A Night Handline Fishery for Tunas in Hawaii

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ABSTRACT—Night handline fishing effectively catches tunas in localized areas. The fishery for tunas by this method in Hilo, Hawaii, experienced a rapid growth when high prices on the fresh tuna market and fast air delivery to distant cities made new markets for the catch available. The simplicity of the method and low cost of equipment makes it a promising method for island cultures of low technology to use for developing a fishery. The paper describes the fishing method and gear in detail.

Introduction

Modern commercial fishing for tunas brings to mind large superseiners and longliners with complicated and costly equipment and gear. In contrast, the rapidly growing night handline fishery for tunas near the island of Hawaii is remarkable in its simplicity and effectiveness. This fishery catches bigeye tuna, *Thunnus obesus*; yellowfin tuna, *T. albacares*; and albacore, *T. alalunga*; on elementary gear, a hook and line.

The effectiveness of the method is demonstrated by its catch rate which is approximately two fish per hook per night on the average. In comparison, catch rates of Hawaiian longline vessels are on the order of 0.03 fish per hook per day (Otsu, 1954).

Because of its inexpensive requirements, this method of fishing seems like a promising method for the many financially impoverished island communities in the tropical Pacific Ocean to utilize a marketable resource of export value. Nevertheless night handline fishing for tunas is not a widespread practice.

To my knowledge, the only other place where this method is used is in the Philippine Islands. There, virtually all of the commercial yellowfin tuna catch is made on night handlines (Oswald[1]). Even in Hawaii this technique is used only by fishermen on the island of Hawaii. Fishermen from the other islands in the State have not yet adopted it. The information in this paper may stimulate interest in handline fishing in other areas.

This report includes a brief history of the fishery in Hawaii, a description of the fishing method and gear, a description of the catch and its value, and a summary discussion. The data for this report were gathered in 1976. Minor changes in method and new fishing areas since then are incorporated in this report.

History

In 1976 night handline operations for tuna in Hawaii were made exclusively from Hilo (population 28,500). The following account of the origins of the fishery are from interviews of oldtimers in the fishing community of that city as written references were not found.

Immigrants from Okinawa are believed to have started the fishery. They went out at night to catch squid as they had done in Okinawa. Occasionally something large would strike and snap their lines. Upon checking with the native Hawaiians they learned that the strikes were probably made by large tuna. They subsequently equipped themselves with gear to catch the tuna.

The exact year when the fishery started is not known. The first Okinawans arrived in Hawaii in 1899 to work in the then burgeoning sugar industry (United Japanese Society of Hawaii, 1971). It took another 7 or 8 years, however, for the immigrants to reach large numbers. By 1911, 12,000 were living in Hawaii. Allowing for time to fulfill their contracts with the sugar plantations, I would guess that the fishery for squid started in the second decade of the 1900's.

In the early years of the fishery the boats were powered by sail; by the 1930's up to about 40 motorized boats were involved. Until World War II the fishery was primarily for squid. The incidental tunas caught were known as "ika-sibi" (squid-tuna in Japanese), the name by which the fishery is called today. Because the boats were too small to have the large fish on board and did not carry ice to chill the catch, these tunas were towed alongside the boat on the way to port. Consequently, the ika-sibi had a reputation for having poor quality and could not compete on the market with tunas caught on longlines.

The squid fishery stopped abruptly on 7 December 1941, with the Japanese attack on Pearl Harbor. Maritime restrictions prevented boats from fishing at night for the duration of World War II.

When the fishery was resumed after the war, three to four boats equipped with iceboxes targeted on the tunas. Until 1971 the tuna-oriented part of the fishery was limited to these few boats by the market for fresh tuna. The entire catch was sold on the island of Hawaii, which had a popultion of 55,000-63,000 during that period. By 1971 fresh tuna prices had increased enough to make air shipment of tunas to other markets economical. By 1976 the night handline fishing fleet had grown to about 30 boats, about half of which

[1]E. Oswald, South China Sea Fisheries Development and Coordinating Programme, Makati, Rizal, Philippines. Pers. commun., 1976.

