BAITFISHING METHODS USED BY THE SKIPJACK SURVEY AND ASSESSMENT PROGRAMME AND RECOMMENDATIONS ON BAITFISHING TECHNIQUES FOR THE TROPICAL PACIFIC

J.-P. Hallier*, R.E. Kearney
and R.D. Gillett

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* Present address: ORSTOM
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CHAPTER IV

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1.0 INTRODUCTION

Most Japanese-style pole-and-line vessels based in the tropical western and central Pacific (Palau, Papua New Guinea, Solomon Islands, Fiji, etc.), and the two vessels chartered by the Skipjack Survey and Assessment Programme, use the same basic "bouki-ami" baitfishing technique. Though the net design is similar, dimensions vary considerably between vessels of different size, as does the use of bait attraction lights. From the commencement of the Programme, Commission scientists modified the conventional Japanese method on the basis of trials previously conducted by scientists from the Department of Agriculture and Fisheries in Papua New Guinea (Kearney et al. 1972).

In some fisheries, notably the Hawaiian pole-and-line fishery for skipjack, beach seines are the primary method used to capture baitfish. In April 1978, the Programme began using a beach seine to supplement bait catches made at night.

2.0 THE USE OF THE BOUKI-AMI

2.1 The Principle of Night Baiting

The principles of night baiting are the same for bouki-ami, lampara or purse-seine nets. Powerful lights are employed either above or under-water to attract fish. When sufficient fish have gathered close to the lights, a net is set to catch them. This net, when pulled, forms an enclosure or bag in which the fish are trapped. Different types of nets suit different fishing conditions and purposes, the end result being that baitfish are caught and loaded live into bait tanks.

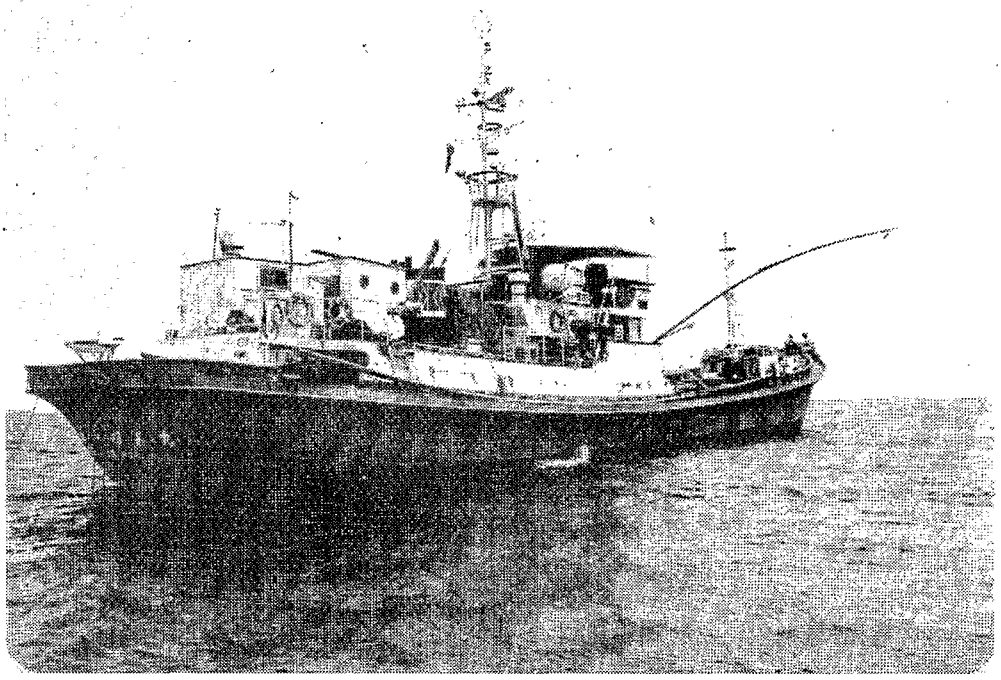
2.2 Fishing Gear

Basic gear involved in the bouki-ami fishing technique includes the vessel, the attraction lights, the net and the bait tanks. Appendix A contains technical specifications for baitfishing gear used by the Skipjack Programme.

2.2.1 The vessels

Two Japanese live-bait pole-and-line vessels, the 192-tonne Hatsutori Maru No.1 (Figure 1) and the 254-tonne Hatsutori Maru No.5, were chartered by the Programme from Hokoku Marine Products Company Limited of Tokyo, Japan. Fieldwork for the Programme during the first two 10-month cruises from October 1977 was carried out using the Hatsutori Maru No.1. During the third 10-month cruise, November 1979 to August 1980, the Hatsutori Maru No.5 was used.

FIGURE 1. THE STARBOARD SIDE OF THE HATSUTORI MARU NO.5. On this type of vessel most of the sponson along the starboard side is devoted to baitfishing. Note the bamboo net float which is lying on the sponson from the stern to the forecastle. Also visible is the pole for the net light extending over the water from the wheel house.



On standard Japanese pole-and-line vessels, most of the sponson (a ramp, 50 cm wide, that encircles the ship and is attached to the outboard and just below the ship's gunwhale) along the starboard side is devoted to baitfishing operations; the port-side sponson, as well as the bow and stern, are reserved for pole-and-line fishing (Figure 1).

2.2.2 Attraction lights

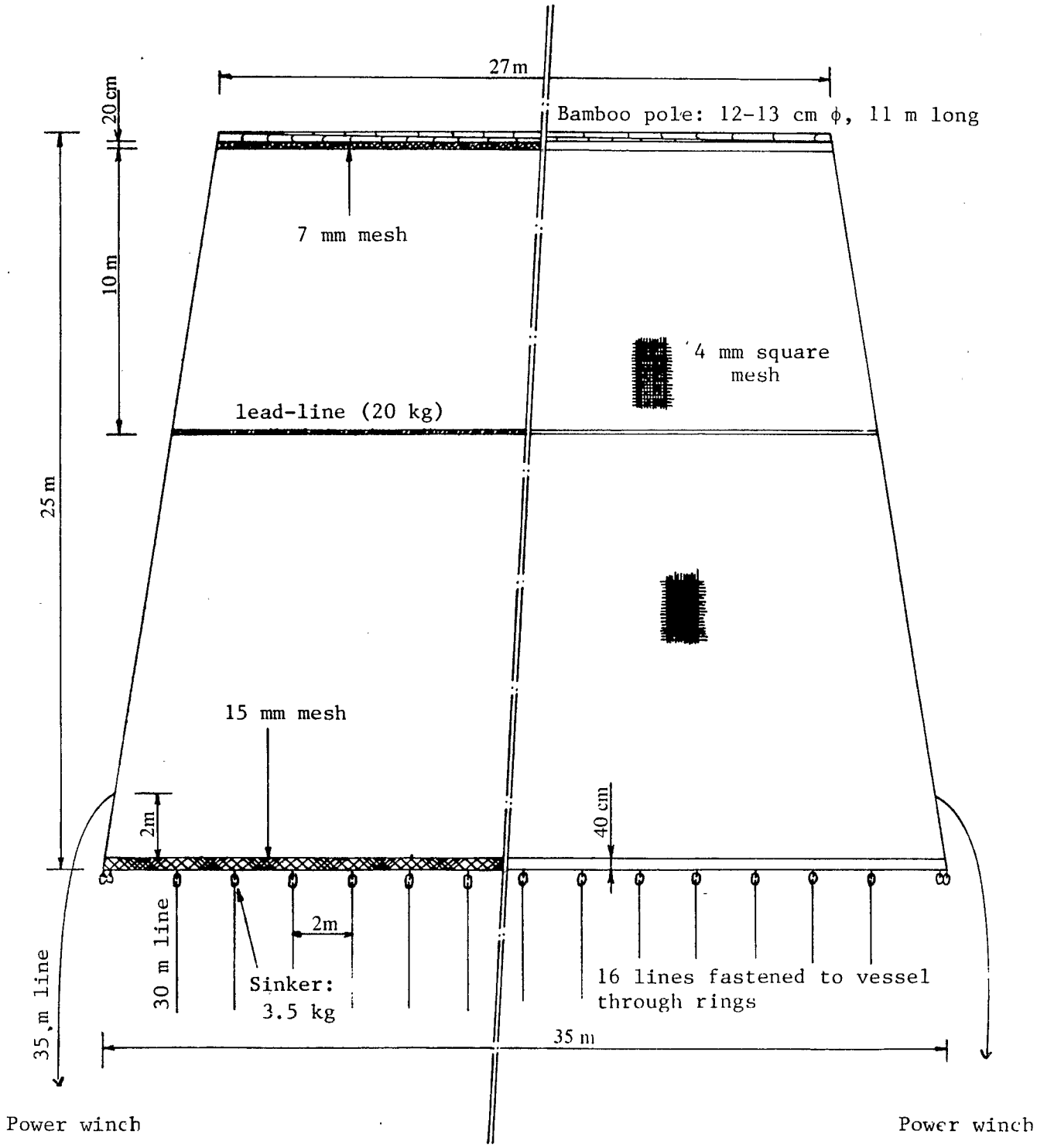
Most Japanese-style pole-and-line vessels operating in the central and western Pacific use underwater lights which are considered efficient in attracting most bait species. These lights are set between the surface and a normal maximum depth of 20 metres.

Bait lights are normally powered by AC current of 100 to 220 volts, according to availability. Power can be supplied either directly from the vessel's main electric system or from independent generators. The Programme initially used underwater lights of 1000 to 2000 watts and later added above-water lights of 100 to 1000 watts. During the transfer of bait from the bouki-ami net into the ship's bait tanks, one or more 40-watt above-water lamps were used to help control the behaviour of the bait within the net and to illuminate part of the deck.

