Fishery Resources of MICRONESIA

FISHERY LEAFLET 239
FISH AND WILDLIFE SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

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United States Department of the Interior, J. A. Krug, Secretary
Fish and Wildlife Service, Albert M. Day, Director

Fishery Leaflet 239

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FISHERY RESOURCES OF MICRONESIA 1/

By Robert O. Smith
Aquatic Biologist, United States Fish and Wildlife Service

INTRODUCTION

This brief report presents salient facts concerning fisheries and other pertinent conditions in an area long closed to all but Japanese nationals. The report is based on data from "Survey of the Fisheries of the former Japanese Mandated Islands," prepared by the author as a member of the United States Commercial Company's Economic Survey, plus such general information as seemed necessary to round out the picture. Persons interested in the complete report should apply to Pacific Ocean Div. U. S. C. C. 1625 K Street, N. W., Washington, D. C.

The Economic Survey was undertaken by USCC at the request of Commander Marianas, and under authorization from Commander-in-Chief, Pacific Fleet, during the period May 2 to August 31, 1946. All phases of native economy were examined by appropriate specialists assigned from USCC, other Government Departments, the University of Hawaii, and the Bernice P. Bishop Museum, Honolulu. In such a cooperative enterprise, grateful acknowledgment for services rendered is due all hands, but especially to Mr. Anthony Aki of Honolulu who, as assistant to the fisheries specialist, contributed in major degree to this section of the Survey.

1/ Data obtained as Fisheries Specialist on the Economic Survey of the United States Commercial Company, Reconstruction Finance Corporation, May 2 to August 31, 1946.

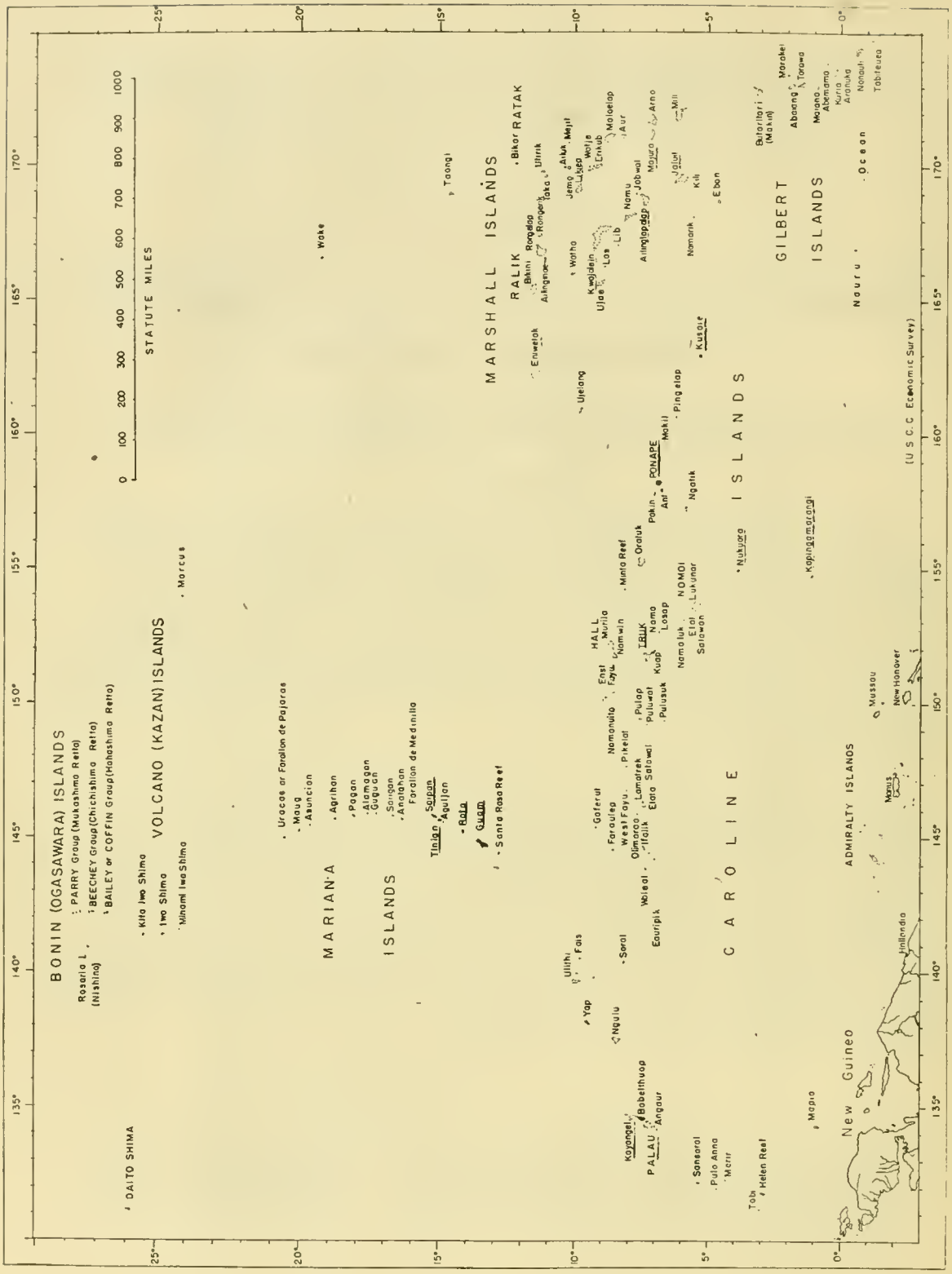

Figure 1.--Map of Caroline, Marshall and Mariana Islands.

The fisheries survey covered the following islands:

Marianas	Carolines	Marshalls
Saipan	Palau, including Kayangel	Eniwetok
Tinian	Truk	Kwajalein
Rota	Kapingamarangi	Ailinglaplap
Guam	Mukuoro	Jaluit
	Ponape	Likiep
	Kusiae	Majuro

Geography.- The relative positions of the three island groups are shown on the general chart (figure 1). Mindinao in the Philippines is about 500 miles west of the Palau Islands (Western Carolines). Pearl Harbor is 200 miles northeast of Eniwetok (Northern Carolines).

The total land area is 902.5 square miles, roughly three-fourths the area of Rhode Island, scattered over an expanse of the Pacific Ocean nearly the size of the United States.

For practical purposes, islands may be classified as high or low. The high islands (figure 2) are few, of volcanic origin, and located in the Marianas (Saipan, Tinian, Rota, Guam) and Carolinas (Palaus, Truk Group, Ponape, Kusiae). Low islands, including all the atolls, are of coral (figure 3) with maximum elevations usually less than 10 feet above mean high water (Eniwetok, Kwajalein in the Marshalls, Kapingamarangi and Kyangel in the Carolines).

Population.-As of the summer of 1946, the native population in the ex-mandate was 73,132, of which 22,783 were on Guam. Racially, the general term for these people is Micronesians. The main racial subdivisions are Chamorros and Kanakas, with admixtures of Melanesians and, of course, some infiltration of Spanish, German, Japanese, Chinese and American blood. Regardless of race, it is necessary to emphasize that the area has been influenced by contact with western culture since the seventeenth century, and the people are by no means simple savages. As in the United States, the degree of native progress is not uniform throughout the area. The people of Guam, who have been under American administration since the Spanish-American War, have profited by opportunities not available to inhabitants of seldom-visited Kapingamarangi. But barring language difficulties, native aptitudes for learning to be mechanics, plumbers, electricians or tradesmen are not below what reasonably can be expected of a relatively unmechanized culture.

