	Trichiurus lepturus
Halibut	Neob-tchi	Paralichthys olivaceus
Mackerel, jack	Chong-gang-i	Trachurus japonicus
Mackerel, Pacific	Go-deung-eo	Scomber japonicus
Mackerel, Spanish	Sam-tchi	Scomberomorus niphonius
Mackerel, spotted	Chom ko-deung-eo	Scomber australasicus
Pollack, Alaska	Myeong-tae	Theragra chologramma
Sardine	Chong-o-ri	Sardinops melanostica
Saury	Gong-tchi	Cololabis saira
Sea-bass	Noon-bol-dae	Doderleinia berycoides
Seabream, red	Tcham-dom	Pagrus major
Seabream, yellow	Ok-dom	Branchiostegus japonicus
Sole	(Mul-ga-ja-mi	Xystrias grigorjewi
	(Tcham-ga-ja-mi	Limanda herensteini
Yellowtail	Bang-o	Seriola quinqueradiata
Invertebrates		
Shrimp, Korean	Dae-ha	Penaeus orientalis
Shrimp, humpback	Chul-mo-seu	Pandalus hypsinotus
Shrimp, pink	Buk-chok-bun-hong-seu	Pandalus borealis
Squid	O-ching-eo	Ommastrephes sloani