2.2.3 The bouki-ami net

A bouki-ami consists of a sheet of fine mesh netting mounted on a bamboo frame (Figure 2). The net used on the Hatsutori Maru No.1 was 25 metres long at the top, 27 metres at the bottom and 23 metres deep, while the one used on

FIGURE 2. PLAN OF THE BOUKI-AMI USED ON THE HATSUTORI MARU NO.5



20 Sinkers: 16 single + 2 double
(i.e. 2 weights at each end)

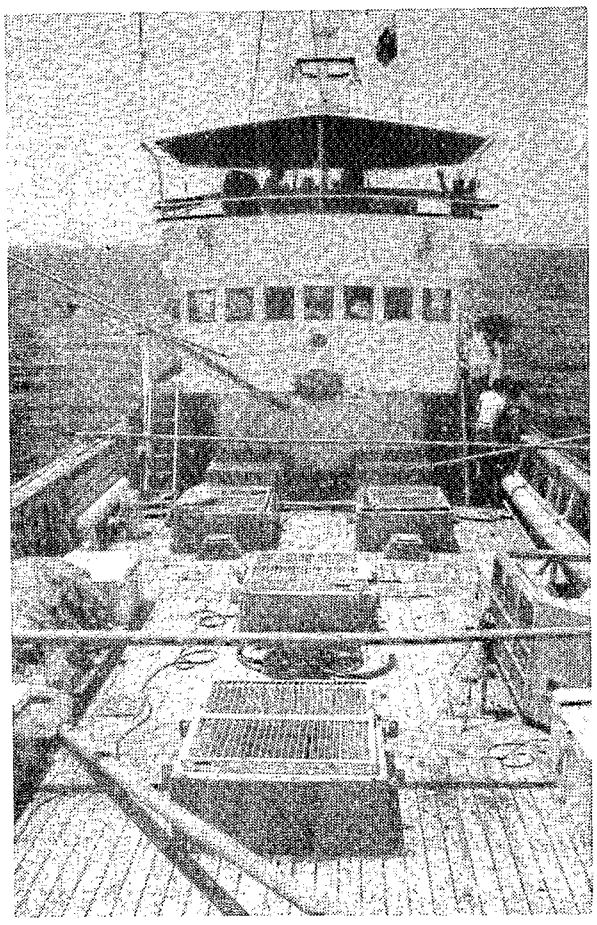
the Hatsutori Maru No.5 was larger, 27 x 35 x 25 metres. Both nets were made from 4 mm square mesh knotless netting made of brown polyamide nylon. Descriptions of the use of this type of net appear in many publications, one of the most recent by Ben Yami (1980). On the Hatsutori Maru No.1, the bottom edge of the net was weighted with 20 sinkers, of 3.5 kg each, placed 2 metres apart with two at each corner. A 20-kg lead-line was attached to the net a third of the distance from the top edge. This helped to keep the net vertical before hauling and prevented folds from forming in the bag while the net was being closed. Eighteen 30-metre lines attached from the sponson to the bottom lead-line allowed the net to be hauled. Two lines, attached on the fore and aft net sides, 2 metres from the bottom of the net, were hauled by power winches and ensured faster closure of the net.

The net, with its bamboo frame, weights and ropes, was assembled prior to the beginning of the vessel charter. The prepared net took up most of the starboard sponson, where it was securely fastened when the ship was not baitfishing.

2.2.4 Bait tanks

On Japanese pole-and-line vessels there are two types of bait tanks: large tanks on the main deck in which baitfish are kept after their capture, and small chumming tanks from which bait is thrown when fishing for skipjack and other tunas. On the Hatsutori Maru No.1, five large bait tanks held a total of 80 cubic metres of water; on the Hatsutori Maru No.5 (Figure 3), seven bait tanks contained 116 cubic metres. All tanks were rectangular in profile.

FIGURE 3. MIDDECK OF THE HATSUTORI MARU NO.5 SHOWING SIX OF THE SEVEN BAIT TANKS. Also visible on the right is the bait transporter (see Section 3.3)



Three types of water circulation systems were used:

(a) Bottom inflow and top outflow

In this type of tank the inflow pipe (20 to 30 cm in diameter) was fixed along three of the inside walls of the well, a few centimetres above the bottom. The pipe was drilled with approximately thirty holes (1.4 cm in diameter) that were regularly distributed along its length. Water was drained off at the top of the tank through an outlet which was covered by a grill to prevent bait from escaping.

(b) Top inflow and bottom outflow

In this tank, water inflow was through a pipe similar to that described in (a), but this pipe was set at the top of the tank just below the top of the walls. The water inflow was directed towards the bottom of the tank where the water was drained through a grill-covered outlet. There was an overflow at the top of the tank for the discharge of excess water, particularly when the bottom grill became blocked with dead bait.

(c) Lateral inflow and top outflow

Water inflow for this tank was through two vertical pipes placed at opposite corners of the tank; holes in these pipes were drilled in such a way that a circular, almost horizontal water movement was created. Outflow was from the standard grill-covered outlet at the top of the tank.

On the Hatsutori Maru No.1, three tanks had a bottom inflow system, one a top inflow system and one a lateral inflow system. All tanks, except one, had cooling coils on the bottom and sides in order to store frozen fish when the vessel was fishing commercially. Five centrifugal HITACHI 2.2 Kw pumps, operating at 1800 rpm, ensured complete water renewal in every tank within 20 to 30 minutes.

On the Hatsutori Maru No.5, three tanks had a bottom inflow system and four a top inflow system. Five of the tanks could be used as freezer holds. Five centrifugal NANIWA 3.7 Kw pumps operated at 1800 rpm and renewed the water in each tank in 15 to 30 minutes.

On both chartered vessels there were two chumming tanks, one at port-stern and the other at port-bow. These small round tanks (265 litres on the Hatsutori Maru No.1 and 375 litres on the No.5) had continuous water turnover approximately every 3 minutes.

2.3 The Bouki-Ami Fishing Technique

Night baitfishing with a bouki-ami is normally a labour-intensive technique requiring at least 20 crew on vessels the size of the Hatsutori Maru Nos. 1 or 5. The sequence for a normal operation can be summarised as follows.

2.3.1 Preparation of the net

Once the ship was anchored at a suitable baitfishing location, the crew untied the bouki-ami and readied the numerous lines. To position the net for fishing, bamboo poles, hereafter called cross-poles, were fastened at right angles to each end and to the middle of the bamboo float. This enabled the net to be moved seaward from the starboard side of the vessel. Prior to setting, the net rested on the starboard sponson with the cross-poles resting on the gunwhales (Figure 3). On both chartered vessels, 12 bamboo poles were needed: six as floats and six (three joined pairs) as cross-poles.

2.3.2 Setting the attraction lights (Step 1 of Figure 4)

Unless the Captain knew the baitfishing ground very well, and knew that it was clear of major obstacles, the vessel was generally anchored before dusk, after echo-sounding for a suitable bottom. An underwater light was then suspended from a skiff tethered at a distance of about 100 metres from the stern of the vessel. Sometimes a second light powered by a generator in another skiff was independently moored at some distance from the parent vessel.

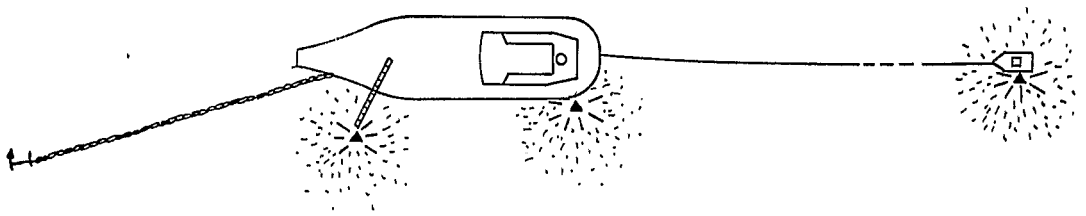
The Programme's research vessels each carried two sturdy fibreglass skiffs. These skiffs were 5.5 metres long and 1.5 metres wide and both were at times used to set underwater lights away from the main vessel. Both research vessels carried two 110-volt generators specifically to supply power for the underwater lights used from the skiffs; each generator provided power for one 1500-watt underwater light. Before nightfall, the 1500-watt light was immersed 10 metres under the skiff, the generator was started and the skiff allowed to drift away from the stern of the ship on its 100-metre-long towline. At the same time, on the port-side near the bow, a 2000-watt light was immersed to a depth of 15 metres. This light was suspended from a bamboo pole which extended about 5 metres from the port-side sponson. A third underwater light of between 1000 and 2000 watts was occasionally set 7 to 10 metres underwater at the stern. Rheostats enabled the light intensity to be varied as required. On the research vessels, two underwater lights, in addition to the skiff light, were controlled by rheostats.

2.3.3 Checking the quantity of bait (Step 2 of Figure 4)

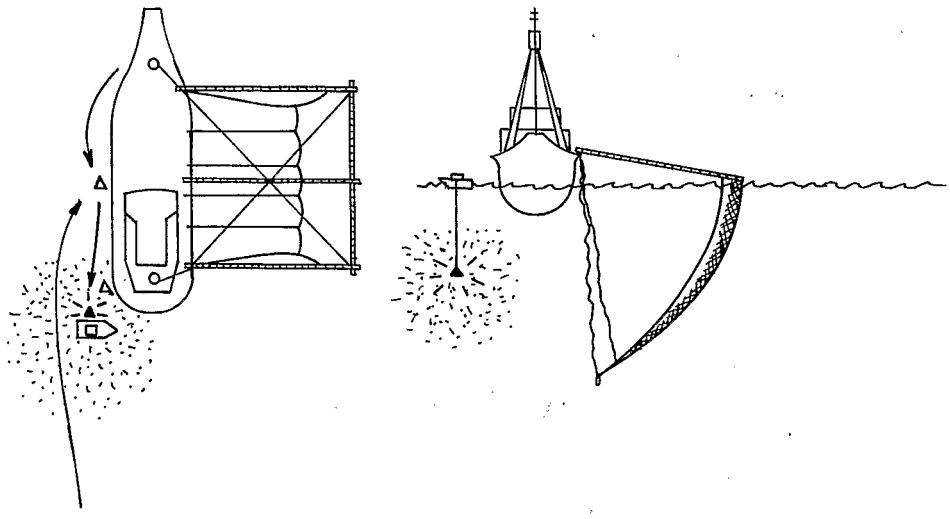
After the lights had been operating for four or five hours, a check for the presence of bait was made. The skiff light and the underwater bow light were moved along the port-side to midship. As the skiff was slowly drawn to the stern of the ship, and subsequently to midship, the stern light, if used, was gradually dimmed to zero, merging the two schools of bait. Simultaneously, the bow light was brought up from a depth of 15 metres to a depth of about 7 metres, and was moved from bow to port midship. The quantity of baitfish present was then checked with an underwater viewing glass from the skiff, and with an echo-sounder. If, on inspection, the quantity of bait was considered to be insufficient, then all lights were switched on again and moved back to their original positions. When sufficient bait had gathered, bait catching operations started.