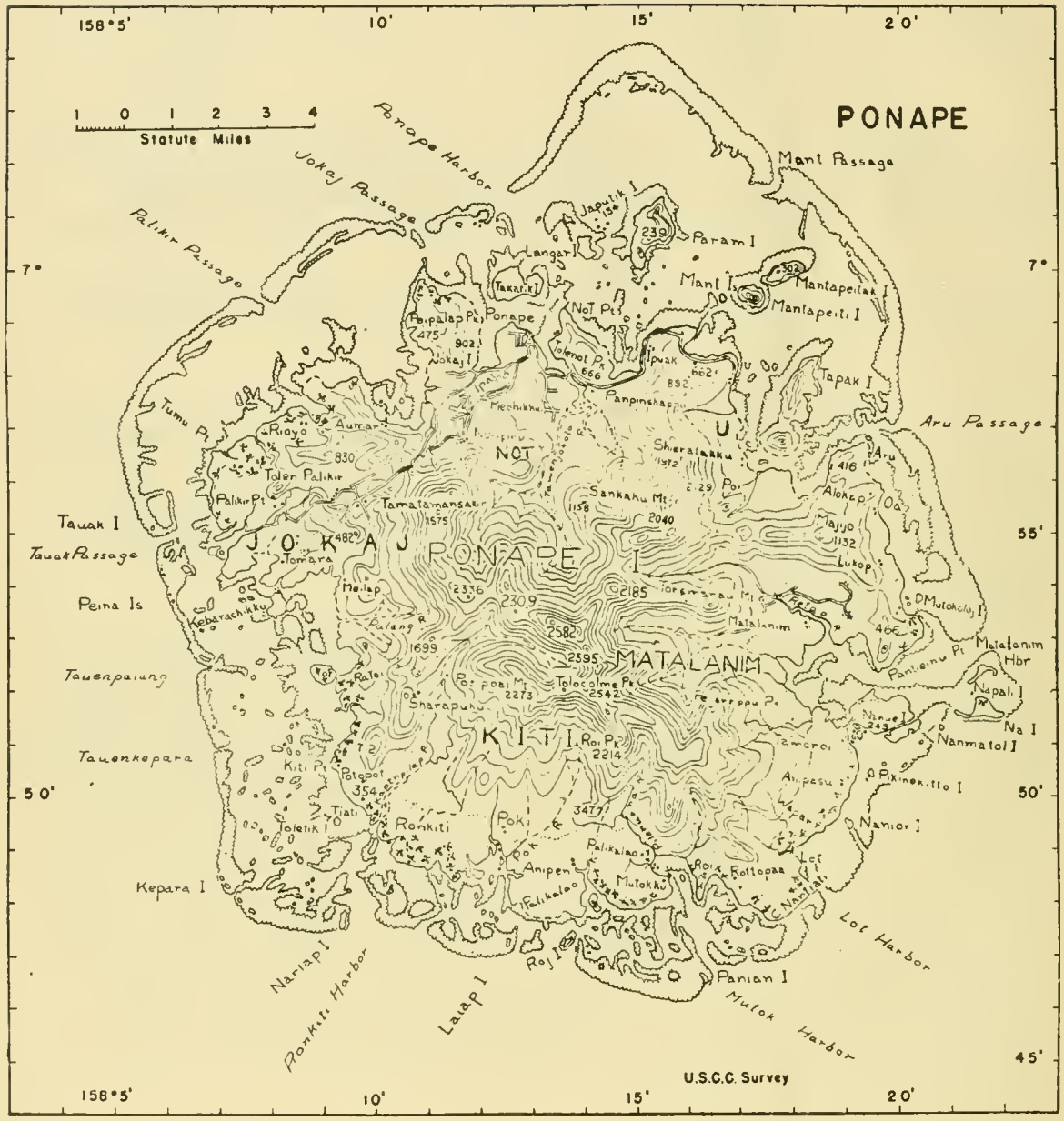

Figure 2. -Map of Ponape.

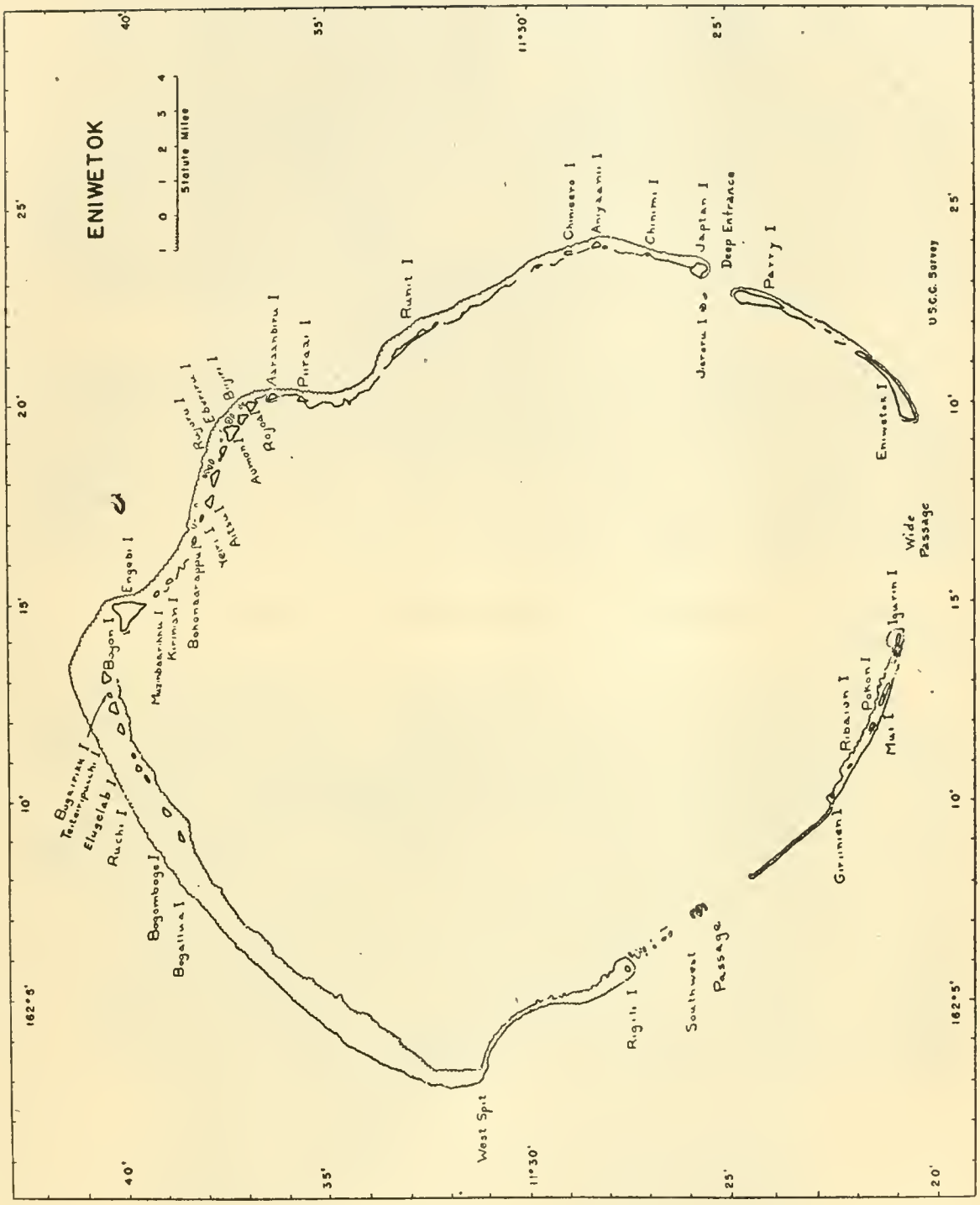

Figure 3.- Map of Atolls, Eniwetok.

Native Subsistence Fishing.--Although the number of economic species of fish, reptiles and marine invertebrates is certainly in excess of 2000, the day-to-day subsistence of the native people is dependent on a comparatively few groups. Of the reef and inshore fishes throughout the area, the most important are angelfish, barracuda, crevalle, goatfish, parrot fish, squirrel fish, surgeon fish and wrasse. Among invertebrates, the more important ones are a type of cockle (Anadara), conchs, crabs (especially the black Samoan crab, Scylla serrata, (figure 4) which lives among mangrove roots, weighs over two pounds, and has claws the size of a Maine lobster's), octopi, "rock oyster" (Spondylus sp.), spiny lobster (figure 5), sea anemone, sea urchin, clams, including the giant clams of which there are three species, trochus of several species, and turbos or cat-eyes. A number of species of sea cucumbers are abundantly distributed over the entire area, but they were not found to be an important part of the native diet, though greatly relished by the Japanese.

Of the open ocean species found outside the reefs, tuna, mackerel and swordfish are of general importance. A few of these offshore fish are taken by natives, usually by trolling a feathertype jig behind a sailing outrigger canoe just outside the breakers on the barrier reef. Occasionally, however, still-fishing is done offshore in depths to 20 fathoms, where swordfish weighing over 200 pounds and yellow-fin tuna up to eighty pounds. There would be more of this type of fishing except that heavy fishing line has been scarce.

Dugongs or sea cows are sometimes taken, but they are now quite rare.

Failure of the natives to develop more of an offshore fishery has not been due to their inability to catch the tuna or other species but because they had no urgent need to do so. From a practical standpoint it was easier for them to obtain their fish from the constant fish population on the reefs and in the lagoons. Their offshore fishing was more in the nature of what we would call "sport fishing." The taking of an extra large tuna or swordfish is described by natives with as much enthusiasm as if it were to be entered into the records of the International Game Fish Association. Difficulties of preserving excess catch also restricted heavy production. In the absence of any kind of refrigeration and scarcely enough salt for seasoning only sun-drying was practical, and even this method was limited to a few localities. Except where local control has been gained with DDT, swarms of house flies immediately cover any meat or fish left in the open.

Figure 4.- Samoan Crab--Koror.

Figure 5.- Spiny Lobsters--Koror.

Figure 6.- Site of Japanese Marine Experiment Station, Koror, Palaus, Caroline Islands, July 1946. A high Island.

Figure 7.- Majuro, Marshall Islands.

Seafood in the native diet.-Fish and shellfish are the most important sources of protein, supplying also minerals and vitamins. Other protein foods, such as chickens, hogs, cocoanut crabs, and fruit bats, are mostly so scarce as to be reserved for feasts and special occasions. Some kind of fish, if it can be obtained, is served with each meal, and estimates made by natives at many different places agree on a figure of a pound per person per day. This rate of consumption is not found everywhere. At Rota, Guam, Koror, Truk, and Ponape, supplies are below needs. On Rota, the reef area is relatively small, and no fishing is done offshore. On Guam, labor requirements of the armed services doubtless always will provide more work under better conditions, and few persons will choose to be fishermen. At Koror, in the Palaus, the Japanese destroyed all but 80 of the 1500 native canoes, so the shortage of fish is temporary, and should return to normal as boat building is resumed. There is no natural shortage of fish or shellfish. On the main islands of the Truk group, where the Japanese population was located (estimated maximum 40,000 military, 2,000 civilians), food shortages were serious because of cut supply lines, so explosives were used on the reefs for quantity production of fish. It will be several years before natural reproduction brings the reef population back to normal. A similar situation exists at Ponape, though destruction of fish was not as great as at Truk. With the exceptions noted, fishery resources are ample to meet native needs, assuming that adequate supplies of fishing gear are provided.