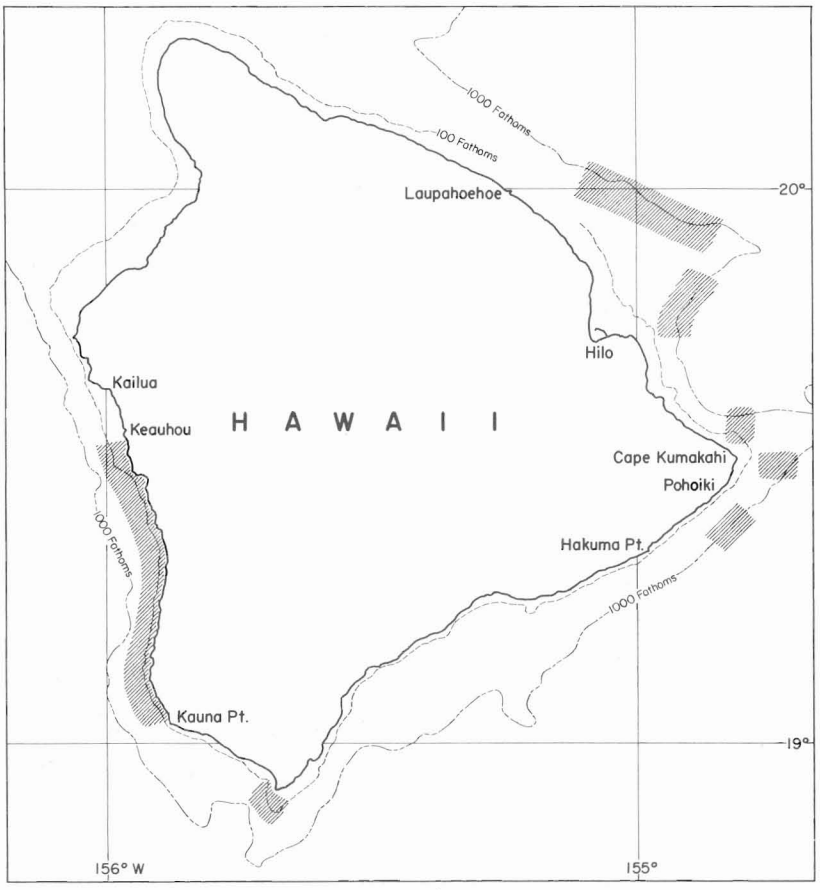


Figure 1.—Fishing locations of night handline fishery for tunas.

were part-timers. In 1977 over 40 boats were involved in the fishery from Hilo and about 10 or so boats were fishing from Kona on the west side of the island.

Fishing Operations

In 1976 the only fishing area was located 24-32 km (15-20 miles) northeast of the port city of Hilo on the east side of the island. Since then the fishery has expanded to other areas, the main ones of which are east of Hilo, south of Pohoiki, and the southern half of the west side of the island (Fig. 1). The areas fished are characterized by a marked increase in slope of the bottom beyond the edge of the shelf that ajoins the island. The depth of the shelf at the edge is about 400 m in the areas on the east side of the island and 200 m on the west side. During 1978 a few fishermen from Kona, a district on the western side, successfully used night handlines in areas where the bottom is 4-5 km deep and relatively flat. They fished at night at sites where tuna were located during the day (Morioka[2]).

Geographic expansion of the fishery was accompanied by an expansion in the fishing season. In 1976 the handline fishing season was from July through December. This still holds true for the east side of the island. On the west side of the island the season runs from January to April.

The boats leave port to get to the grounds at sundown. Upon arrival the engine is turned off and a parachute is attached to the bow and lowered into the water as a sea anchor. Two above surface lights and one underwater light are turned on. Some fishermen use just the above surface lights and some use just the underwater light but most of them use both types. Typically 25-W and 50-W incandescent bulbs are used for the above surface and underwater lights, respectively. Some fishermen use slightly brighter lights on moonlit nights.