FIGURE 4. THE DIFFERENT STEPS OF THE CONVENTIONAL BOUKI-AMI TECHNIQUE

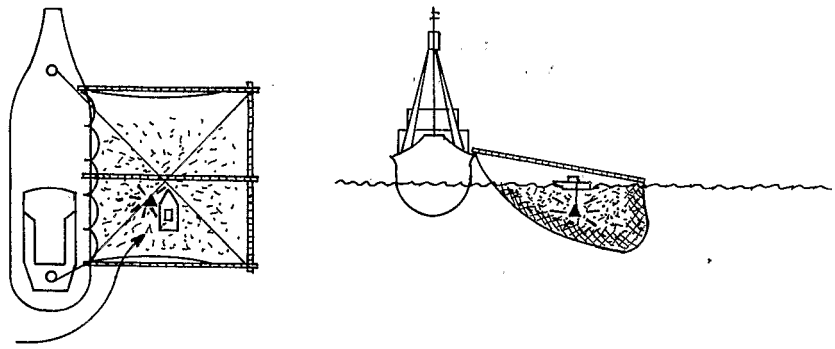
1. Attraction lights on



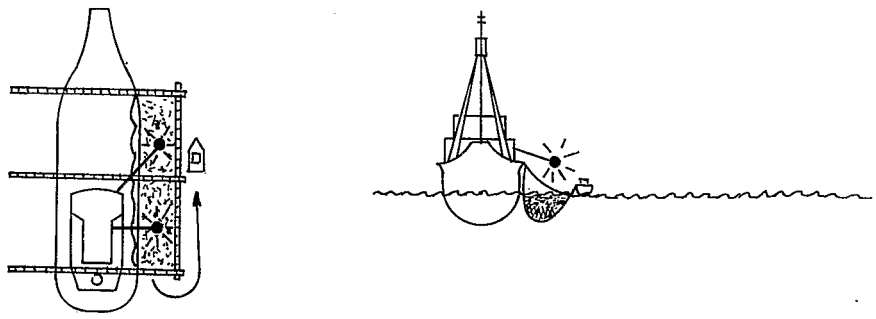
2. Checking the bait and setting the net



3. Concentrating the bait and hauling the net



4. Crowding the bait (see Figure 6)



2.3.4 Setting the net (Step 2 of Figure 4)

Available crew then took up positions on the starboard sponson and at the ends of the three cross-poles. The bamboo float was then lowered from the sponson into the water and gently pushed by the cross-poles away from the vessel. The net, which had been lying along the starboard sponson, then gradually spread out. When the bamboo float was about 18 metres from the side of the ship, the ends of the cross-poles were securely fastened to the ship's gunwhale and two spring lines were tied diagonally across the net to strengthen the framework. The bottom of the net, along with the sinkers and connecting lines, were then thrown overboard from their position on the sponson. While the net was sinking, the fishermen checked the tension on the lines to make sure that the net was spreading out evenly. The fishing master or the Captain also checked the position of the net from the upper deck. The area bound by the bamboo, the net and the vessel formed a box, which on the Hatsutori Maru Nos. 1 and 5 was approximately 26 metres long by 18 metres wide. The attracted bait had then to be drawn to a catching position between the net and the vessel before the net was raised from its vertical position under the bamboo float.

2.3.5 Concentration of the bait (Step 3 of Figure 4)

At this stage, under the conventional Japanese system, two men direct the skiff and its light, around which the bait has gathered, towards the starboard side of the ship. The skiff passes under the stern cross-pole and is moved forward to the middle of the rectangle formed by the bamboo frame and the ship. All movements of the skiff and the attached light must be very slow so that the baitfish follow the light and do not panic. When the skiff reaches the middle cross-pole, the light intensity is reduced. The degree of dimming depends upon the brightness of the moon, the water clarity and the species of bait present. In addition, the light is brought up slowly from a depth of 10 metres to within 1 metre of the surface. The purpose of these two simultaneous operations is to aggregate the baitfish and bring them close to the surface where they are more vulnerable to the net. Baitfish behaviour is monitored with an underwater viewing glass and an echo-sounder. If the bait does not gather satisfactorily around the light, further adjustments of the light are made. If all is well, the net is hauled.

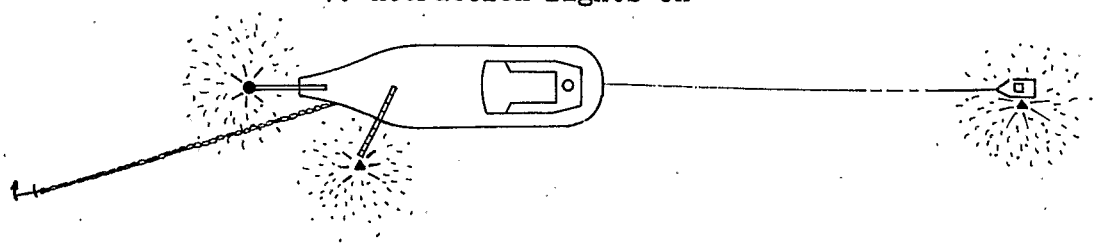
Scientists on board the survey vessels found that the cumbersome operation of bringing the skiff with the underwater light into the framework of the net could easily be replaced by suspending an underwater light in the centre of the net's frame. This modification was first made at the beginning of the Programme in October 1977, and was used with few exceptions during the three years of the Programme's fieldwork. A 2000-watt light was attached to a rope which slid on a pulley at the end of an 8-metre bamboo pole overhanging the bouki-ami. These fittings allowed both the depth of the light and its distance from the ship's side to be adjusted as required. The light was normally set about 6 metres below the surface. After the bait had been gathered around the underwater light at port midship (Section 2.3.2) and the net had been set, the 2000-watt underwater light between the net and the vessel was switched on, and the port light dimmed to effect transfer of bait to the light between the net and the vessel (step 3 of Figure 5).

2.3.6 Hauling of the net (Steps 3 and 4 of Figure 5)

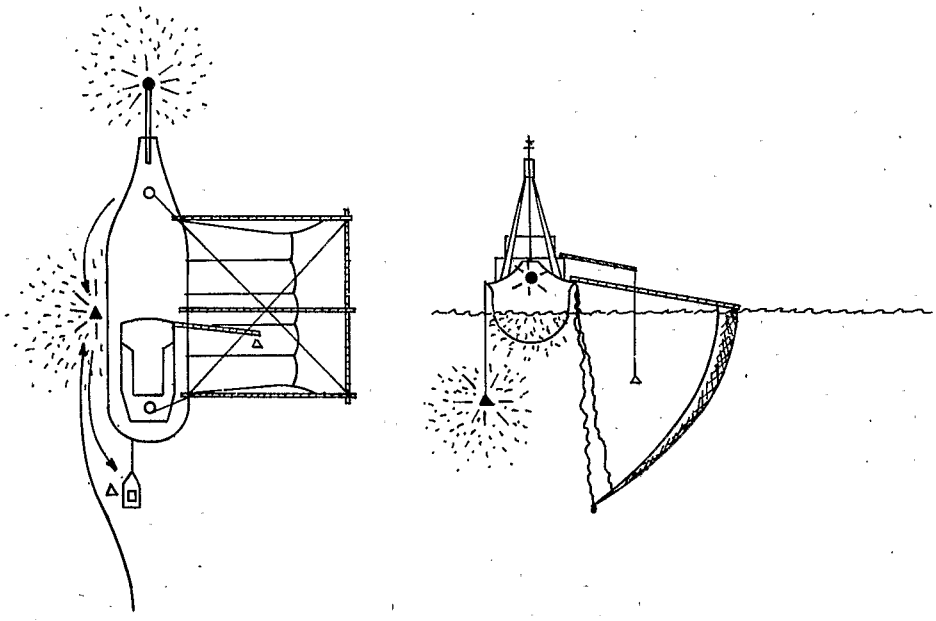
When the Captain and scientists agreed that the bait had concentrated around the light between the vessel and the bamboo float, the signal was

FIGURE 5. THE DIFFERENT STEPS OF THE BOUKI-AMI TECHNIQUE AS MODIFIED BY THE SCIENTISTS OF THE SKIPJACK PROGRAMME

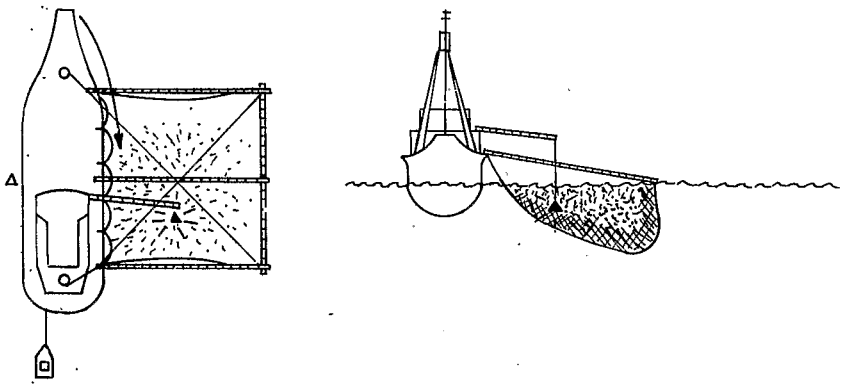
1. Attraction lights on



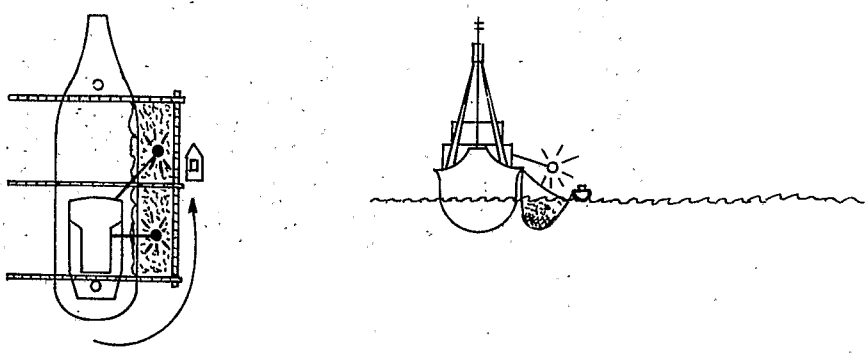
2. Checking the bait and setting the net