Methods of preparing seafood are varied, but little seasoning is used. Some fish and most bivalves, such as clams, are eaten raw. The Japanese custom of marinating raw fish with lime juice is common, and soy sauce was used to a limited extent. Baking on hot stones, and boiling, are the commonest cooking methods. Frying in cocoanut oil is less common, except in the Marianas. Turtles are roasted in their own shells.

NATIVE FISHING METHODS

As of 1946, home made natural-crook wood shark hooks, and pearl and tortoise shell jigs occupy about the same position in Micronesia as spinning wheels in the United States: a few are still made, but nobody depends on them. Native fishing methods, soundly developed over the years, have been modified only to the extent of using machine made products. My own observations lead me to doubt that these mass-produced items catch more fish than native handcrafted ones. The advantage is in man-hours of labor saved. Two examples will suffice. The white inner stalk of the spider lily, Crinum asiatica, tied around a hook (figure 9) catches barracuda as well as a feather lure, but is good for only one bite. This performance is not a matter of opinion but of records made by trolling the two side by side. A sennit (cocoanut fiber) beach seine, hand knotted, from twine laboriously rolled on the thigh, has floats of balsa wood and leads of cockle shells. It takes two months to make, but is durable, and lays out as well as any factory net.

Diving and Spearing.-Women rarely do this kind of fishing. Usually several men work together, as it often takes more than one to capture a large fish, octopus, moray eel or turtle. Five fathoms is about the maximum working depth, and probably 90 percent of the fish are taken in less than three fathoms. Length of time under water depends on how much exertion is required. Most divers do not exceed 90 seconds since they are quite active.

The best spear fishing is found around coral heads in lagoons and along the outer face of barrier reefs. In addition to reef fish, many shellfish are taken, especially trochus, *Trochus niloticus*, cowries, *Cypraea sp.*, and giant clams, *Tridacna gigas*, *T. elongata*, and *T. crocea*. Giant clam shells, of course, are not brought up, the meat only being cut out. Spine-thrillers to the contrary, divers consider the chances of getting a foot caught in the jaws of a giant clam about on a par with the possibility of accidentally falling out of a jail window.

Each diver has a length of strong cord or wire on which to string his catch and a small pouch of woven cocoanut leaves to hold small shells, which can't be kept in the breech cloth. He also has a pair of diving goggles, Japanese-made with hard rubber frame and window-glass lenses. Spears are made to suit local conditions. They range in length from a two-foot piece of 3/16-inch diameter rod propelled by a sling-shot, to a heavy 12-footer (figure 11) whose double barb tip is made from an automobile brake rod. Throwing spears are likely to have a bamboo shaft so that they will come to the surface in case of a miss, while spears used mainly for jabbing are apt to have a hardwood shaft which helps in pinning a fish against the coral rock. Of course there is no hard and fast rule about this, because the shaft will have to be made from whatever is at hand.

Some attention was given to recording the amount of fish taken by spearing. As in any kind of fishing, the total depends on the abundance of fish and the skill of the fisherman. There was a wide difference in catch per man from 5 to 25 pounds of fish per hour. Most reef fish are under a pound in weight, but some larger ones are speared, especially brown spotted groupers, *Serranus tauvina* Forskal, and the green wrasse, *Cheilinus undulatus* Ruppell, (figure 10). Experienced divers seldom strike at fish weighing over five pounds unless two men can strike at the same time for, if not killed, or paralyzed by the blow, a large fish will dart away to deep water with the spear, which may not be recovered.

Figure 8.- View of Low Island, Jaluit, Marshall Islands.

Figure 9. -Native Spider-lily Jig--Kayangel Islands, Palaus.

Handlining.-Two or three men fish together from each canoe. As in diving, the best fishing spots are around coral heads in lagoons, and just outside the barrier reefs. Cut bait is used, fish, octopi or shellfish. As stated previously, some fishing is done to depths of 20 fathoms, but mostly less than half that. No. 20 cotton twine, medium laid, is the best all-round size. Hook sizes desired are 5 to 10/0. Hooks developed by the Japanese are superior for reef fishing, the point being recurved toward the shank to minimize fouling.

Although the same species are caught as in spearing, the fish average somewhat heavier as the older fish seek deeper water. In addition, crevalle, *Caranx* and *Carangoides* spp., barracuda, tuna, swordfish and sharks are caught.

Seining and hand-netting.-The simplest use of netting is found in the hand-net (figure 12), used by women in the Carolines, but for some reason rare in the Marshalls and Marianas. A characteristic of the shore area of many islands is the fairly flat coral table extending seaward as much as several hundred yards before dropping off abruptly to several fathoms. At low tide, water over this table is from 6 to 24 inches deep. A litter of coral rocks provides cover for small fish and shellfish. After placing the two nets around a rock it is moved and the small fish are trapped in the nets as they dart away. However, the commonest use of these nets is by a group of women and girls, frequently the whole female population of a village, working together. In single file, the group wades out in a semicircle from a point on shore. When all are in position, with nets in either hand extended to join her neighbors, each woman moves slowly toward shore. Inside the semicircle, youngsters splash about and chase the small fish from their hiding places. Finally the fish are driven into a compact mass which can be scooped onto the shore where all participants share in the catch, though not equally, the chief's wife and those of other village dignitaries making off with the choicer fish as in any well-regulated community. Since the catch is preponderantly of minnow size, netting mesh is from 1/8 to 1/2-inch square. Machine-made netting being scarce, most of the nets were knitted locally from home-made sennit twine. On Truk, some very fine netting is made from the fibers of a seaweed which gives a smoother, less bulky cord than sennit.

Most beaches are either too rough and littered with coral, or drop off too abruptly for beach seining of the kind shown in the frontispiece. Where seines are used at all, they are of the type known as surround nets, which are set in shallow water and the fish driven into them, no attempt being made to haul the nets ashore.

Figure 10.- Blue-green Wrasse, Cheilinus undulatus, Koror.

Figure 11. Native Fish Spear, Kapingamarangi, Caroline Islands.

Figure 12.- Hand-net--Kusiae, Caroline Islands.

Trolling.-Although hampered by shortages of heavy line (figure 13), hooks, leader, wire, and feather jigs, natives trolled at every opportunity. Except at Kusiae, trolling is done from sailing canoes, as well as from whatever types of powered craft happen to be available. There were no sailing canoes at Kusiae, but two or three natives could paddle a canoe fast enough for trolling.

Native-made trolling gear was seen only at Kayangel, Palaus; and at Kapingamarangi and Nukuoro, extreme southern Carolines. At Kayangel, the lure made by wrapping and tying a section of spider lily stalk around a hook was common but not seen elsewhere. It is believed to be a recent development to substitute for the Japanese feather lure which it resembles. It will be seen in figure 9 that the stalk is cut and tied so that a number of flaps are left trailing. There was only one opportunity to observe the action of the lily jig (July 19, 1946) when a total of 9 fish were caught trolling, of which 32 barracuda and one king mackerel hit the lily. Comparatively, 5 fish—one barracuda and 4 crevalle—were taken on a Diamond No. 7 brass spoon. Compared to results with a feather lure, the lily jig did very well.

We ourselves trolled at all times when traveling by small craft, excluding paddling outrigger canoes, although it was not always possible to record trolling data.

No spoons were seen in native hands, most probably because none was used by the Japanese. This is rather surprising since we had about 6 strikes on spoons to one on feathers or lily, even though the two were trolled side by side. Compared with the feather lure, spoons have an additional advantage of being relatively indestructible, but they do have to be polished each time before using.

At Nukuoro and Kapingamarangi (Southern Carolines), a few trolling jigs are still made. The pattern is basically Samoan, and consists of a body or shank cut from the thick hinge portion of the black-lip pearl oyster, *Pinctada margaratifera*, and a curved barb or point of tortoise shell, tied to the distal end of the shank. These are rarely used now, being generally reserved for sale as handicraft.

Scoop nets.-Flying fish, especially large ones of the genus Cypselurus, are among the common food fish of the ex-mandate, and also furnish sport for the natives who catch them. A popular method of fishing in the Carolines is by means of the scoop net, construction of which is shown in figure 14. The net is used at night, preferably in the dark of the moon. A canoe is paddled or sailed parallel to the beach and well outside the breakers. A bundle of dried cocoanut leaves is lighted to make a torch which attracts the flying fish and they are snared with the net as they sail toward the light. A good night's catch for three or four men in a canoe is from 50 to 100 fish ranging in length between 8 and 12 inches.

Figure 13.- Native Trolling and Hand-lines, Kusiae.

Figure 14.- Scoop-net for Flyingfish, Kapingamarangi.

Throw nets.-This is a most important type of gear throughout the ex-mandate. On many of the islands, the coral reefs are so rough that any kind of seining is impossible, but many spots can be fished with a throw net.