The first fishing operation is to catch the squid, *Notodarus hawaiiensis*, for bait. Cross-sections of mackerel scad, *Decapterus pinnulatus*, or frozen squid, *Loligo opalescens*, roughly 1 inch (3 cm) wide, are used as chum. Squid are caught by angling and gaffing. The hooks are baited with mackerel scad by cutting off the tail so that the body of the scad is the proper length to fit on the shank of the hook and inserting the shank of the hook through the length of the fish starting with the cut end and ending at the mouth. A light line or wire attached to the proximal tip of the shank is wound around the fish to keep it from falling apart. This makes it possible to use the same piece of bait repeatedly despite the squid bites that are inflicted upon it. The baited hook is tossed out about 5 m and slowly pulled back to the boat. In this manner the hook is used not only to hook squid but also to lure the school of squid to within gaffing range of the boat.

A few fishermen prefer to gaff the squid exclusively. In this case the squid are lured to the boat by tossing out a whole scad hooked through the head with a fish hook and retrieving it in the same manner applied to the squid hook.

In the past, fishing for tuna began after 5-10 squid had been caught. Today most fishermen bait their tuna lines with mackerel scad and proceed with fishing while catching squid for bait. In fishing for tuna the baited hook is lowered to 20-30 m. The fishing line is tied to the boat with a restraining line to keep the hook at the desired depth. The restraining line is fairly heavy, about 18-34 kg (40-75 pounds) breaking strength, because it is intended to set the hook when the fish strikes. Three well separated hooks are fished: One at the bow, one amidship, and one at the stern. Some boats fish a hook at

[2]R. Morioka, Hawaiian Telephone Company, P.O. Box 1510, Kailua-Kona, Hawaii 96740. Pers. commun., 1978.

each corner of the stern and one amidship. None of the boats seems to fish more than three hooks at a time. While waiting for the tuna to strike, the fishermen continue to fish for squid.

On the western grounds where squid are scarce, squid fishing is often not done. The tuna hooks are baited with mackerel scad.

When a tuna strikes, the restraining line sets the hook and the fish is allowed to run until the outgoing line is slow enough to be handled. The fish is hauled by hand to the boat. At this point the fishermen differ in their techniques; some stun the fish and then gaff it; others stun the fish after it is on board. Fish are stunned with a blow on the head with a baseball bat or a wooden mallet. Recently many fishermen have resorted to killing the fish by shooting it in the head with a handgun when it is alongside the boat.

When there is a strike at least one of the other two lines is removed from the water as soon as possible to reduce the possibility of the lines tangling. This practice is not followed when the tuna is small enough to land quickly or during times when strikes are infrequent. Tuna strikes tend to be clustered and while it is possible to keep two lines with struggling fish from tangling, it is almost impossible to do so with three lines. The fishermen claim that tuna schools move away when the lines get tangled.

The fish are stored in iceboxes with a mixture of ice and seawater. Whenever the catch exceed the icebox capacity, excess fish are left on deck, covered with wet canvas or burlap, and cooled periodically with seawater. Departure from the fishing grounds is timed so that the fish can be delivered in time for the 7:00 a.m. auction. The newer and faster boats can thus stay on the fishing grounds longer.

Gear

Two sets of gear are used, one for catching squid and the other for catching tuna. There is much individual variation in the choice of materials and design of the gear. The following description is of the most typical gear.

Jigs and gaffs are used to catch squid. A typical squid jig (Fig. 2) has a shank 25 cm long and eight prongs each of which is 5 cm long. Variation in the jigs occur in the number of prongs, which may be 6-10, and in the linear dimensions, which vary about 10 percent. The gaff (Fig. 3) is similar to the jig but with slightly longer prongs (7 cm). The handle is a straight piece of bamboo 1 m long and 2 cm in diameter at the larger end.

The tuna fishing gear (Fig. 4) consists of a hook, a leader, a lead weight, and a line. The hook (Fig. 5) is of a Japanese design (Tonkichi[3] *BKM* #54). The leader is either seven-strand stainless, 227-kg (500-pound) test, wire or monofilament nylon of similar strength, sometimes braided for easier gripping. The leader length preferred by most is about 1 m but leaders 0.6-1.8 m are used. The weight (Fig. 5) is a lead tube of 227-397 g (8-14 ounces). The tube is bent at the middle about 30° to keep it from rolling around on the boat. A stainless steel rod is placed through the tube and its ends are fashioned into eyes to facilitate the attachment of line and leader. The favorite material for the lines is polypropylene rope either 0.95 cm (⅜ inch) or 0.79 cm (5/16 inch) in diameter. Lengths of the line range from 110 to 130 m. The fishing gear is coiled and kept in a square wooden box for easy handling.