3. Concentrating the bait and hauling the net



4. Crowding the bait (see Figure 6)

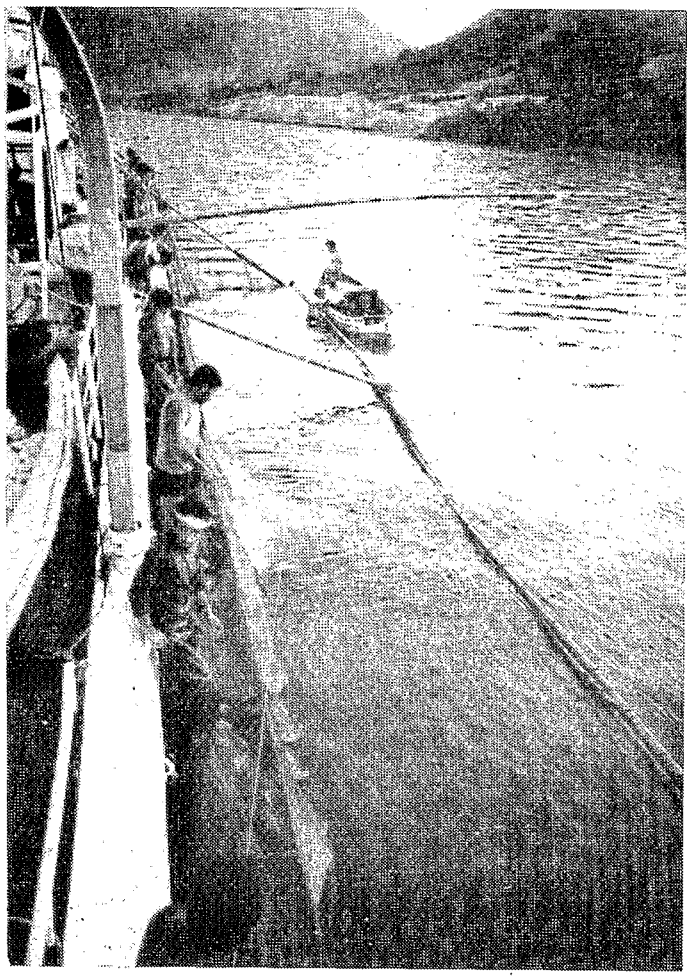


given for the crew to begin pulling the ropes. The two side ropes, which were under considerable tension, were hauled by power winches located at the bow and at the stern of the ship. These closed the fore and aft sides of the net while the ropes attached to the bottom of the net were pulled more slowly by hand.

With all net edges at the surface, the enclosure, or bag, thus formed trapped the bait. As soon as this bag was properly closed, the underwater light in the net was switched off and removed from the water. The skiff was then moved out of the net by the same route as it was entered.

The size of the bag was gradually reduced by hauling the net on board and pulling in the bamboo cross-poles. This work was carried out with the help of the two men in the skiff. During these operations, aimed at concentrating the baitfish, the lead-line incorporated into the mid-section of the net helps to keep folds from forming in the net, thereby preventing live bait from being trapped in small pockets. However, when currents or winds are strong, this lead-line is often not sufficient and additional weights, which are attached to lines connected in board of the sponson, are thrown into the bottom of the net. These weights are gradually removed as the size of the bag is reduced. The final size of the bag depends on the size of the catch, but generally the depth in the bag is kept to between 1 and 2 metres to assist loading, and the width is usually reduced to about 2.5 metres. At this stage, small deck lights are switched on over the net and on the deck to illuminate the loading operation, or the net is left as it is and the bait loaded after daybreak, as shown in Figure 6.

FIGURE 6. CROWDING THE BAIT (Step 4 of Figures 4 and 5)



2.3.7 Loading of bait

The final crowding of the bait in the net took place at the middle of the starboard side of the fishing vessel where the sponson is lowest; this made it easier to transfer the buckets of baitfish and water from the net to the bait tanks. When the bait was crowded into this restricted area, only limited effort was needed to continue adjusting the net, therefore most fishermen were free to assist with loading the bait into the bait tanks.

A plank was then placed across the net, one end resting on the skiff and the other suspended from a strong rope attached to the gunwhale. Two men were positioned on the plank; one guided or scooped the bait into buckets filled with water and the other lifted the full buckets and handed them to the fishermen standing on the ship's sponson, who then passed them from hand to hand (Figure 7) and emptied them gently into the bait tanks. The size of the bag formed by the net was reduced as the loading of bait proceeded.

FIGURE 7. BUCKETING BAIT FROM THE BOUKI-AMI TO THE BAIT TANKS

When all the bait had been transferred to the bait tanks, the last portion of the net and the bamboo float were pulled on to the sponson by means of the bamboo cross-poles. The net was left ready to be used again later the same night, or was tied up until the next baitfishing operation. In the latter case the cross-poles were removed and stored, and the remainder of the net and the bamboo floats simply fastened to the sponson.

Prior to loading bait onto the research vessels, an estimate was made of the amount of bait in the net bag. This estimate was used to decide which bait tanks to fill with water, and how to apportion bait amongst partially loaded and newly filled tanks. This estimate was made well before loading began so that sufficient tanks would be filled with water (15-30 minutes to

fill) ready for loading. The loading of bait tanks was rotated after every 20 buckets of bait (approximately 30 kg of bait) so that baitfish would have a chance to settle down and form slowly moving schools around the underwater lights in the tanks. Most of the bait tanks were loaded to a maximum of 100 buckets for tropical bait species, and to a maximum of 400 buckets for temperate and cultured bait species. However, these levels did fluctuate depending on such factors as amount of bait captured, weather, water temperature, bait species and their condition immediately after capture, water flow rate and capacity of particular tanks.

2.4 Additional Modifications Introduced After Commencement of the Programme

2.4.1 Echo-sounder's transducer placed into the net

During baitfishing operations, as bait moved out from under the vessel and into the netting area, their trace disappeared from the vessel's echo-sounder. The transducer of the echo-sounder was permanently located near the keel and therefore its beam did not cover the surface area between the vessel and the net where bait gathered. In order to follow bait movement at the final stage of their capture, Programme scientists used a small portable echo-sounder (see Appendix A) to which the transducer was attached by 18 metres of coaxial cable and supporting rope. The supporting rope was attached to the middle of the central cross-pole so that the transducer hung 50 cm below the water surface, in the centre of the bamboo frame and very close to where the bait was gathered. In this manner it was possible to follow bait movement during the entire capture process.

2.4.2 New light manipulation procedures

As mentioned in Section 2.3.5, the conventional Japanese method of mooring the skiff and underwater light between the net frame and vessel was replaced by using an underwater light, suspended from a pole on the starboard side. The port underwater light was gradually dimmed by means of the rheostat. Then the deep bait moved under the vessel and gathered around the starboard light. The voltage of this light was then very slowly reduced to approximately one-third of maximum intensity, and the light was raised to about 1 metre below the surface. This concentrated the bait close to the surface where it was most vulnerable to the net. The net was then hauled (Figure 5).

In some countries surveyed by the Skipjack Programme, surface bait species were more abundant than the generally more common mid-water or bottom species. In such circumstances, above-water lights were tested and found to attract more baitfish than underwater lights. In July 1978 in Kiribati, a 300-watt above-water light was suspended 5 metres above the water surface from a 3-metre bamboo pole projecting from the ship's bow. From December 1978, this light was replaced by a 1000-watt light. When the above-water light was used it was slowly walked around from the bow along the starboard sponson to a midship position and switched off just prior to hauling of the net (Step 3 of Figure 5). Normally, the surface bait followed the above-water light from the bow into the netting area and remained gathered around the glow of the underwater light.

Different light combinations were sometimes used on a trial basis. For instance, on occasions when bait was scarce, attempts to offset the very low bait density were made by increasing the number of lights and by monitoring

baitfish movements even more closely. In the lagoons of some atolls, two skiffs were used, each carrying a generator providing power to an underwater light. One skiff was kept tied up to the stern of the vessel as previously described, while the other was moored 100 to 200 metres upwind from the vessel. This enabled the moored skiff to be paddled back downwind to the vessel after bait had gathered around it. In a number of instances, an extra underwater light was set immediately below the stern of the vessel.

2.5 Advantages and Drawbacks of Modifications to the Conventional Japanese Technique

2.5.1 Advantages of the modifications

(i) The use of underwater lights on both sides of the vessel, in combination with the ship's echo-sounder and the portable sounder adjacent to the starboard underwater light, makes it possible to monitor more accurately the movement of bait under the vessel and into the netting area.

(ii) By eliminating the use of the generator and skiff during the final stages of baiting, noise levels are minimised. This was considered to increase the overall effectiveness of the lights for attracting and holding baitfish, particularly those species that normally occupied lower sections of the water column and were difficult to attract to the surface.

(iii) The addition of an above-water light greatly improves the attraction of surface bait species, thus increasing the amount of baitfish caught.

2.5.2 Drawbacks of the modifications

(i) When the moon was very bright, part of the bait attracted around the port and stern lights was lost during transfer from the port underwater light to the starboard underwater light. In these circumstances, it is more efficient to use a skiff carrying an underwater light in order to transfer bait to the starboard side.

(ii) When the skiff is used inside the net, baitfish behaviour can be visually monitored from the skiff during the net hauling phase using an underwater viewing glass. This is not possible when the skiff with its light is replaced by an underwater light controlled from the vessel. This drawback was largely overcome by the use of a portable echo-sounder with its transducer set in the netting area.

(iii) The modifications discussed required the following extra materials: one underwater light, one rheostat, one pulley, several bamboo poles, electrical cable; however, the extra cost of these materials is not great (approximately US$450 in 1982).

2.6 Recommendations for the Selection of a Light Attraction System According to Fishing Conditions

Trials over the three years of fieldwork of the Skipjack Programme led to the following recommendations for light attraction systems.

When fishing in a new baitfishing ground where species composition is unknown, or in an area where surface bait is abundant, the addition of an above-water light is recommended. If it is used in association with the conventional Japanese method, the procedure is as follows: after the skiff

with its underwater light is brought to midship on the port-side, the above-water light should be switched off. At this time the surface bait under the above-water light should move to the port-bow underwater light, which is then brought slowly towards the skiff and in turn switched off. All the bait, surface or otherwise, gathers around the skiff light. From this point, the conventional procedure continues as previously described.

When weather conditions are poor (rough seas, heavy rain), and/or when benthic or mid-water bait species are present, it is more efficient to use the fixed underwater light between the vessel and net.

At other times, and particularly during periods of full moon, the conventional method is recommended with the addition of an above-water light if surface bait species are present.

2.7 The Selection of Baitfishing Areas

The selection of a baitfishing ground is governed not only by abundance of the desired bait species, but also by physical limitations of the fishing gear. Major factors to be considered are:

2.7.1 Occurrence of desired baitfish species

Suitable bait species are mostly coastal. Populations may be resident or temporary. High abundance is often associated with presence of large shallow expanses of water, e.g. bays and lagoons, with depths ranging from a few metres to about 20 metres (Kearney *et al*. 1978). In the waters surrounding islands with mountainous topography, river sediments and extensive mangrove swamps help to provide a favourable environment for baitfish. For atolls, the size of the lagoon is often a good indicator, the larger lagoons being better.