The Polynesian and Micronesian throw net differs in construction from the cast net of our Atlantic and Gulf coasts mainly in not having drawstrings. After throwing the net it is necessary to dive in after it to recover fish and net. This arrangement, or lack of it, may seem inconvenient to American fishermen, but again, much of the bottom is so rough that drawstrings simply could not be used to close the net. Otherwise the nets are similar. Most native nets have a length or radius of 4 1/2 to 7 feet. A 6-foot Kusiae net is shown in figure 15, and the method of gathering it for throwing is illustrated in figure 16. Nowhere did we see any large, native-made nets like the 14-foot radius Hawaiian net shown in figure 17, being thrown by my assistant, Mr. Tony Aki. At Eniwetok, one cast of this large net caught 81 goatfish, Mulloidichthys auriflamma Forskal, weighing about half a pound apiece.

Native nets vary in mesh size from 1/4-inch square, used to catch bait fish, to 1 1/4-inch square for food fish. Prior to the war, when the Japanese supplied ample stocks of twine, there was nearly a throw net per family in the Marianas and in the Carolines. For some reason this net is not so popular in the Marshalls, perhaps because there is more sand beach where full-size seines can be used. By the summer of 1946, few of these nets remained anywhere, and replacement twine from the United States was slow in coming in.

Traps.-Stone traps are built by community effort. Loose coral rocks are piled together to form a crude heart, with one wing leading toward shore, the other extending along the top of the reef toward deeper water in the lagoon. A number of these traps exist, but only two were seen--at Kapingamarangi (Carolines) and at Piiraai Island, Eniwetok Atoll (Marshalls). Depth of water in one trap visited is near 4 feet at high tide, and less than a foot at low tide, some parts of the heart being out of water at low tide. Usually only men take part in driving fish into the trap at half-flood to high water. Catch is commonly goatfish, tang, mullet, mackerel and crevalle, but every kind of reef fish is occasionally taken.

A good catch for a drive into this kind of trap is several hundred pounds of mixed fish, except that sometimes schools of mackerel, Scomber japonicus Houttuyn, come inside the lagoon during March-May, and several thousand pounds are caught in a drive.

Stake or fence traps are not common in the ex-mandate because of the labor involved and the short life of wood or fibers left in sea water continuously. Natives of Yap construct a trap with leads and heart of bamboo.

On Guam chicken wire of 1 to 1 1/2-inch mesh is used for leads and heart, supported by mangrove stakes. These traps are licensed and give exclusive fishing rights to certain sections of the coast line. A trap examined at Merizo was set 100 yards offshore in four feet of water, with one lead to shore and the other parallel to the shore line and also 100 yards long. The bottom is muddy, and mangroves fringe the shore. The heart of the trap was 6 feet square, with the top covered to prevent escape of crabs, especially the Samoan crab, Scylla serrata Forskal. This trap contained two sting rays Dasyatis sp.; 2 Samoan crabs 7 inches across the carapace; three goatfish 8 inches long; and an assortment of 20 small fish under 6 inches in length comprising crevalle, Caranx sp., moonfish (like Selene sp.) and spiny puffers, Diodon sp. It was stated that traps sometimes have as much as 100 pounds of fish for a day's haul.

Hoop or fyke nets were not seen and natives did not recognize them from a description.

Basket traps were common on atolls of the Carolines. They may be made of bamboo, vines or split wood according to local availability. Figure 18 shows a Kapingamarangi model, roughly 18 inches square at the ends by 30 inches long. The catch is small reef fish and eels.

Use of Poisons.-Historically, the natives of Micronesia knew how to use poisonous plants and animals for stupefying fish. Present generations also have this knowledge but the method is not now widely practiced because Japanese conservation measures strictly forbade it. At present, almost every fisherman of Kusiae and Ponape (Carolines) carries a supply of derris root in his canoe, and at Majuro (Marshalls) sea cucumbers are occasionally used, but elsewhere poisons were not observed, though it is not assumed that they were never used. The common poisons are listed below. Regardless of the kind, the method consists in pounding or macerating the poison and dropping it into caverns or quiet pools along the outer reef. Destruction of immature fish is severe.

1. Derris elliptica is a vine, the root of which is cut into short lengths and folded into a bundle containing 6 to 8 feet. It may be used fresh or dried. Because of its wide distribution and ease of handling, it is the most popular of the fish poisons. The active principle is rotenone.

2. Barringtonia racemosa and asiatica is an attractive shade tree sometimes planted along native and Japanese streets. The trees are 20 to 25 feet tall and grow naturally near the water's edge. Fruits are large, sometimes over 4 inches in diameter. Only the kernel of the dried nut is used for poison. The active principle is said to

Figure 15.- Native Throw-net, Kusiae, Aug. 1946.

Figure 16.- Native Method of Holding Throw-net, Kusiae.

be an alkaloid. Like Derris, this poison does not affect the taste or edibility of fish, but it is not so generally used as Derris root.

3. Tephrosia purpurea is a tree, the leaves and bark of which are rarely used to poison fish because they give a disagreeable flavor to the fish.

4. Sea cucumbers, family Holothuridae, are sometimes pulped for use as a fish poison in the Marshalls.

JAPANESE DEVELOPMENT

Neither the Spanish nor the German regimes which preceded the Japanese could profitably use in their economy the fishery products from Micronesia, and so made no effort to exploit them. Exports consisted of small amounts of Trochus, Trochus niloticus, and pearl oyster, Pinctada margaritifera, shells to the button industry, and a few tortoise shells from Chelonia imbricata.

Under Japanese mandate, the decade from 1920 to 1930 was one of general inquiry to determine the kinds of marine resources present. Actual production for export to Japan was negligible. Beginning with 1930, the tonnage exported to Japan increased steadily until halted by the imminence of war. Highest production of bonito was apparently in 1937, when over 75,000,000 pounds were produced. Insofar as the abundance of fish is concerned, there is reason to believe that production has not reached a maximum. Exported processed food products consisted chiefly of dried bonito sticks, dried and canned tuna, and trepang (dried sea cucumbers) amounting altogether in 1937 to slightly over 6000 metric tons. Compared with total production in the Japanese Empire, fisheries products from the mandated area were valued at less than two percent.

The natives had little part in this developing industry. Okinawan fishermen manned the fishing vessels and Japanese operated processing plants and facilities on shore. There is no record of a native crew being permitted to operate a fishing vessel in the offshore fishery. After the outbreak of war, natives were not allowed to go outside the lagoons.

The Bonito Fishery Euthynnus pelamis Linne, Ocean Bonito, Skipjack, Aku (Haw.), Katsuo (Jap.)

Japanese statistics for the bonito catch in the mandated area for 1934 to 1941, inclusive, are given in table 1. Minor discrepancies

Figure 17.- Hawaiian 14-foot Throw-net--Tinian, Marianas.

Figure 18.- Native Bamboo Trap, Kapingamarangi.

Table 1—Bonito Catch, Japanese Mandated Islands, 1934 to 1941

Catch in Millions of Pounds, 000 omitted. 1/

PLACE	1934	1935	1936	1937	1938	1939	1940 2/	1941
SAIPAN	5,535	3,929	3,721	8,134	5,702	4,591	—	2,854
YAP	9,207 3/	4/	--	—	123 3/	79 3/	—	12,349 3/
PALAU	8,313	11,860	8,439	30,304	11,924	12,207	—	7,277
TRUK	2,639	6,605	12,914	27,353	11,648	16,807	—	9,561
PONAPE	2,645	2,888	5,930	8,940	3,290	8,157	—	5,333
JALUIT	561	505	369	200	14,770 3/	—	--	372
Totals	19,702	25,787	31,373	74,931	32,701	41,841		25,409

1/ Original data in kilograms; conversion to pounds x 2.2.
2/ Data not available.
3/ Actual pounds.
4/ No commercial production at Yap 1935-1939, inclusive.

between totals of table and text result from rounding off the 000 in the table. As stated above, maximum production was in 1937, with a catch of 74,933,780 pounds, valued at $958,476 (conversion rate 4 ¥en to Dollar), or 1.3 cents per pound average to the fishermen.

The price of fresh bonito varied from place to place, fluctuating according to local abundance as shown in table 3, but basically it was a percentage of the market price for dried bonito sticks in Japan. The 1937 price of fresh bonito at point of production was 9 percent of the market price for bonito sticks in Tokyo. The local price in the Palaus, for example, was established monthly, calculated at 9 percent of the price at which Palauan bonito sticks sold in Tokyo the preceding month.

In 1938 the catch dropped to 32,703,981 pounds, and to 25,411,466 pounds in 1941. This is the last year for which statistics were available from the South Seas Government records, but it is known that the catch declined abruptly in subsequent years.

The heavy catch in 1937 seems to have resulted from the operations of an unusually large number of fishing vessels some of which were withdrawn the following year. Table 2 lists the number of fishing vessels at bases in the mandate in 1937. Figures for the following years are not available, but the number is known to have been less.

Table 2—Number of Fishing Vessels in the Mandated Islands, 1937

Port	Below 20 Tons	Above 20 Tons	Total	No.Crew
SAIPAN	34	3	37	630
YAP	4	0	4	96
PALAU	89	160	249	3154
TRUK	47	3	50	817
PONAPE	18	1	19	586
JALUIT	1	0	1	21
Total	193	167	360	5304

Japanese recommendations, which the present survey showed to be practical, are that the number of vessels in the bonito fishery should be 25 at Koror (Palaus, Carolines); 20 at Truk; and 10 at Ponape. In addition, 40 vessels of 50 to 60 tons could be used for tuna, Neothunnus macropterus Schlegel, 20 each at Koror and Truk.