Other equipment used by all boats are a parachute, lights, and a baseball bat or a wooden mallet. The parachute is 7.2 m in diameter and equipment surplused by the military. The lights, used for attracting squid, are of two types: Above surface and underwater. Above surface lights are 25-W incandescent bulbs with polished metal reflectors. Usually two of these are used. The underwater light, usually one, is a 50-W incandescent bulb that has been waterproofed and weighted. Brighter bulbs are sometimes used for moonlit nights. The lights are powered by storage batteries. The baseball bat and wooden mallet are used for stunning fish.

A wide assortment of boats is used in the fishery. These range from 6-m (20-foot) fiberglass skiffs to an 18-m (60-foot) boat that fishes longlines during the off-season. The boats are usually manned by two men, but fishermen will often go out alone.

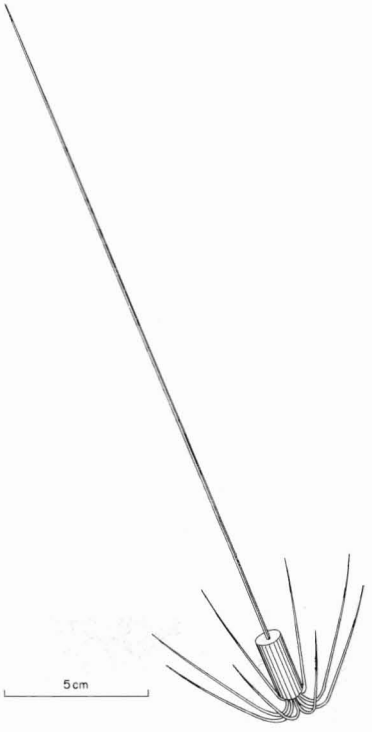
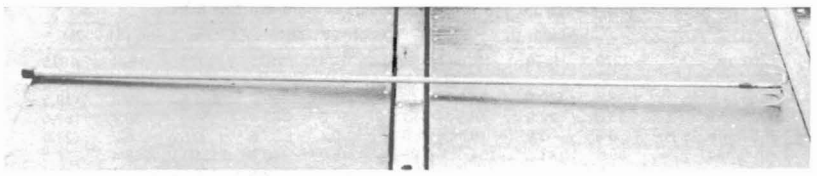


Figure 2.—Drawing of a hook for catching squid.

[3]Reference to trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Figure 3.—A squid gaff.



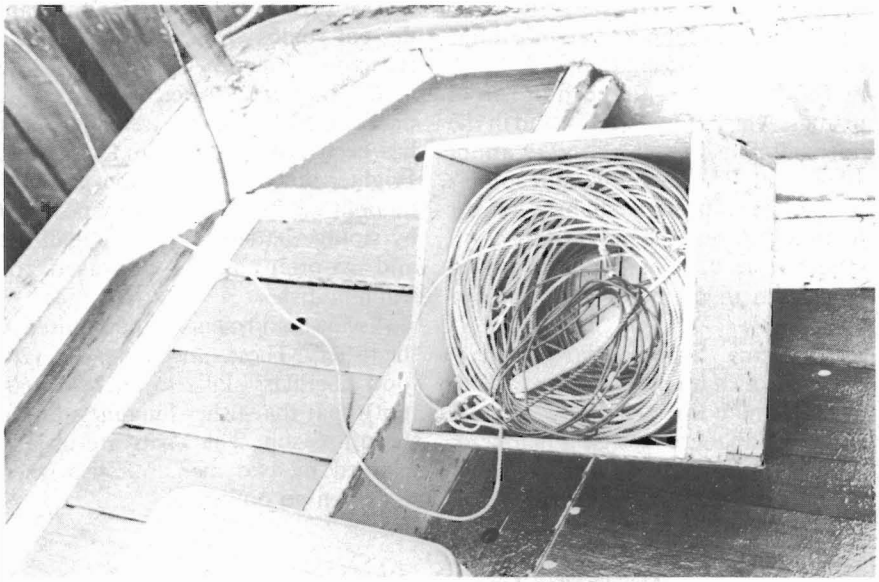


Figure 4.—Photograph of a unit of handline gear.