Water clarity, which varies according to the proximity of rivers, mangrove swamps, currents, swell, etc., also affects bait abundance. For example, sprats are generally found in very clear waters, while anchovies are often associated with more cloudy waters.

2.7.2 Depth and bottom type

The depth of the net often limits the areas that can be fished. Nevertheless, if the bottom is sand or mud, and clear of obstructions, the net can be set in places where the water depth is less than the net fall. During the three years of Skipjack Programme fieldwork, the majority of baitfish hauls were made in waters between 25 and 35 metres deep; however, some sets were made in depths of 20 metres or less. On a few occasions the net was purposely set in shallow water to capture particular species such as Marquesan sardines (Gillett and Kearney 1980). Good quantities of bait are more often found on mud or muddy-sandy bottoms than in areas with pure sand.

2.7.3 Anchoring of vessel

When anchoring the ship, care must be taken to check that the area liable to be covered by the ship as it swings on its anchor is free of all obstacles such as large rock outcrops, coral patches, wrecks or sunken logs. The bottom should also be relatively flat as sudden variations in depth tend to make handling of the bouki-ami difficult, and can damage it.

On both Hatsutori Maru No.1 and No.5, limitations of the anchor windlass restricted the maximum depth for anchoring to about 45 metres.

2.7.4 Currents

Where currents are prevalent, it is sometimes effective for small vessels to anchor "across current" with bow and stern anchors so that the current will push the net away from the ship. This type of anchoring was not attempted with the large vessels chartered by the Programme. Consequently, there were instances where current decreased bait catches by causing the net to billow or fold and fish at a shallower depth than normal.

The bouki-ami, because of its fine mesh (4 mm) and its bamboo frame, is sensitive to even the weakest current. On several occasions, bamboo cross-poles were broken by strong currents. The effects of current could often be minimised by hauling the net during periods of slack tide.

2.7.5 Wind

If winds are strong at the time the haul is concluded, the forward (windward) end of the bouki-ami will occasionally catch the wind and billow like a sail. On the chartered vessels, at such times, 3.5-kg sinkers (the same as those tied along the bottom of the net) were pitched into the billowing net. When winds were exceptionally strong, a chain was attached between the forward end of the bamboo float nearest the bow cross-pole and the sponson. When the net was in position, this chain acted as a lead-line to prevent the net from billowing.

2.7.6 Swell and wind-chop

Rough seas hinder bouki-ami fishing; firstly, because of the very great strain placed on the bamboo poles and the ropes that hold the net in position; secondly, because the skiff becomes difficult to handle; and thirdly, because of injury to the baitfish during crowding and loading.

2.8 Recommended Procedures for Loading of Baitfish

Once baitfish are trapped in the net, they must be crowded together for bucketing and loading. Care must be taken during transfer to keep mortality to a minimum. In this respect time is a critical factor. When baitfish are severely crowded they can be loaded much faster, but some species tend to panic more and consequently mortality is higher. On the other hand, loading time increases as crowding decreases, and increased time in the net can also result in a high incidence of injuries.

Once the bait is adequately crowded, it is bucketed on board. Scoops are used to crowd bait into buckets filled with water (Figure 8). If flat scoops are used to fill the buckets, loading takes longer. If deep scoops are used, crowding in the bouki-ami can be less severe and loading time is kept short; however, such scoops result in more abrasion to the bait than the flat ones, which tend to direct the baitfish into the buckets, rather than force them in.

The Skipjack Programme used two scoops of different depths; a 40-cm diameter flat scoop with a stretched depth of 10 cm, and a 40-cm diameter scoop with a stretched depth of 25 cm. The netting in both scoops was of the same material and mesh size as the bouki-ami. Loading techniques were varied

according to the bait species captured and the weather conditions at the time of capture. For example, in the lagoon at Wallis Island, the only accessible baitfishing ground for the Programme's vessel was open to strong south-east winds and sea conditions were often rough during loading. The dominant species, a delicate anchovy, Stolephorus devisi, would normally have been loaded in the most gentle manner possible. However, in this instance bad weather required rapid loading, hence the anchovies were tightly crowded and the deep scoop used.

FIGURE 8. GENTLY CROWDING BAIT INTO BUCKETS

2.9 Care of Baitfish Once Loaded

As bait captured by the Skipjack Programme was normally used within hours of capture, there was little need for baitfish husbandry, and consequently improvements to conventional bait handling techniques were few; there were some exceptions, however. Whenever the vessel travelled long distances between countries with bait on board, particularly cultured bait (Poecillia mexicana and Chanos chanos) or bait purchased in Japan (Engraulis japonicus and Sardinops melanosticta), a feeding regime was initiated. Either prepared fish food or finely ground skipjack gonads and flesh was offered several times daily. At times, an antibiotic (Furacin) was included with food, and in one instance a pre-treated fish food containing tetracycline was used to good effect.

The incidence of disease was found to increase when dead baitfish were allowed to accumulate in the tanks for long periods. Thus, as a matter of course, all crew members participated in removing accumulated dead bait from the grills over the surface outlets. This dead bait was either accumulated in plastic buckets placed beside the tanks, which were then periodically weighed before the bait was discarded, or, when mortality was low, the dead bait was simply allowed to pass through the drain by removing and shaking the grill. In this case, the scientist in charge of preparing the bait log made

a subjective estimate of the amount of bait dying over a 24-hour period based on visual observations of dead bait on the grills. When dead bait accumulated on the bottom of the tanks, an electrical water pump was used to remove it and the bait so accumulated was weighed before being discarded.

3.0 BAITFISHING WITH A BEACH SEINE NET

Most of the skipjack fleets based in the islands of the central and western Pacific use the bouki-ami technique as the sole means of capturing baitfish. Skipjack Programme scientists appreciated the value of the bouki-ami technique, but felt that, as bait was frequently the limiting factor for skipjack fishing, increasing bait catches by utilising any alternative capture techniques would result in increased tuna catches. In March 1978, the Programme began using a beach seine to supplement bait catches made at night.

The basic principle of this method is to spot a baitfish school in shallow water during daylight hours and then encircle the school with a net set from a fast-moving skiff. Beach seining techniques used by the Programme were based on the Hawaiian anchovy (*Stolephorus purpureus*) fishery; however, in response to variable local conditions and the need to capture a variety of baitfish species, techniques evolved considerably.

3.1 Fishing Gear and Crew

Specifications for the rectangular 148 x 7-metre beach net, made of 4-mm knotless netting, and the 80-metre extension, together with a list of associated gear, appear in Appendix A. This relatively deep beach seine was used in conditions ranging from shallow atoll lagoons (Kiribati) to steep high islands without reefs (Marquesas Islands). It was found that, with experience, the 7-metre net was only a minor disadvantage in water shallower than one metre, and enabled many sets to be successful in deep water. Well over a half of all bait beach-seined by the Skipjack Programme came from sets where the water depth was greater than 4 metres.

The optimum length of the net should be determined according to the target species. For baitfish that are tightly schooled, such as hardyheads and goldspot herring, a short net may be an advantage as it can be set and hauled quickly. For fish that are dispersed or in several small schools strung out over a large area, a long net gives a better catch rate. Marquesas sardine, goatfish and mullet are examples of species which are frequently dispersed. As the Skipjack Programme frequently had to operate in areas of extreme bait scarcity, where these dispersed species were prevalent, an 80 x 2-metre extension was added to the larger net. This additional netting was set after the main net had been paid out, and then only on an optional basis when necessary to capture the remnants of a school or dispersed groups of fish. As it was only 2 metres deep, it was the last section set and the first section hauled, serving only to retain the fish for a few minutes until the school was securely surrounded by the deeper main net. The very light weight of the small section detracted little from the speed of the skiff while in the process of setting.

Additional gear used with the beach seine included a skiff large enough to hold the net and several fishermen, a 25-hp outboard engine, scuba gear for two divers, and a bait transporter. A second skiff was used but was not absolutely necessary. The net could be set with as few as 6 fishermen, but up to 14 were usually involved.

3.2 Fishing Operations

The net was stacked neatly into the outboard-powered skiff with the lead-line forward and the cork-line aft (Figure 9). Wetting the net with a deck hose while stacking proved useful as the wet net sank faster. Four to eight fishermen were involved in the search for bait from the net skiff (Figure 10).

FIGURE 9. THE BEACH SEINE STACKED IN THE 5.5 METRE SKIFF. The cork-line is stacked aft and the lead-line forward. In addition, the photograph shows bait being transferred from the bait-transporter to the survey vessel (see Section 3.3).