Table 3--Prices of Fresh Bonito, Dockside

PORT	Cents per pound 1934	1937	1941
SAIPAN	02.5	01.25	03.25
YAP	03.5	1/	1/
PALAU	03	01.25	02.5
TRUK	02.5	01.25	02.5
PONAPE	02.5	01.25	02.5
JALUIT	02.5	01.25	07.5

1/ Not available.

Table 4, from South Seas Government figures for 1941, shows the production from the more important marine fisheries at centers in the mandated islands. In the case of white pearl shells (from the gold-lip pearl oyster, Pinctada maxima, Jameson), it is believed that most of the catch was made in the Arafura Sea, none having been found native to the mandated area.

In using the table, note that bonito and tuna sticks are processed from the fresh fish, consequently the vertical column totals for weight are incorrect. Also, the figures for shark fin production in the Palaus are confusing. It is obvious that 42,858 kg of sharks would not yield anything like 22,028 kg of fins. Quite possibly fins were removed from captured sharks, and the carcasses discarded. This, however, is mere speculation. It is likely that a digit was left out of the value for sharks in the Palaus. In any event, the figures from Table 4 are the only ones available for the last pre-war year, and are sufficiently valuable to be included in this report.

No figures could be found on the extent of the canning industry. The only information is that the Palau cannery at Koror, with a capacity of 500 cases a day, was completed in 1939, and operated at capacity for a short time in 1940. It packed tuna in oil, and was the only cannery in the mandated islands operating on a commercial scale.

History of the Japanese Bonito Fishery in the ex-mandate.-The length of time required to establish a new fishery is well illustrated by Japanese experience in attempting to exploit the bonito resources. Although they were in control from 1914 on, it was not until the middle twenties that enough information had been gathered to indicate the possibility of a large fishery. Their first attempts were in the vicinity of Saipan, but because of the shortage of live bait, the results were not encouraging. Further search showed that a much greater supply of bait existed in the Palaus, and special attention was given to this area.

Table 4--Production from the more important marine fisheries at centers in the mandated islands, 1941

Weight in Kilograms--Value in ¥en
2.2 Pounds 4 ¥en to Dollar

		SAIPAN	YAP	PALAUS	TRUK	PONAPE	JALUIT	TOTAL
Bonito	Kg	1,297,354		3,308,160	4,346,259	2,424,260	169,020	11,545,053
Fresh	¥	358,996		827,040	1,118,166	509,094	105,638	2,918,934
Bonito	Kg	182,152		370,290	724,800	332,266	24,332	1,333,840
Sticks	¥	491,227		907,210	2,011,718	774,384	65,895	4,250,434
Tuna	Kg	33,669		906,150	24,150	12,768	46,356	1,023,093
Fresh	¥	19,913		253,722	5,847	9,150	27,073	315,705
Tuna	Kg			54,533	3,956	2,730	5,500	66,719
Sticks	¥			97,069	11,373	6,552	14,888	129,882
Horse	Kg	4,014	1,896	1,613	7,559	14,830		29,932
Mackerel	¥	2,302	1,251	1,290	4,031	7,425		16,299
King	Kg	5,767		14,092				19,859
Mackerel	¥	3,356		11,555				14,911
Mullet	Kg	75				6,075		6,150
Fresh	¥	40				3,037		3,077
Sharks	Kg	10,705		42,858		2,665		56,228
	¥	3,012		214 ?		527		3,753
Shark	Kg	150		22,028				22,178
Fins	¥	500		44,056				44,556
Other	Kg	288,688	46,742	334,877	56,419	134,973	26,724	828,405
Fish	¥	105,033	24,779	174,137	22,765	67,486	13,362	407,556
Trochus	Kg		21,080	1/	48,835			69,875
Shells	¥		2,524		6,479			9,003
White Pearl	Kg			212,688 2/				212,688
Shell	¥			183,430				183,430
Black Pearl	Kg			559				559
Shell	¥			50				50
Sea Cucumbers	Kg	2,117	3,136	9,556	14,486	9,172		38,477
(Trepang)	¥	4,437	4,892	12,723	22,227	15,317		59,596
Coral	Kg			18,236				18,236
	¥			261,305				261,305
Other	Kg	53,555		206,875	135,131	12,075		407,576
Shells	¥	12,179		35,758	30,269	2,415		80,621
Totals	Kg	1,878,236	72,854	5,502,515	5,361,595	2,951,814	271,932	
	¥	1,000,995	33,446	2,809,559	3,232,875	1,395,387	226,856	8,699,118

1/ No open season for Trochus in the Palaus in 1941 (So stated in Japanese report).
2/ Pearling fleet based at Koror, Palaus, but shells taken elsewhere (Author's note).

In the late 1920's bait fish were found at Truk, and development there began. Realizing that some form of subsidy would be needed to get commercial production started, the Japanese Ministry of Agriculture and Commerce offered special inducements to Okinawan fishermen who would migrate to the new centers. These inducements were in the nature of cash awards for the construction and outfitting of fishing vessels and for shore installations. As production increased and the fishery got on a more stable basis, a number of fishermen organized cooperative fishery companies, while others operated their own vessels independently. By the early 1930's, operations had been extended from the original localities around Saipan, Truk and Palau, to Ponape, Kusiae, Yap and Jaluit. Because of the long distance involved (approximately 2000 miles from Tokyo to the Palaus), the catch was processed for export in the form of dried bonito sticks, which represented about 17 percent of the round weight of fish, as shown in table 5. It is interesting to note that producers of this item in the Japanese homeland were not pleased to have competition from a new direction and at first adopted customary methods of trying to freeze out competition.

Table 5—Weight Relation of Bonito Sticks to Fresh Bonito.

	Pounds		
Year	Fresh Bonito	Bonito Sticks	Percent
1936	14,265,772	2,422,856	17
1937	34,060,809	5,812,745	17
1938	14,958,592	2,501,222	17
1941	11,545,053	1,333,840	11.6 1/

1/ It is reasonable to suppose that this low figure was in some way connected with beginning of the war.

The Fishing Industry during the War Years, 1942-1945.-In order to make clear the post-war status of fisheries in the ex-mandate, we must bridge the gap between pre-war development and the end of hostilities. Our data on this transitional phase from peace to war are in part from native observers and in part from Japanese reports. From statistics of production and processing (table 4) we can obtain a fair estimate of conditions in the fishing industry of the mandate in 1941, as Japan was about to enter the war. The bulk of the production of food fish was in the Carolines, at Truk, Palaus, and Ponape in that order, followed by Saipan in the Marianas, and a small amount from Jaluit in the Marshalls. As the Yap production is not excessive for local consumption, it is unlikely that any was exported to the homeland.

Of the population, native and Japanese, to be fed largely from local sources as the war progressed, we have no exact record, though Japanese were undoubtedly more numerous than the 1935-37 census shows. Garrisons of Japanese soldiers and/or sailors were sent in later. Japanese civilians in 1935-37 numbered 52,620 in the mandate, and there were 51,185 natives, excluding Guamanians.

Table 6—Population, Main Islands, Japanese Mandated Area, 1935-37 1/

Island Group	Japanese	Natives	Totals
MARIANAS 2/	39,327	4,345	43,672
Saipan	20,280	3,282	
Tinian	14,108	25	
Rota	4,841	764	
CAROLINES	12,783	36,737	49,520
Palaus	7,825	5,747	
Ponape	2,478	5,601	
Truk	1,978	10,344	
Yap	392	3,713	
MARSHALLS	510	10,103	10,613
Jaluit	428	1,989	
TOTALS	52,620	51,185	103,805

1/ From South Seas Statistical Yearbook.
2/ Excluding Guam, Native population 19,455 in 1935.

The first year of war (1942),being for the most part replete with Japanese vistories, had little effect on the fishing industry. From 1943 on, however, shortages became increasingly stringent in every category except labor. Until the heavy bombings of Japanese industry in 1945, most scarcities were due to lack of shipping rather than to production or supply. This was especially true of netting, engines and parts, and fishing implements including hooks. Among the most crippling shortages was fuel, including gasoline, diesel and lubricating oil. In the main, fish production continued at relatively normal levels until the United States Fleets began their series of paralyzing air strikes. These began by destroying plants, docks and utilities, but as shore targets became fewer, pilots turned their attention to vessels, finally sinking all but a handful of small craft. By the end of the war, no usable shore facilities remained at Koror (Palaus), Truk, Ponape,Kusiae or Jaluit. All fishing craft at Saipan were sunk prior to our landings there. Less than five were afloat at the other Japanese fishing bases.

Evidence of the effectiveness of air warfare is best seen at Truk, where no invasion was attempted. The pre-war retail price of whole fresh bonito weighing 6 to 8 pounds was 3 or 4 ¥en per fish. Toward the end of the war the price per fish rose to 100 ¥en. At this stage,

the Japanese found it necessary to obtain additional supplies of fish by using explosives on the reefs, a practice which not only reduced food fish but also bait fish.

Post-war Status of the Bonito Fishery.-Beginning shortly after the Japanese surrender, both Japanese and Okinawan civilians, including fishermen, were repatriated. The last to leave were Okinawan fishermen from Tinian about mid-June, 1946. Since few natives were familiar with the Japanese or Okinawan fishing methods, with shore facilities damaged beyond repair, with fishing vessels subject to salvage and in most cases major hull and engine reconditioning, it is not surprising that there has been no revival of the industry in spite of the ready market for dried bonito in Japan.