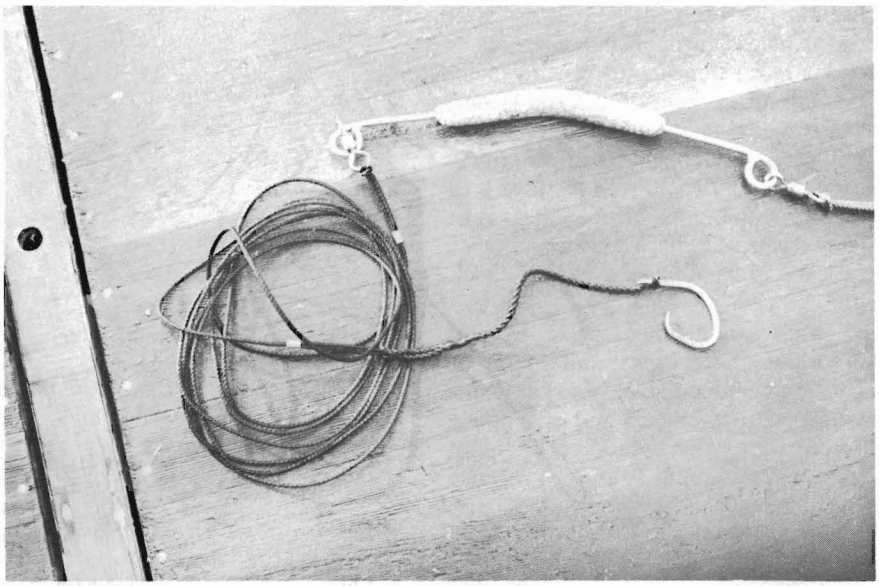


Figure 5.—Photograph of a hook, weight, and leader of handline gear

Table 1.—Weight and value of products of night handline fishery.

	Weight (t)			Weight (1,000 lb)			Value ($1,000)		
Species	1973	1974	1975	1973	1974	1975	1973	1974	1975
Bigeye tuna	65.4	120.2	63.0	144.2	265.0	139.0	102 6	249 8	149.5
Yellowfin tuna	23.3	22.9	75.5	51.3	50.5	166 4	38 0	38 4	157.0
Albacore	0 4	0.2	16.1	0.8	0.4	35.5	0.5	0.2	21.0
All tunas	89.0	143.3	154.6	196.3	315.9	340.9	131.1	288.4	327.5
Squid	5.0	1.7	1.3	11.1	3 7	2.8	6.2	3 5	3.5

Catch

Data on the catch, i.e., species, date of capture, number of fish, weight of each fish, and ex-vessel price for the years 1973-75 inclusive, were made available by Suisan Company, Ltd., which handled the sales of virtually all the catch of the night handline fishery at that time. On the sales records, weight is expressed in whole pounds. In the data analyses the pound was retained as the unit of weight. In the following presentation where weight is given to 0.1 kg, it is simply the metric equivalent of the original expression in pounds and was not meant to convey any implied precision.

The weight and value of the total catch are tabulated by species and year in Table 1. The annual weights and values for all tunas combined show a consistent growth of the fishery from 89,000 kg (196,000 pounds) to 155,000 kg (341,000 pounds) and from $131,000 to $328,000 over the 3-year period. The annual catches of the individual species, however, show a wide variation between years with 2 years having about the same catch and 1 year having a much greater catch. For the bigeye tuna, the catch in 1974 was almost twice those of the other 2 years. The catch of yellowfin tuna in 1975 more than tripled the catches of the previous 2 years. The catch of albacore, also high in 1975, was almost 60 times as great as the catch for the other years. The catch of squid reported in Table 1 is the amount sold at auction and represents the amount caught in excess of the squid used for bait.