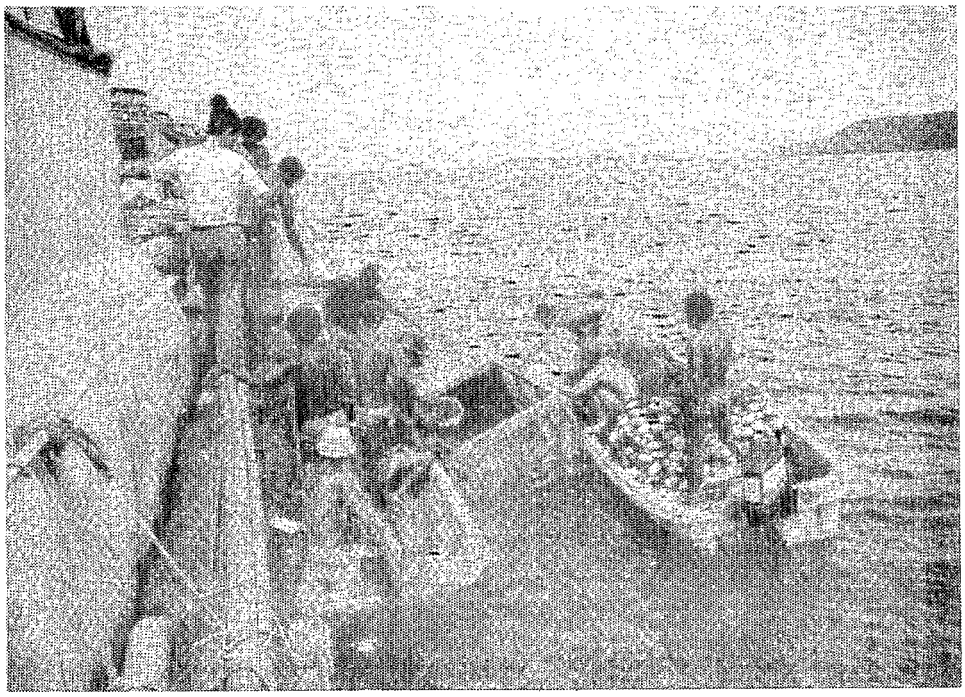
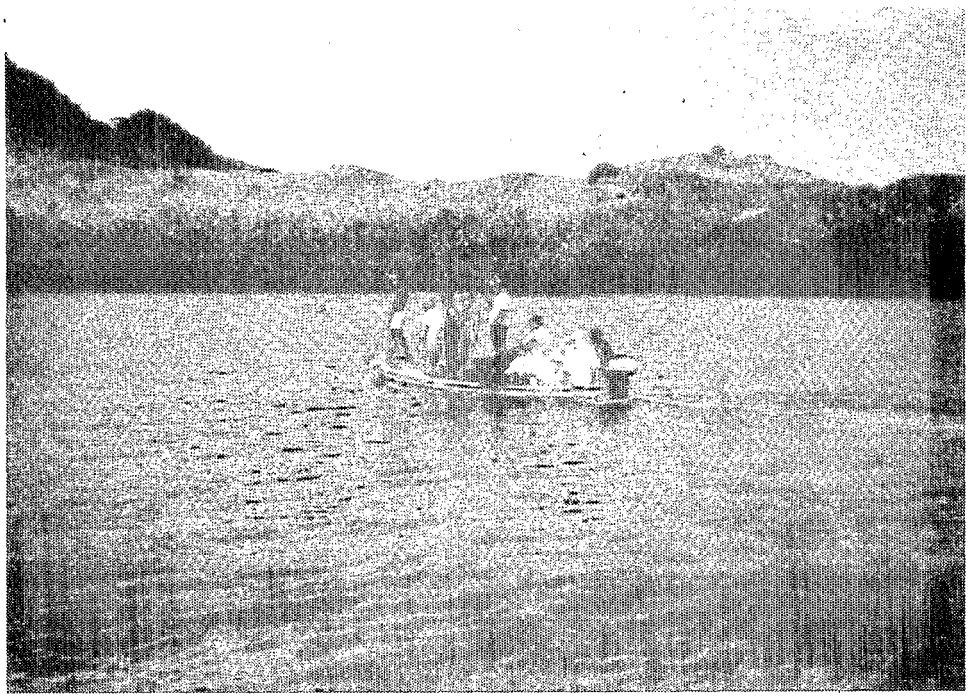


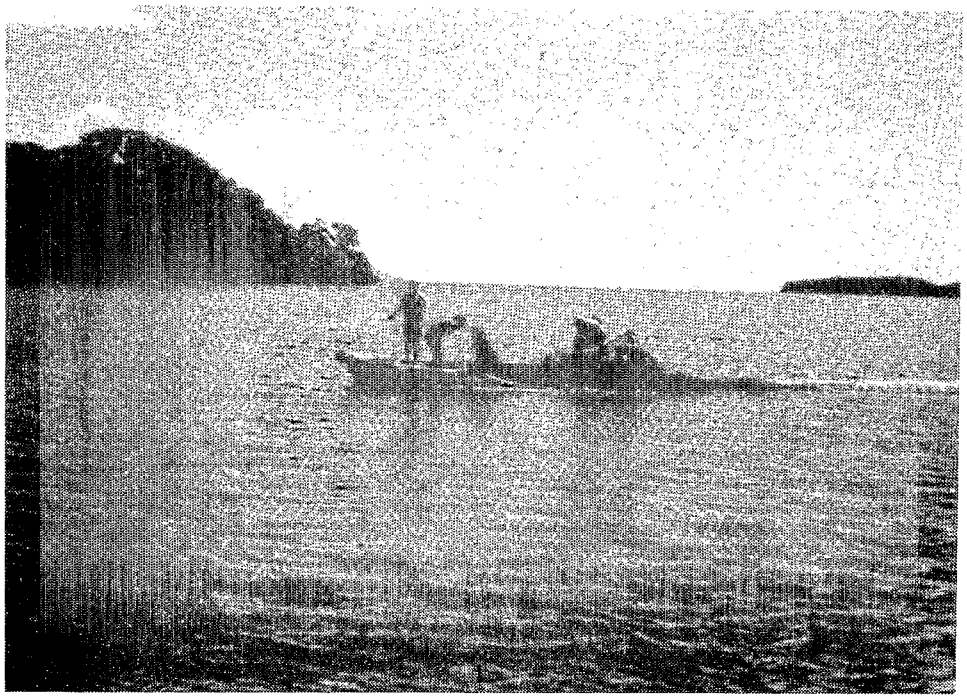
FIGURE 10. FISHING CREW IN SEARCH OF BAIT WITH BEACH SEINE. When the decision is made to set the net, all five of the crew who are standing will dive into the water.



Baitfish were found by looking for birds, spotting bubbles or ripples on the surface, direct observation (in which case polaroid sunglasses were helpful), or by diving with a face mask. After bait had been located, the decision to set the net was based on the absence of large quantities of coral, and the water being deep enough for the outboard but shallow enough for the net.

Immediately upon sighting baitfish that were judged to be vulnerable, one fisherman, holding the tow-line of the net, jumped into the water from the skiff as it was travelling at full speed. A second fisherman tossed the cork-line overboard in bunches of about 2 metres, while a third tossed the lead-line in a similar fashion (Figure 11). Others in the net skiff dived overboard ready to assist with hauling the net. This decreased the weight in the skiff and hence increased the setting speed. The skiff operator paid close attention to the movements of the baitfish, depth of the water, the speed at which the net was being thrown, the amount of net remaining on board, and any coral patches. Depending on underwater topography, distance from the beach, behaviour of the bait and surf conditions, the net was set either in a complete circle (Figure 12), or between two points on the beach. The encircling method resulted in a faster haul, while setting from beach to beach covered a greater length of beach. If the latter technique was used, the ends of the net were walked together along the beach. After the net formed a complete circle, hauling procedures for the two techniques were identical.

FIGURE 11. SETTING THE BEACH SEINE AT FULL SPEED



The cork-line from the section of the net first set was tied to the bow of the skiff. A diver, using scuba gear, was positioned directly under the skiff to hold the two sections of the lead-line together as the net was being hauled. Two to four men hauled and re-stacked the net in the skiff while other crew members constantly dived to clear the lead-line from any obstructions such as rocks or coral. An additional man, a second skiff, or an anchor was used to keep the net skiff in proper position with respect to

the net for ease of hauling. During the final stages of the haul, the lead-line was brought together on the bottom and the net was pursed (Figure 13). Most of the remaining net was dried-up to crowd the bait together. Care was taken to eliminate folds in the net in which baitfish could be trapped. Figure 14 is a schematic representation of the setting and hauling process.

FIGURE 12. THE BEACH SEINE FULLY SET (Step 2 of Figure 13)

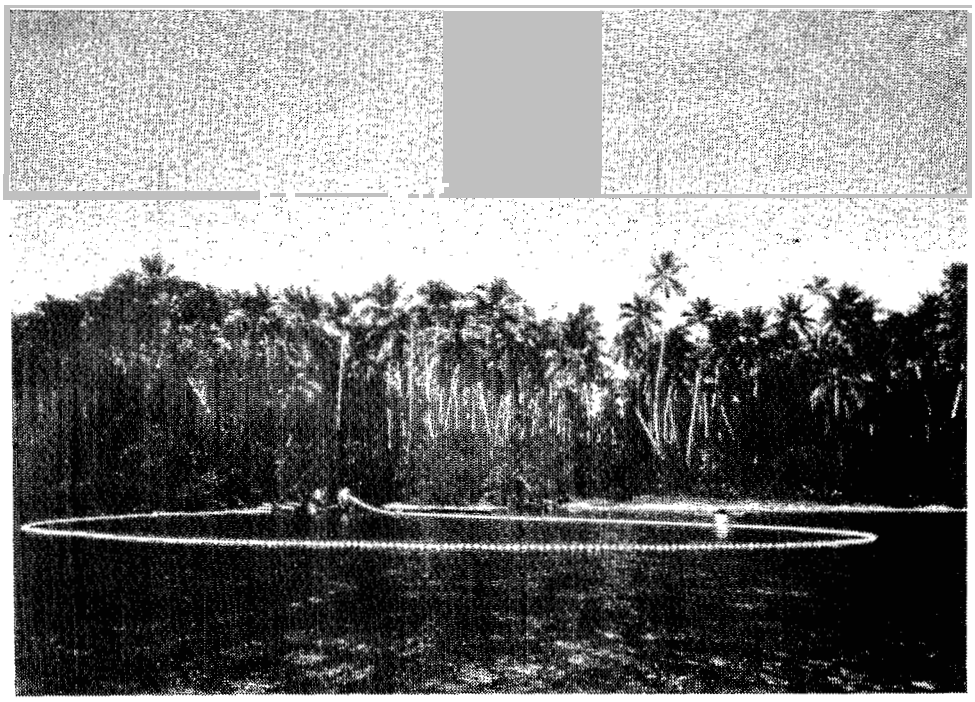
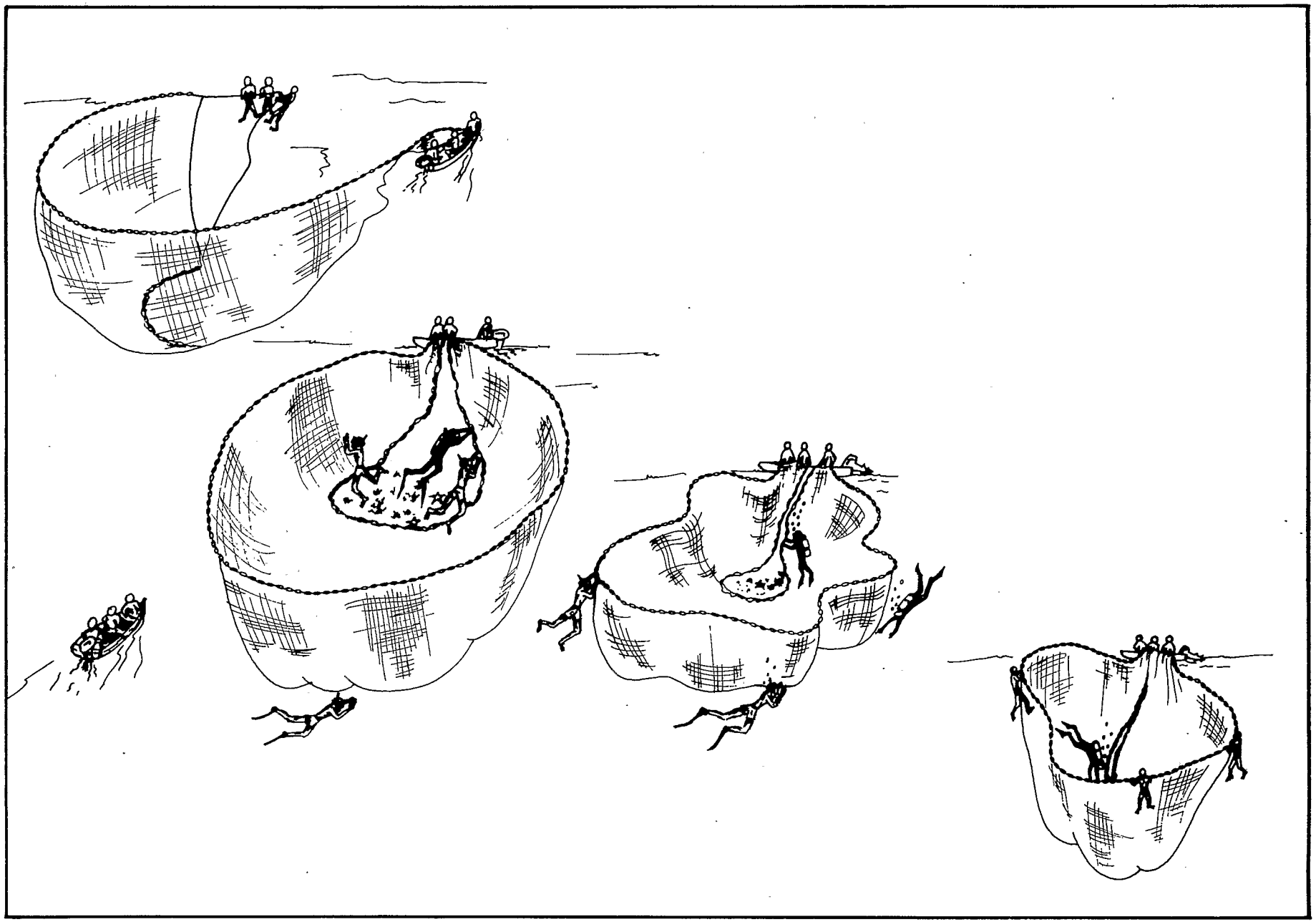