The one exception to the above general condition has been at Saipan, where shortly after the invasion Lt. G. M. Taggart, USNR, salvaged four sunk Japanese fishing vessels and started them producing bonito with Japanese crews. By the time the Japanese were repatriated, two native crews were able to carry on using Japanese methods. Since these methods have proven successful they will be described later in considerable detail, as it is believed that they must be the basis for redevelopment of bonito fishing in native hands. There can be no question of the ability of natives to own and operate modern diesel-powered fishing vessels up to 75 feet in length, and many native fishermen at Koror, Ponape, Kusiae and in the Marshalls have expressed a desire to do so.

Notes on the Improbability of Trading with the Japanese.-A basic function of the fisheries portion of the Economic Survey was to determine not only what resources existed, but also how they might be utilized for increasing native income. The existence of large quantities of bonito around the ex-mandate was already known, and when it became obvious that natives were capable of engaging in the fishery with skill and energy, there seemed no reason why immediate steps should not be taken to produce and export dried bonito to Japan where, according to report, a serious shortage of seafoods existed. Also it was learned that there were already in Japan, stockpiles of such necessary items as diesel engine replacements, bait netting, hooks and other fishing gear with which to outfit a number of sunk Japanese fishing vessels which could be salvaged and repaired at relatively small expenditure of time and money. The problem was particularly urgent because as a result of the war, the natives were not as well off under United States administration as they had been in the pre-war years under the Japanese. It was felt that every effort should be made to increase native income at the earliest possible moment to balance higher prices

of American goods sold in place of Japanese merchandise. If efforts were not made toward this end, there would be justifiable criticism of American administration.

But there are a number of reasons why it is difficult to do business with Japan. Probably it is unnecessary to go beyond the fact that Japanese currency is blocked—they haven't any money with which to buy anything. Nor is it possible either to place orders with, or sell goods directly to, Japanese producers or wholesalers. The established procedure for purchasing Japanese products is to place an order with SCAP or the U. S. Commercial Company. If approved, the order will be sent to the Japanese Government clearing house, which has the product manufactured. In selling to Japan, it appears that it can only be done on an involved barter basis, for example, bait netting traded for dried bonito, no money changing hands. Such an arrangement was clearly impossible as a means of putting the bonito fishery on a paying basis, and further attempts to rehabilitate the industry were held in abeyance pending a change in the system, or until United States funds might be made available directly to a rehabilitation project.

Japanese Method of Bonito Fishing—Native crew, Saipan, June 1946. The importance of the bonito fishery, not only at Saipan, but at other bases throughout the former mandated area, warrants a full description of the method of fishing, since it will become a pattern for future operations. The sequence of activities is reported from an actual day of fishing out of Saipan with a native Chamorro crew of 26. The Japanese vessel, locally called a sampan, was of the type shown in figure 19.

Departure from the dock was at 0400 (dark), and by 0545(first dawn) the vessel was standing close inshore along the cliffs of Tinian to search for live bait. As soon as it was light enough to see, the vessel moved slowly along the cliffs, and a diver was sent over about every hundred feet until one of them located a school of small anchovies, *Anchoviella purpureus*. The vessel moved ahead approximately a hundred yards and was quickly anchored from bow and stern parallel to shore and less than a hundred feet from the cliffs. While this was done, a dozen divers formed a line extending fifty feet out from the cliffs and began slowly swimming and splashing toward ship, driving the bait ahead of them. From the vessel, two or three lines with a hook at the end were carried ashore by swimmers and fastened to the rocks at water level to hold the ship from drifting away from shore. They were then in position to set the bait net, which measured 30 by 60 feet, and of very heavy bobbinet. This net was stretched between the ship and cliffs, with one short edge inshore, the other on the ship. The short edge which was pulled to shore by divers (figure 20) was held at the surface by a bundle of bamboo, acting as a float. The leading edge of the net (nearest the bait fish) was weighted down at or near the bottom with rocks. The trailing edge away from the fish was held at the surface. If necessary, additional divers go over

Figure 19.- Japanese Fishing Vessel,"Sampan", Truk.

Figure 20.- Bonito Fishing, Saipan, No. 1, Laying out Live Bait.

the side to form a semicircle around the school, driving them into the net by swimming and splashing as shown in figure 21. As soon as the bait were within the leading edge of the net it was lifted to the surface. Some of the net was taken aboard, and some was rolled around the bamboo float until the bait were brought alongside (figure 22). They were then bailed into two large tanks amidship (figure 23). The tanks were formed by two water-tight bulkheads, further subdivided into two tanks. In this section of the hull, 2-inch holes were drilled through the bottom to provide circulation of sea water. Bait and tanks are shown in figure 24. Since circulation is dependent on motion of the vessel, bait can be kept alive only a few hours, not overnight.

After an hour spent in getting bait, the vessel moved offshore and began looking for flocks of seagulls feeding at the surface, the usual indication of bonito. When fish were sighted, the ship was brought across the head of the school about a hundred yards away, the motor thrown out of gear, and small quantities of live bait were scattered around the ship to attract the fish. Once bonito were attracted alongside, there was a definite division of labor among the fishermen. Seventeen men fished with poles; four men across the stern and 13 men along the port rail from bow to stern. No fish was done on the starboard side because the vessel drifted in that direction. One man on the starboard quarter threw live bait over the stern to keep fish attracted there. Amidships on the port side, one man threw live bait both fore and aft for the fishermen there. Two men got bait from the tanks, while two others passed it to the bait throwers. One man took care of the fish as they were swung aboard, and the Captain and Engineer fished as their other duties permitted.

Throughout the fishing, salt water was sprayed over the side from nozzles spaced about every four feet. Nozzles at the stern are shown in figure 26. There were eleven nozzles on the port side and three on the stern. The purpose of this spraying is twofold: first, it tends to prevent the fish from being frightened by sight of the fishermen; second, the action of the spray on the water is similar to a school of bait fish trying to escape. As will be seen in the illustrations, each fisherman has a heavy bamboo pole about 10 feet long to which is attached a heavy line of the same length. Attached to the line by a short wire leader is a barbless hook with an ounce weight molded to the shank. The hook may either be baited with one or two live anchovies, or have white feathers attached. The feather jig is used first, and is towed back and forth at the surface. After a few minutes the bonito seem to realize that the jig is not alive and cease striking at it. This jig is then removed and the plain barbless hook is put on with live bait attached through both lips. Fishing continues until the bonito sound or the live bait is exhausted.

Figure 21.- Bonito Fishing, Saipan, No.2, Driving Bait into Net.

Figure 22.- Bonito Fishing, Saipan, No. 3, Drying up Live Bait.

Figure 23.- Bonito Fishing, Saipan, No. 4, Bailing Live Bait.

Figure 24.- Bonito Fishing, Saipan, No. 5, Bait.

Figure 25.- Bonito Fishing, Saipan, No. 6, Salt Water Sprayer.

Figure 26.- Bonito Fishing, Saipan, No. 7, Jigging Bonito.

The actual fishing requires considerable skill and dexterity. As soon as a fish strikes, the fisherman leans back and down, heaving the fish quickly out of the water and toward the ship. The amount of power put into the heave is gauged carefully so that the fish will come aboard at about the height of the fisherman's waist. He grabs the fish under his left arm, removes the hook if it hasn't come out of its own accord, throws the fish on the deck behind him and drops the hook back into the water. Some fishermen were so skillful that they heaved the fish aboard, disengaged the hook in the air, and dropped the hook back overboard in practically one movement. Experts caught 10 to 12 bonito per minute using the feather jig which required no time for rebaiting. See figure 25. A total of 4017 pounds of bonito was caught in 65 minutes of fishing. The average weight per fish was 9.5 pounds.

It is suggested that it might be worthwhile to undertake experiments with some type of purse seine or lampara net for taking bonito. Certainly there are many difficulties involved, especially the rapidity with which the schools of fish travel, the transparency of the water, and the fact that there is no smooth bottom in shallow water. Quite possibly the operations would have to be carried on at night. Such a method would make possible the establishment of fisheries in localities where bait fish are not abundant. Recognizing the limitations imposed by dependence on live-bait, the Japanese experimented with purse seines in the 1920's, but were unsuccessful in developing a suitable method.

Japanese Fishery for Tuna.-Most abundant species is the yellow-fin *Neothunnus macropterus*; some albacore, *Thunnus germo* (Lacépède); also present are oriental tuna, *Thunnus orientalis*, Schlegel; big-eyed tuna, *Parathunnus mebachi*, Kishinouye, the latter not highly regarded by the Japanese.

Although the natives had taken tuna occasionally, and comparatively large supplies were known to be present, the Japanese did not develop tuna fishing until around 1940. Probably the reason for this delay was the need for larger and better equipped vessels, additional shore facilities and especially refrigeration. The establishment of a cannery in the Palaus did much to stimulate this industry. Experienced tuna fishermen from Japan, with vessels ranging in size up to 60 tons net were just getting into production at the beginning of the war. The Palaus cannery had a capacity of 500 cases a day, but it is not believed to have operated at that rate very long. There was also limited tuna fishing at Truk. In contrast to the bonito fishery, where pole fishing was employed, the tuna industry was largely long-line fishing. The depth at which the lines were fished, and the total number of hooks which could be handled per vessel are not known. Information obtained at Truk was to the effect that tuna vessels were frequently away from port two weeks or more, but natives did not know the exact localities fished. Although tuna production

was only in the neighborhood of 2,000,000 pounds in 1941, there is every reason to believe that this industry would have expanded rapidly and perhaps have reached as high a level as bonito in the course of another four or five years.