Bigeye tuna caught in this fishery range in size from 2.3 to 128.3 kg (5-283 pounds). Frequency distributions of weight by year (Fig. 6) show that most of the bigeye tuna weighed less than 45.4 kg (100 pounds). In 1973 fish weighing 45.4 kg (100 pounds) or less comprised 87.7 percent of the catch; in 1974, 78.7 percent; in 1975, 71.7 percent. The size range of yellowfin tuna caught was from 2.7 to 125.2 kg (6 to 276 pounds). The size composition of this species varied considerably from year to year (Fig. 7). The median weight is a good example of the variability. It was 21.8 kg (48 pounds) in 1973, 81.6 kg (180 pounds) in 1974,

and 56.2 kg (124 pounds) in 1975. Albacore had a much more limited size range than the other species, 15.4-34.5 kg (34-76 pounds) (Fig. 8). There was one unusual individual of 3.2 kg (7 pounds).

The monthly distribution of catch for the years 1973 through 1975 (Fig. 9) show peak catches for yellowfin tuna and albacore during September and October, respectively. Bigeye tuna catches were more evenly distributed in time than the other species. October and September were the leading months.

Mention was made earlier of the high positive deviations in the catch of bigeye tuna in 1974 and yellowfin tuna and albacore in 1975. The bigeye tuna catch of 1974 and the yellowfin tuna catch of 1975 were compared with the catches of the other 2 years with respect to fish size and month to analyze the increase. More specifically, the average monthly catch in weight for each 4.5-kg (10-pound) weight class of 1973 and 1975 was subtracted from its corresponding catch in 1974 for bigeye tuna; the average monthly catch for each 4.5-kg (10-pound) weight class of 1973 and 1974 was subtracted from its corresponding catch in 1975 for yellowfin tuna.

The results for bigeye tuna (Fig. 10) show that for the months of July and August 1974 catch was slightly better than in the other years. The increase in catch was distributed fairly evenly over the remaining 4 months of the season. Contributing most to the 1974 increase was the December catch of 5.0- to 40.8-kg (11- to 90-pound) fish. Other major contributors to the increase in order of magnitude were the 68.5- to 104.3-kg (151- to 230-pound) fish in November and October, and the 27.7- to 45.4-kg (61- to 100-pound) fish in September.

The 1975 increase in yellowfin tuna catch was concentrated in the month of September (Fig. 11). Two-thirds of the increase in catch was made in September, 17 percent in October, and 15 percent in November. The largest increase in weight was in the 91.2- to 113.4-kg (201- to 250-pound) group. There was also a large increase in the 41.3- to 68.0-kg (91- to 150-pound) group.