FIGURE 13. FINAL STAGES OF HAULING THE BEACH SEINE. At this stage the net has been pursed on the bottom by bringing the two sections of the lead-line together. Shortly hereafter, both sections of cork-line, both sections of lead-line and netting will be simultaneously hauled on board the skiff.

FIGURE 14. SCHEMATIC REPRESENTATION OF SETTING AND HAULING THE BEACH SEINE



3.3 The Transfer of Bait

As the research vessels drew nearly 4 metres of water, they often could not get close to the beach seining site, thus requiring the bait to be transported considerable distances. A box-type bait-transporter, as pictured in Figures 3 and 9 and described in Appendix A, was considered to be the most successful arrangement for bait transport. If the sea conditions were calm and the vessel was not too far from the baiting area, it was often more efficient to crowd the bait into a section of the net, and then sling this section between the two skiffs for transport to the fishing vessel.

3.4 Modifications

Numerous variations to the above techniques were carried out: (1) Valuable bait species were often found in and around large objects such as old wrecks. The seine was partially set adjacent to a wreck, or other obstacle, and bait scared into the net. (2) Setting the beach net at night in conjunction with an electical generator and underwater light was occasionally successful at the same location where regular day baiting had failed. (3) In shallow water, it was possible to set half of the net and then walk the remaining net several hundred metres parallel to the beach to increase the area of coverage (Figure 15). (4) When there was surf, the set was usually made in deeper water to avoid having the skiff in the impact zone.

FIGURE 15. THE BEACH SEINE PARTIALLY SET. The fishermen have walked several hundred metres along the shore to increase area of coverage.

3.5 Other Considerations

A scuba-equipped diver is considered helpful when water under the skiff is deeper than 1 metre, and necessary in water more than 2 metres deep. There were usually two divers using scuba, one directly under the skiff to haul the net and the other to swim the perimeter of the net in order to free the lead-line from obstructions and then to assist in hauling the net. The

entire hauling operation was significantly faster using divers with scuba gear. On occasions, the entire 228-metre net was set and hauled in less than 22 minutes.

Net maintenance was very important. Only rarely was the beach net used without at least a few minor rips in the netting, usually caused by coral or rock obstructions. At the first opportunity after each beach seining operation, the net was inspected and repaired. As the mesh was of square knotless material, patches could be sewn over the holes, a procedure requiring little net-mending expertise.

The stage of the tide affected the success of beach seining in two ways. Firstly, in areas where the bottom was generally unfavourable, due to the presence of coral, seining was sometimes possible in the sandy inter-tidal area during periods of high tide. Tidal ranges are greatest during new moon and full moon periods and the area available for beach seining is then at a maximum. It is therefore convenient that during full moon, when night baiting is poor, opportunities for beach seining are greatest.

Tidal stage also affects vulnerability of certain species. For example, it was thought that the Marquesan sardine was most vulnerable to beach seining at low tide.

The effectiveness of the beach seine technique is greatly influenced by the habitat and behaviour of the species being pursued. Notes on the habitat, school type and behaviour of the most common species exploited by the Skipjack Programme are given in the Table. Despite the often rough beach seining conditions (wind chop, surf, etc.) and frequently long transport distances to the fishing vessel, baitfish mortality was surprisingly low. For instance, Spratelloides delicatulus, considered by some fishermen to be too fragile for use as bait, was beach seined and kept on board for five days during a trip from Truk Island to Saipan. In the Marquesas Islands, mortality for large quantities of beach-seined Marquesan sardine was no higher than that for the same species caught at night by bouki-ami.

3.6 Drawbacks of Beach Seining

A major problem with beach seining is that obstruction free, sandy areas, of proper depth, where baitfish species congregate are rare or non-existent around many islands. Another limitation is that the capture of quantities of fish close to shore during daylight hours could cause conflict with local traditional fishing rights. Furthermore, the efficiency of the beach seining technique in terms of catch per set or catch per unit of time was usually considerably less than for the bouki-ami. Over a period of three years, the Skipjack Programme caught an average of 45 kg of bait per haul of the beach net (74 hauls), compared to 122 kg per haul for the bouki-ami (561 hauls).

There are other disadvantages which are applicable only in certain situations. For instance, time spent in day baiting activities is normally time lost for tuna fishing. Beach seining is exhausting, physically demanding work that could be an additional hardship on the crew if other intense activities (night baiting, vessel maintenance, successful tuna fishing) are pursued during the same 24-hour period.

TABLE. BAIT SPECIES CAPTURED BY SKIPJACK PROGRAMME WITH BEACH SEINE

Species		Depth Captured	School Type	Behaviour and Comments
Hardy heads (Silversides)	Atherinidae: *Hypoatherina ovalaua* *Pranesus pinguis*	0.1 - 3 metres	Small to medium, dense close to beach.	Slow, easy to spot, easy to catch.
Gold spot herring	*Herklosichthys punctatus*	0.3 - 3 metres	Medium to very large, dense, close and far from shore. Frequently mixed with Atherinids.	Fast, if escape is found from net most bait will follow. Important to keep net on bottom. Difficult to estimate amount and overcrowd. Birds frequently indicate position.
Marquesan sardine	*Sardinella marquiensis*	0.8 - 7 metres	Small to medium, medium density, fairly close to beach. Frequently many small schools in one area.	Long net useful. Can be spotted by small bubbles on surface or by diving. Easily escape from net.
Blue sprat	*Spratelloides delicatulus*	1.5 - 10 metres	Dispersed school. Frequently on edge of drop off. Frequently around piers and wharfs.	Often in deep water adjacent to shallow area and may be scared to catchable location. Difficult to spot without diving. Leap when chased by predators.
Scad	*Selar crummenophthalmus*	2 - 5 metres	Dense, moving	Very fast, will try to outrace skiff, jumping in process.
Goatfish	*Mulloidichthys* sp.	1.3 - 3 metres	Very dispersed. Sandy area near beach. Small schools.	On bottom. Hard to see. Often in shade of overhanging trees.
Mullets	Muligidae	0.1 - 2 metres	Dispersed, near shore	Not usually found in concentrations. Net walked for several hundred metres to increase area of coverage.
Bone fish	*Albula vulpes*	0.3 - 4 metres	Dispersed, on bottom	

4.0 BAITFISH SAMPLING AND DATA COLLECTION

Detailed data on catches of all baitfish species, and their subsequent use, were collected and recorded regardless of which baitfishing technique was used.

4.1 Sampling Methods and Estimation of Total Catch

While the bait was being loaded into the bait tanks following each baitfish haul, a sample of one bucket was taken from approximately every 20 buckets of bait loaded. This sample ratio was reduced for very large hauls, and rarely were more than three buckets taken even when the total catch was more than 60 buckets. The wet weight of the baitfish in the samples was then taken to the nearest 1/10 kg using a spring balance. Total weight of bait loaded was then estimated from the product of average sample-weight and total catch in buckets. When the haul was less than 20 buckets, a sample was taken from several buckets with a small net scoop and the average weight of bait per bucket was estimated visually.

Sometimes the amount of bait caught exceeded the capacity of the bait tanks, and occasionally a significant amount of bait died in the net before loading. In both these situations the bait was discarded directly from the net and the amounts discarded alive or dead were estimated visually.

4.2 Sample Analysis and Estimation of Bait Usage

Baitfish species making up more than one per cent of the catch, or which had potential as tuna bait, were identified to the level of species; others were identified to family or genus. Percentage numerical abundance was determined from counts of each species making up more than five per cent of the sample. For each of these species, a subsample of 10 specimens was measured for standard length to the nearest millimetre with a stainless steel micrometre rule. During the course of the Programme, examples of the dominant species, species whose identification was difficult, and species of particular scientific interest were preserved in 10 per cent formalin or 80 per cent alcohol for the reference collection on board the vessel.