Japanese Method of Preparing Dried Bonito Sticks.- Bonito sticks, as prepared originally in Japan, and subsequently in the mandate, have several advantages chief of which is durability. They may be transported and kept without refrigeration for months. Packaging consists in wrapping each stick in paper and packing 82 pounds in a box (10 Kan= 82.67 pounds). Main requirements of the process are facilities for boiling and an oven for drying, though in order to take advantage of large runs of fish, some refrigeration is essential.

A number of women were employed in butchering, skinning, scraping, trimming and packing. In some cases they were paid a flat monthly wage of from 40 to 60 Yen, but ordinarily they received a basic wage, plus a bonus for piece work. In addition to their salaries, they obtained discarded parts of the fresh fish for home consumption. Native women were employed as well as Japanese and Okinawans. Native men were not commonly employed.

In describing the process, the present tense has been used for clarity, although the action, as far as the ex-mandate is concerned, no longer exists.

From the fishing vessels, bonito are brought in to the butchering tables, where the head is cut off and the guts removed. Gutting is generally accomplished by cutting off the entire abdominal section of the fish. Two fillets are then cut from the backbone, and these strips again cut lengthwise, making four pieces from each fish, unless they are quite small, when there may be only two pieces. Extra large fish may require cutting the fillet across again, making four pieces per side.

The strips then are placed in a single layer on steel trays which are stacked in the boiling kettles. The water temperature is kept below boiling when the fish are put in. Usually it is between 170° and 190°F. It is then slowly raised to boiling point and cooking continued for about an hour. Cooking is done at as low a temperature as possible to prevent the flesh from splitting. Fresh fish requires somewhat lower temperature than stale fish. When the cooking is completed, the fish are allowed to cool slowly, and then the skin and small bones are removed. In order to keep the original shape of the individual pieces, any cracks in the flesh, or broken pieces are carefully replaced with a paste of cooked flesh. After these repairs are made, the pieces are ready for drying.

Ovens are made of brick, 6 feet high, of which 4 feet is underground, and the other dimensions convenient to take the drying trays which may be varied in size. The latter are of wood with a bamboo screen across the bottom and are triangular in shape, approximately 3 feet on two sides, 2 feet on the third side, with a depth of three

inches. Ten of these trays were stacked on top of each other in the oven above a wood fire. The maximum temperature at the top tray was held to approximately 175°F. The strips are dried for only one hour a day and during this period the trays are interchanged in position so as to give even temperatures from top to bottom. Altogether from ten to fifteen heatings are necessary. The purpose of this slow drying is to prevent the outer flesh from drying while the interior still contains a large amount of moisture.

After the sticks are thoroughly dry, they are carefully scraped to bring them all to a uniform size and shape. The next step is to allow the sticks to mildew. They are packed in wooden boxes holding 82 pounds, covered, sealed, and stored in a warm room for about two weeks. When the sticks are covered with green mold, they are removed from the warm room and dried in the sun. This treatment removes the fat which otherwise would decompose and give a rancid flavor and taste to the sticks. After removal from the warm room and sun drying, the sticks are brushed, repacked in boxes, and placed in a sterilization room where carbon bisulfide is evaporated, and also steam sterilization is used. Following this, the mildew process is repeated twice and between treatments the sticks are again sterilized. After the final sterilization, the sticks are wrapped in paper and packed 82 pounds per box, for shipment to Japan.

OTHER MARINE RESOURCES

Sponges.-Native sponges of several unidentified species, especially of the horny (Class Demospongiae) varieties, are common throughout the ex-mandate. At Ponape, Kusiae and Likiep, they are abundant enough to be used in place of a towel after bathing, and for scouring cooking utensils. They occur in depths less than two fathoms, but no investigation was possible to determine if there were additional resources at greater depths. The specimens seen had no commercial value, and the Japanese did not attempt to harvest them.

Japanese Sponge Culture in the Marshalls.-In June and July of both 1939 and 1940, the Japanese imported live sponges to Ailinglaplap Atoll and planted them in a protected area of about 2 acres with a depth of 3 to 5 fathoms over a fine white coral sand bottom. In the absence of any Japanese records regarding this project, there is no way of determining where the sponges were brought from, how they were kept alive in transit, how many were planted, or how large each cutting was. The information presented here is from an inspection of the plantings on August 26, 1946, and conferences with natives nearby.

The method of planting was simple, and carried out by natives under Japanese supervision. Cement blocks 5 x 5 x 2 inches were used as anchors; from this block a piece of solid aluminum wire, about No. 12, stretched upward to a float made of a tightly corked and sealed Japanese beer bottle. The length of wire varied somewhat, but was long enough so that 24 sponge cuttings could be strung on it about 4 inches apart. A few wires had as many as 30 sponges on them. Not all of the cuttings survived, but mortality was not excessive, for almost all wires had 20 to 24 sponges on them. The bottle float was from 1 1/2 to 2 fathoms below the surface. The lowest sponge was 12 to 18 inches above the bottom. Anchors were spaced 10 feet apart on the bottom, sufficient to prevent fouling the wires in case of a storm, for we saw no wires which had become tangled.

According to a native informant, samples were sent to Japan, but no commercial harvest was made. A few sponges are taken by the natives for washing babies. Their method of cleaning sponges is to bury them under water and sand on the lagoon reef for 3 days, wash in salt water followed by fresh (rain) water, then dried in the sun.

Although it was impossible to make an exact count, there are several hundred sponges remaining. The aluminum wire is becoming brittle, and the sponges should be restrung or removed by August, 1947.

The sponges are a very dark blue color when alive, but after cleaning are very nearly white without bleaching. The size varied from 4 to 6 1/2 inches in largest dimension. Shape was rather irregular almost all individuals having one or more short protuberances which prevented them from having a spherical shape.

Dr. M. W. deLaubenfels reported on a sponge sent him for identification as follows: "The specimen is Spongia officinalis, subspecies mollissima, known as Fine Levant or Turkey Solid. One expects to find this exclusively in the eastern Mediterranean, and it is absent or rare elsewhere in the world. The specimen is one of the finest I have ever seen. Its fibers are a little bit weak, perhaps as a result of chemical bleaching, but in general it is worthy of enthusiasm. This is the sort of sponge that is suitable for some of the highest-price use, such as for blood absorption in surgical operations. I have tested it carefully; its elasticity, holding power, and allround 'sponginess' are superlative."

Pearl Shells.-The black lip pearl oyster, Pinctada margaritifera, is widely distributed throughout the ex-mandate. Specimens were taken at Saipan, the Palaus, Ponape, Kapingamarangi, Nukuoro, and Likiep. They are abundant only in the Palaus. Japanese figures for 1939 showed a production from the Palaus of about 2500 tons of pearl shells, but it is thought that the figure includes catches made elsewhere. In addition to the Palaus, it is believed that

Figure 27.- Equipment for Pearl Culture, Koror, July 1946.

Figure 28.- Wire Baskets for Holding Culture Pearl Oysters, Koror, July 1946.

limited commercial production would be possible at Truk and Ponape, and it would be worthwhile to attempt increasing the abundance in a number of localities such as Kusiae, Kapingamarangi, Ailinglaplap, Majuro and Eniwetok.

No specimens of the gold lip pearl oyster, Pinctada maxima, were seen at any place visited. However, it is known that the Japanese brought some live ones to Koror for their experiments in pearl culture and it is quite likely that a more thorough investigation would reveal some in that vicinity.

Pearl Culture.-Following the success of Mikimoto in commercializing the culture of pearls in Japan, numerous attempts were made to establish this industry in the mandated area, and also in the Philippines and the Dutch East Indies. The main experiments were carried on in the Palaus, where plantings were made as early as 1930, and at the time the war began, four companies were engaged in pearl culture there. There was also a planting on a smaller scale at Ebon in the Marshalls. The total number of pearls produced, and their quality, is not known, but Japanese reports for 1939 listed 17,783 pearls valued at 77,046 Yen exported from the Palaus. However, pearls were shipped whenever it was desired to do so, and the figure above does not necessarily represent the actual production in 1939.

The great advantage to culturing pearls in the Palaus and other places in the ex-mandate was the presence there of the larger black lip pearl oyster, and availability of the gold lip. Because of their larger size they were not only easier to use as hosts for mother-of-pearl blanks, but also the nacre was laid down at a more rapid rate, so that pearls could be produced in two years rather than in the 3 to 5 required for the native Japanese pearl oyster, Pinctada martensi.

A popular impression exists that a very minute speck of material is used as a base for a cultured pearl. Actually, the blank is practically the size of the finished pearl. Blanks are graduated in size, and because of the thinness of the nacre overlay, a large pearl is produced as rapidly as a smaller one. Equipment, including a slug, for culturing pearls is shown in figure 27. After the slug is inserted, the oysters are placed in wire baskets (figure 28) holding 10, and are suspended off the bottom in depths from 5 to 25 fathoms.

Trepang (Dried Sea Cucumbers, Beche-de-Mer).-A dozen species of sea cucumbers (not yet identified) are very abundant on the inshore reefs and in the lagoons of Micronesia. A few of them are eaten sparingly by the natives, usually raw, sometimes seasoned with lime juice. Six species were dried by the Japanese to make trepang, an important ingredient in oriental soups.