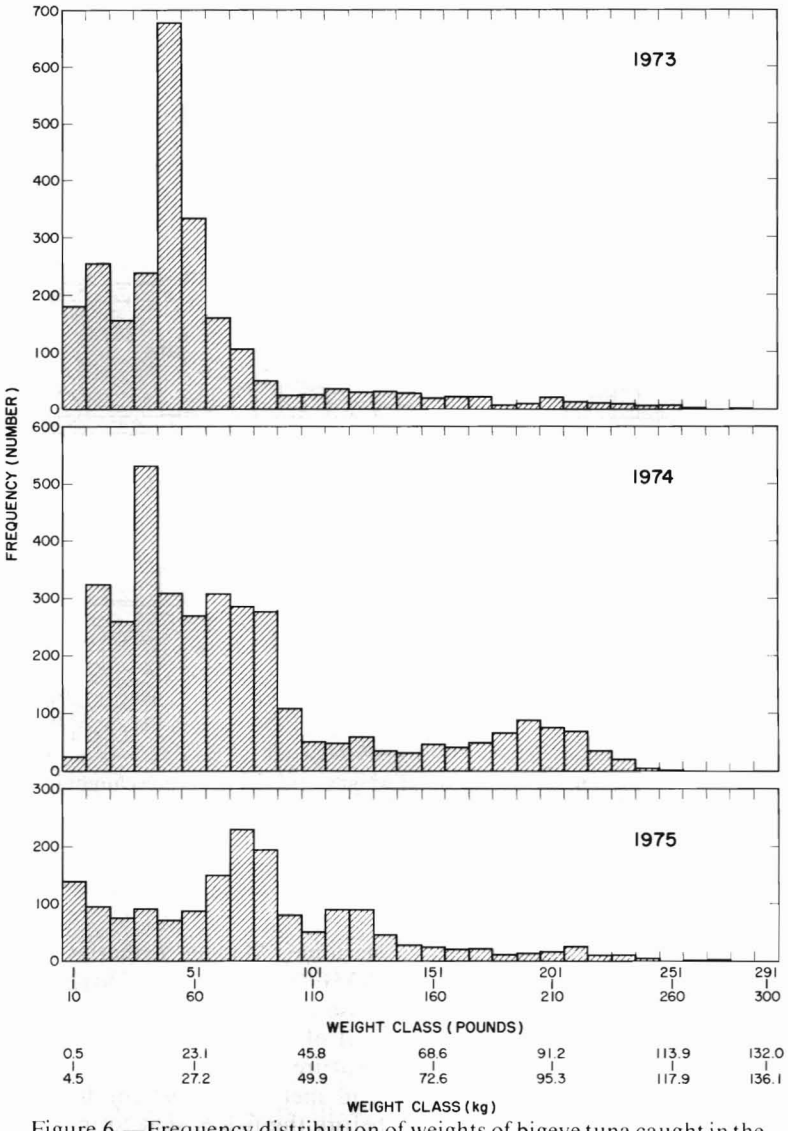


Figure 6.—Frequency distribution of weights of bigeye tuna caught in the night handline fishery for tunas.

Ages were assigned to the bigeye tuna catch based on size at age information of Shomura and Keala (1963) who assumed that spawning occurred in April. Since the fishing season has its peak half a year from the spawning season the fish were assigned mid-year ages. The catch curves constructed from the data (Fig. 12) indicate that recruitment is complete at age 2.5 years and possibly a year earlier as suggested by the data of 1973. Instantaneous rates of total mortality for fish between ages 2.5 and 7.5 years estimated from lines of least squares fit for 1973 and 1975 resulted in Z values of 0.73 and 0.90, respectively. Calculations were not made for the obviously anomalous year of 1974.

Discussion

The growth of the Hawaiian night handline fishery for tunas was dependent on two major factors: 1) The increased demand for fresh tuna of high quality for "sashimi" (a Japanese raw fish dish) and 2) the ability of modern transportation systems to speedily deliver the fish to markets as much as 6,400 km (4,000 miles) from the fishery.