The weight of bait used for fishing each day was generally estimated from the number of buckets of bait taken from the tanks during fishing operations, and a visual estimate of the average weight of bait per bucket. In the middle of a "good biting" school, however, these estimates would often be inaccurate since the amount of bait per bucket was highly variable at such times, and the number of buckets used was sometimes misrecorded. Consequently, this estimate of the amount of bait used for fishing was cross-checked against the amount of bait estimated to have died during the day, and a visual estimate of the amount of bait remaining in the bait tanks at the end of the fishing day. Daily bait usage, in standard 1.5 kg buckets, was therefore monitored on the basis of four observations recorded in the daily log: (1) bait carried at the beginning of the day's fishing; (2) bait used during the day for fishing; (3) bait mortality during the 24-hour period prior to commencement of fishing (Section 2.9); and (4) a visual estimate of species composition of the bait on hand at commencement of fishing (only the dominant three or four species).

In addition to the above information, the following data were recorded for each baitfish haul: date, time and position of the haul, depth of water, type of bottom, and light combinations used. For most bouki-ami hauls, the trace obtained from the Programme's echo-sounder was attached to the

log-sheet. Each day, data from individual bait hauls were entered onto the baitfish computer log-sheets, following the coding instructions listed in Appendix B.

4.3 Baitfish Identification

Identification of tropical bait fishes in the field is difficult. Separation of the more common species within the baitfish genera is particularly troublesome, often requiring the use of a dissecting microscope for careful anatomical examinations. The task is complicated because classifications of many baitfish are being revised as a result of current taxonomic studies, requiring constant up-dating of field keys. A draft field guide, prepared by scientists of the Programme, was used extensively by the Skipjack Programme to separate bait species in the families Engraulidae, Dussumeriidae, Clupeidae, Atherinidae, Carangidae, Leiognathidae, Caesiodidae, Apogonidae, and Scombridae. Keys in the guide were based on publications by Schultz et al. (1953), Chan (1965), Ronquillo (1965), Munroe (1967), Berry and Whitehead (1968), Paxton (1972), Whitehead (1972), and Fisher and Whitehead (1974). A revised key for Atherinids was supplied in September 1979 in pre-publication form by Dr W. Ivantsoff, Macquarie University, Australia. Throughout the Programme, field personnel maintained a baitfish reference collection and recorded visual features that assisted in rapid classification under field conditions. Specimens that could not be identified, but were common in the catch, were forwarded to specialist taxonomists for detailed examination.

The field guide, together with the baitfish reference collection accumulated during the survey, were invaluable aids to classification of baitfish species. An updated version of this field guide, including details on distribution and occurrence of the important baitfish species, is currently in pre-publication form (Lewis et al. MS).

5.0 SUMMARY AND CONCLUSIONS

During the three years of the Skipjack Programme, night baiting with the bouki-ami and day baiting with the beach seine led to a total catch of more than 68,000 kg of bait in the waters of 25 countries and territories. Catches with the bouki-ami exceed 65,000 kg, while day baiting with a beach seine in the waters of eight countries accounted for over 3,200 kg. These techniques produced large catches under a wide variety of conditions. Many bait species with different behaviour patterns were vulnerable to one or other, or both methods of capture.

Both techniques are labour intensive; however, this is not generally regarded as a handicap by most Pacific Island countries. The equipment is comparatively simple and resistant to the rough handling on board fishing vessels. Both techniques, when properly executed, are gentle on the baitfish, which is a valuable quality when handling the delicate species common in the South Pacific Commission area.

Trials conducted during the Programme showed that while underwater lights are generally more efficient, an above-water light can be more effective for attracting certain species of surface bait. The practicality of combining both types of lights was demonstrated.

When using the bouki-ami, replacement of the skiff and its underwater light by an underwater light controlled from the vessel's deck, improved

flexibility of the fishing operations. Placement of an echo-sounder transducer between the net and the vessel enabled improved monitoring of the bait and the net at the final stage of the fishing operation.

In addition to work on bait capture, several methods of loading baitfish from the net to the bait tanks were tried, particularly techniques for scooping and bucketing live bait from the net. It was possible to improve survival considerably by gently scooping and bucketing bait into the bait tanks.

Details of results from these baitfish methods and resulting resource assessments for each of the 25 countries surveyed by the Skipjack Programme are presented in the Final Country Report series.

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APPENDIX A. SPECIFICATIONS OF GEAR USED FOR BAITFISHING BY THE SKIPJACK PROGRAMME

- Underwater lights :
  2000 watts - 200 volts
  1500 watts - 110 volts
  1000 watts - 110 volts

- Above-water lights :
  100 watts - 110 volts
  300 watts - 200 volts
  1000 watts - 200 volts

- Portable generator :
  YANMAR - 3000 watts - 100 volts

- Bouki-ami :
  Hatsutori Maru No.1 : 25 metres (float-line length)
  27 metres (lead-line length)
  23 metres (depth)

  Hatsutori Maru No.5 : 27 metres (float-line length)
  35 metres (lead-line length)
  25 metres (depth)

- Bamboo :
  Length : 11 metres
  Diameter : 12 cm

- Skiffs (two per vessel) :
  Length : 5.5 metres
  Width : 1.5 metres
  Material : fibre-glass
  Design : bottom flat

- Underwater viewing glass :
  Height : 42 cm
  Diameter at the bottom : 30.5 cm
  Diameter at the top : 26 cm

- Echo-sounders :
  Hatsutori Maru No.1 : SANKEN TS-16 0-1600 metres (4 scales - wet paper)
  Flying Bridge

  SANKEN NSS 1300 0-1320 metres (wet paper)
  Wheel House

  Hatsutori Maru No.5 : SANKEN TL-32 0-3200 metres (wet paper),
  2 frequencies 28 KHz-200 KHz. Flying bridge.

  SANKEN NSS-1300 0-1320 metres (wet paper),
  frequency 28 KHz. Wheel house.

Portable echo-sounder : JAPAN MARINA, JMF-707AB-1.2 volts DC, frequency 50 KHz

- Scuba Gear :
  Air tank : 80 cubic foot aluminium SCUBA tanks - max. PSI 3000
  Double stage regulator : Sherwood
  Octopus pressure gauge : 0-3500 PSI, USD
  Backpack : U.S. Divers
  Air compressor : Luchard "Porpoise", 6.7 cubic metres per hour
  Weights : 2 lbs, 1.5 lbs, 0.75 lbs
  Weight belt : Sextec
  Diving masks, fins and snorkels

- Buckets :
  Volume : 13 and 15 litres
  Material : Blue plastic

- Scoops :

	Bait-loading scoops		Bait-chumming scoops
Diameter	40 cm	40 cm	24 cm
Depth	27 cm	12 cm	10 cm
Handle length	80 cm	41 cm	40 cm
Mesh size	4 mm	4 mm	4 mm

- Beach seine :
  Material supplier : K. Kida Fishing Supplies
  212 Kamani Street
  HONOLULU, Hawaii 96813

  Dimensions : 148 x 7 metres
  Type of mesh : 4 mm, square mesh knotless
  Floats : egg shaped, 12 x 6.5 cm, spaced every 24 cm

- Beach seine extension :
  Dimensions : 80 x 2 metres
  Mesh size : 5 mm (bar length) mycle knotless
  Floats : round, 3.5 x 5.5, spaced every 42 cm
  Leads : 4.5 x 2.0 cm, 100 g, spaced 1 metre apart
  Dry weight : 40 kg

- Bait transporter:
  Length : 2.45 metres
  Width : 1.22 metres
  Height : 1 metre

APPENDIX B. INSTRUCTIONS FOR COMPLETING THE BAITFISH LOG

Heading in Log	Column Number	Data Entered
AREA	-	General description of area
RECORDER	-	Person recording data
yymmdd	5-10	Date in year/month/day format
ht	11-14	Time of haul of bait net
ctry	15-18	Three-letter country code plus visit number
no	19-20	Sequential haul number for country
lat	22-27	Latitude of position of haul to 1/10 of minute
long	28-34	Longitude of position of haul to 1/10 of minute
s	38	Surface conditions, i.e. placid, rough
sst	41-44	Sea surface temperature
d	45-46	Depth of water in metres
b	47-48	Composition of bottom, e.g. sand, mud
l	51-52	Code number for location and number of bait attraction lights used
lt on	53-56	Time when lights switched on
n	57-58	Type of net used, e.g. bouki-ami, beach seine
bl	60-62	Number of buckets of bait loaded onto the research vessel
bw	63-54	Average dry weight of a bucket of bait
sbl	65-67	Number of standard (1.5 kg) buckets of bait loaded
bda	68-70	Number of standard buckets of bait discarded alive
bdd	71-73	Number of standard buckets of bait discarded dead
comment	15-80	Comment on unusual circumstances, e.g. moon very bright, strong current
f/gen	15-19	Five-letter abbreviations of family or genus of baitfish, e.g. <u>Spratelloides</u> (SPRAT)

Heading in Log	Column Number	Data Entered
sp	21-25	Five-letter abbreviation of species of baitfish, e.g. Sardinella (SARDI) (A separate line for each species)
%	26-28	Numerical percentage occurrence in net haul
lcf	30-68	Standard length to nearest millimetre of random sample of ten fish of each species

* Columns not listed were left blank.

BAITFISH LOG

AREA HELEN REEF 2 RECORDER JNI

	3	5 yymmdd	11 ht	15 ctry	19 no	22 lat	28 long	35 ma	37 os	39 cc	41 st	45 d	47 b	50 s	l	53 lt	on	57 n	60 bl	63 bw	65 sbl	68 bda	71 bdd	75 lt	pr
--	H-	800808045	0	CAR3	21	02552•5N	1314646•6E			R		29	1	3655	-			BK	-	702	2	1	03	1	20 -

comment 15

--	C-	DS SKIFF LT BROUGHT INTO NET

		15 f/gen	21 sp	26 %	30 lcf	lcf	lcf	lcf	lcf	lcf	lcf	lcf	lcf	lcf	70 m	74 low	78 high
	S-																
1		SRRAT	DELIC	50	56	55	49	48	39	39	33	37	22	28	41	22	
2		DUSSU	ACUTA	21	158	162	160	157	162	152	158	142	160	159	157	142	
3		RHABD	CYPSE	11													
4		SPRAT	GRACI	6				-									
5		HYPOA	TEMMI	10	59	61	56	61	61	57	65	57	54	55	59	54	
6		ARCHA	LINEO	1													
7		PTERO	PISAN														
8		DIPTE	LEUCO														
9		PARAP	SP														
10		BLENN															
11		SYNOD															
12		SQUID															
13		SHRIM															
14																	
15																	
16																	
17																	
18																	
19																	
20																	