The usual method of preparing this delicacy was to boil, eviscerate and dry in an oven, with or without smoking, the process taking from 5 to 10 days. At least six grades are recognized; some are shown in figure 29.

Collecting sea cucumbers provided a source of cash income to natives, though information was not forthcoming as to the price paid them. No doubt it varied considerably according to species, size, abundance, condition and season. Prepared trepang was said to have sold pre-war at Truk for 5 ¥en per kilogram. which on the basis of 4 ¥en to the Dollar, would have been 57 cents per pound. It was stated to have brought 8 ¥en per kilogram in Japan, or near 91 cents per pound. Chief centers of production were Truk, the Palaus, Ponape, Saipan,and Yap. Statistics of catch and production for 1941 are given below in table 7.

Table 7--Trepang (Dried Sea Cucumbers) Catch and Production, 1941

	Catch--Sea Cucumbers		Production--Trepang	
Place	WET WEIGHT Pounds 1/	VALUE Dollars 2/	WEIGHT Pounds	VALUE Dollars
Saipan	119,673	678	4,657	1,109
Yap	68,952	1,567	6,899	1,223
Palaus	341,244	556	21,023	3,181
Truk	1,142,779	1,818	31,869	5,557
Ponape	201,784	458	20,178	3,829
TOTALS	1,874,432	5,177	84,626	14,899

1/ Japanese figures in kilograms. Conversion x 2.2.
2/ Japanese figures in ¥en. Conversion 4 ¥en to Dollar.

Trochus Shells.-Several species of trochus are common in the ex-mandate, but the one commercial species, Trochus niloticus, was found only in the Palaus and Yap. Under the direction of the South Seas Government, transplantings were made between 1930 and 1937 from the Palaus to Saipan, Truk, Ponape, Ant, Mokil, Kuop, Pakin, Ngatik, Nukuoro, Kapingamarangi, Pingelap, Jaluit, Ailinglaplap, and no doubt others unknown to us. Most transplantings seem to have been successful. From 1,000 to 12,000 were planted in a locality according to its area.

Trochus are most abundant on the outer edge of the barrier or fringing reef in depths to two fathoms. It is said that they prefer places where seaweed is present.

Collection of trochus shells was given over to the natives, who were permitted to harvest individuals over 3 inches base diameter during a two-week period in May or June. Japanese paid from 10 to 15 Sen each, the total production being shipped to Japan for making common pearl buttons. Statistics are not available showing increase in production following transplantings. In 1939 the catch seems to have been in excess of 125 tons of shells, of which about 100 tons were taken in the Palaus. No collections were made from 1942 to 1946. In the latter year the U. S. Commercial Company purchased shells from natives at Yap, Saipan, the Palaus, Truk (figure 30) and Ponope, amounting to something over a hundred tons. There is every reason to expect that future production may be 50 percent higher than pre-war.

Sea Turtles--Tortoise Shell.-Both the hawksbill, *Chelone imbricata*, and the green turtle, *Chelone mydas* or *japonica*, are found throughout the area, but more abundantly in the Carolines, less so in the Marshalls and Marianas. Females come ashore on sandy beaches during late spring and early summer to deposit their eggs, numbering up to 150. A hole is dug in the sand above high water mark, the eggs laid in and covered, then left to be incubated by the sun. The young hatch out at the end of 60 days and immediately take to the water.

The hawksbill, being carnivorous, is not highly regarded for food as the flesh spoils quickly, but the large horny scutes, or plates, on the back constitute the "tortoise shell" of commerce. Market value of the plates depend on their coloration and thickness, plain dark plates having less value than ones with a greater proportion of light area.

Turtle fishing was mostly a native pursuit, about 200 hawksbill being taken annually by spearing or netting around Truk, Ponape and the Palaus. Japanese paid from 100 to 160 Yen per kilogram for the cleaned back shells according to a native at Ponape. This would be a rate of 11 to 18 dollars per pound. Price fixed by Naval Military Government, Summer 1946, was from 36 to 60 cents per pound.

The Japanese had strict laws protecting the hawksbill. No turtles or their eggs could be taken on shore, nor could any turtle be taken measuring less than 60 centimeters (24 inches) in length.

The green turtle has no commercial value in the islands, but being herbivorous, is highly regarded for food. The common method of cooking is to bake the animal in its shell. The Japanese identified the green turtle as *Chelone japonica*, Thunberg, but it probably is identical with the Philippine species, *C. mydas*, Linn.

Figure 29.- Trepang (Dried Sea Cucumbers) Prepared by Natives at Koror, July 1946.

Figure 30.- Sorting Trochus Shells, Truk, May 1946.

GENERAL CONSIDERATIONS

United States Administration of Micronesia.-It must be borne in mind that United States control of the ex-mandate is based on military security. Regardless of whether eventual administration is military or civilian, it must be expected that certain areas will not be open to free commercial exploitation.

Under Naval Government, native welfare is very properly placed ahead of commercial exploitation by outside capital. For the present, private capital may not operate in the area, but if and when this restriction is removed United States firms will still have to comply with protective regulations relating to:

a. Conservation of natural resources.

b. Native property rights; there is no "wild" land; foreigners cannot own land.

c. Established wage scales.

d. Local customs, laws, taxes.

Physical limitations to establishment of export fisheries

Shore facilities.-Insofar as commercial availability is concerned, the following items are non-existent, and would have to be supplied by the developing company.

Fresh water on atolls must be made by evaporators. Surface wells are brackish, quantity is small, easily contaminated. High islands have a limited supply of potable water, but no systems of distribution except those serving the military.

Ice and Cold Storage plants do not exist beyond the needs of the military.

Power produced by portable gasoline or diesel generators is for use of Military Government agencies, and in any case would not be adequate for commercial needs. Japanese installations were destroyed.

Sewage and Other Disposal Systems are provided only to military areas. Japanese installations mostly were destroyed.

Housing is insufficient for the native population. Construction materials are practically non-existent. No local timber above native needs. Japanese construction levelled; some foundations could be used.

Buildings, Docks, Wharves, etc.--Some foundations could be used.

Roads, Bridges, Causeways were generally repaired to meet military requirements. May be termed passable except for such obstructions as the bridge at Koror.

Marine Repair Facilities could be rebuilt on Japanese foundations.

Aids to Navigation limited to minimum Navy requirements. Channels mostly open. Maintenance rare on markers, beacons, ranges, or channel obstructions. Mined areas partly swept. Loose and stranded mines common.

Marine Transportation is provided by commercial steamship lines from the United States to Guam only.

Within the area, main centers are served by Naval vessels supplying their bases on fairly regular schedule.

Inter-island service is irregular to say the least. Varies from outrigger canoe to small landing craft.

Local Supplies--Food, clothing, sundries can be obtained only from such Naval stores as are available to authorized personnel. U. S. Commercial Company supplies native stores.

Communication is difficult beyond main centers served by NATS. Some bases rebroadcast news daily. No commercial cable or radiograms except at Guam.

Tariff Duties on imported goods apply as from foreign countries.

Native Labor may be scarce until 1948 because of large demands for rehabilitation. Skilled labor scarce anyway because of military needs. Except on Guam, main centers could supply from 100 to 400 natives for fishing industry. This would be true at Saipan, Koror, Truk, Ponape, Kusiae, Majuro.

POISONOUS FISH

Around 125 species of central Pacific fish and other marine animals are said to be poisonous when eaten. Others, such as cone shells and sea snakes, have a venomous bite, and a third group, including corals, sea urchins and moray eels, cause wounds which frequently become infected and are difficult to heal.

The problem of poisoning from eating fish is a baffling one. Only the puffers (family Tetradontidae), and their spiny relatives, the porcupine fish (family Diodontidae), seem to be universally regarded

Figure 31.- Outrigger Paddling Canoe, Nukuoro, Caroline Islands, August 1946.

Figure 32.- Sailing Outrigger Canoes, Kapingamarangi, August 1946.

as dangerous. Other species, especially the snappers, groupers and pompanos, are poisonous in one place but harmless elsewhere. Even the virulence of the poison varies from place to place and with season of the year. As far as could be determined, there are no poisonous species in the Palaus. Elsewhere, it is good judgment to follow recommendations of the native people, who from long experience, have come to know the harmful local varieties. The only other generalization is that surface feeding fish, taken by trolling offshore, are not known to be harmful. The poison evidently originates in the food of reef and lagoon fish.

SUMMARY

Local stocks of fish are adequate for subsistence of the Micronesian native population, using their traditional fishing methods. This is assuming that they receive ample quantities of hooks, twine, netting and other fishing supplies.

Tunas, especially the yellow-fin, Neothunnus macropterus, skipjack, Euthynnus or Katsuwonus pelamis, albacore, Thunnus germo, and little tunny, Euthynnus alleteratus, are abundant enough to warrant the expectation of a fishery yielding in the neighborhood of 200,000,000 pounds annually if the problem of live bait supply can be solved.

Because of the destruction of Japanese shore facilities, a large initial investment would be required to establish a fishery. The most favorable locations would be at Koror in the Palaus, Truk, Ponape and Saipan. These are recommended because they have reasonably good conditions with respect to living, communication and labor supply, and there are known supplies of live-bait.

Factory ships would have the important advantage of mobility but might find considerable difficulty in solving supply problems, particularly for fuel and fresh water.

Other exportable products of the area include trepang; trochus, black-lip pearl oyster and tortoise shells; cultured pearls; sponges and decorative shells including giant clams.