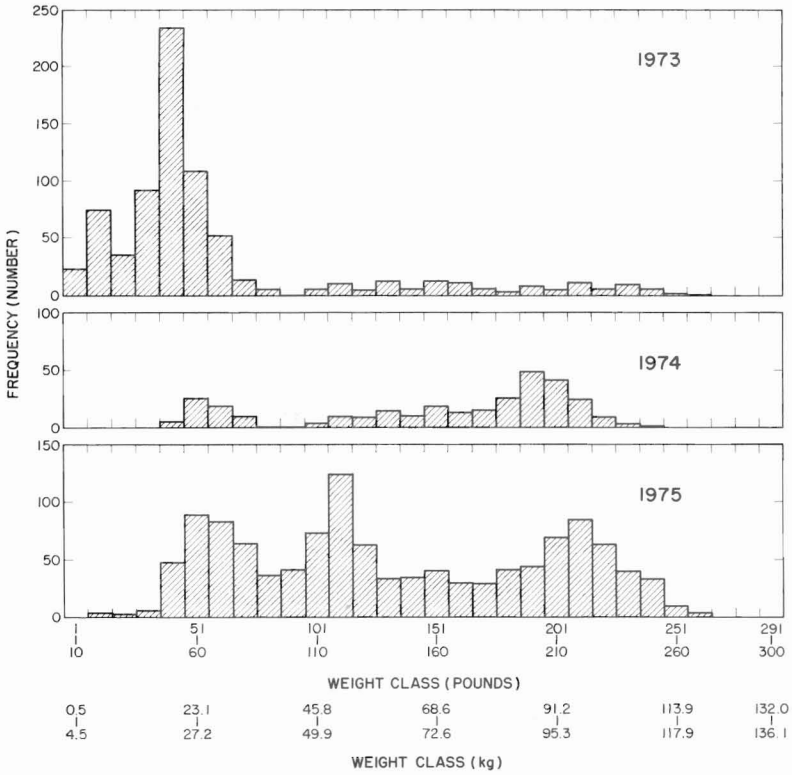


Figure 7.—Frequency distribution of weights of yellowfin tuna caught in the night handline fishery for tunas.

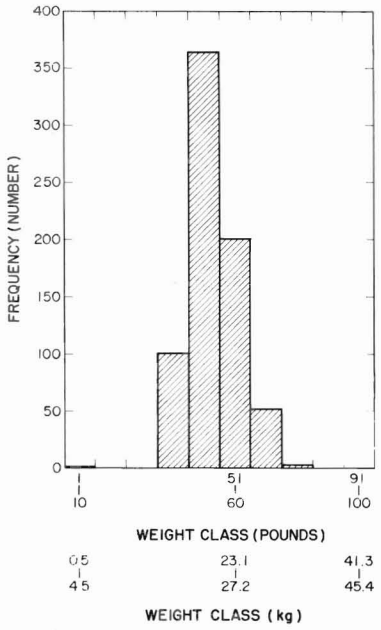


Figure 8.—Frequency distribution of weights of albacore caught in the night handline fishery for tunas.

One of the problems of the fishery, which is handled expediently at the local level and accentuated by remote marketing, is the problem of "burnt" tuna. Tuna are labeled "burnt" when the normally dark red, translucent flesh is light pink, opaque, and slightly sour in taste. Burnt tuna is considered to be less desirable than normal tuna and sells at a lower price. "Burnt," however, is not a clear-cut condition, i.e., there is a continuum from very lightly burnt to heavily burnt. The burnt condition cannot be detected until the fish is dressed and the flesh exposed. Because tuna are transported whole to preserve their quality the burnt condition is not detected until after transportation expenses have been incurred. The problem is compounded when the seller who must accept the distant buyer's judgment of quality begins to doubt the integrity of the buyer.

The Honolulu Laboratory of the National Marine Fisheries Service (NMFS) is now working to identify the cause of the burnt condition with the goal of preventing it. As an interim measure NMFS is also working on a field method to test for burnt tuna before the fish is sent to market.

The successful development of the night handline fishery in Hawaii depended heavily on knowledge of where the fish are going to be and the time of the year they are going to be there. Similar information will be required for development of night handline fisheries in other island communities.

Most of the Pacific island communities are not within the network of daily air transport schedules. Consequently, their tuna catches would have to be stored for later shipment and would be ineligible for the blue chip, fresh fish market. Two market options would still be open, however. The first, and probably less profitable of the two, is to

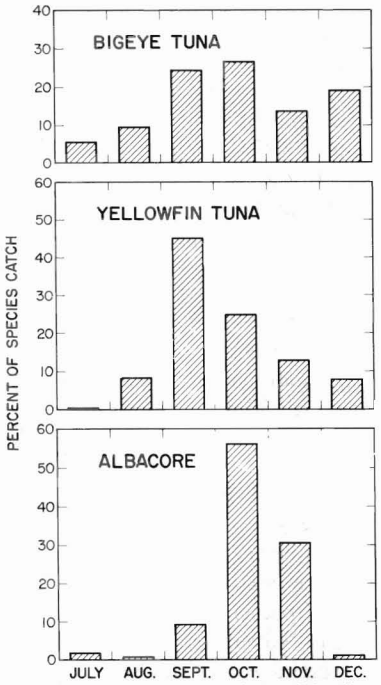


Figure 9.—Proportion of individual species total caught each month. Data of 1973 through 1975 combined.

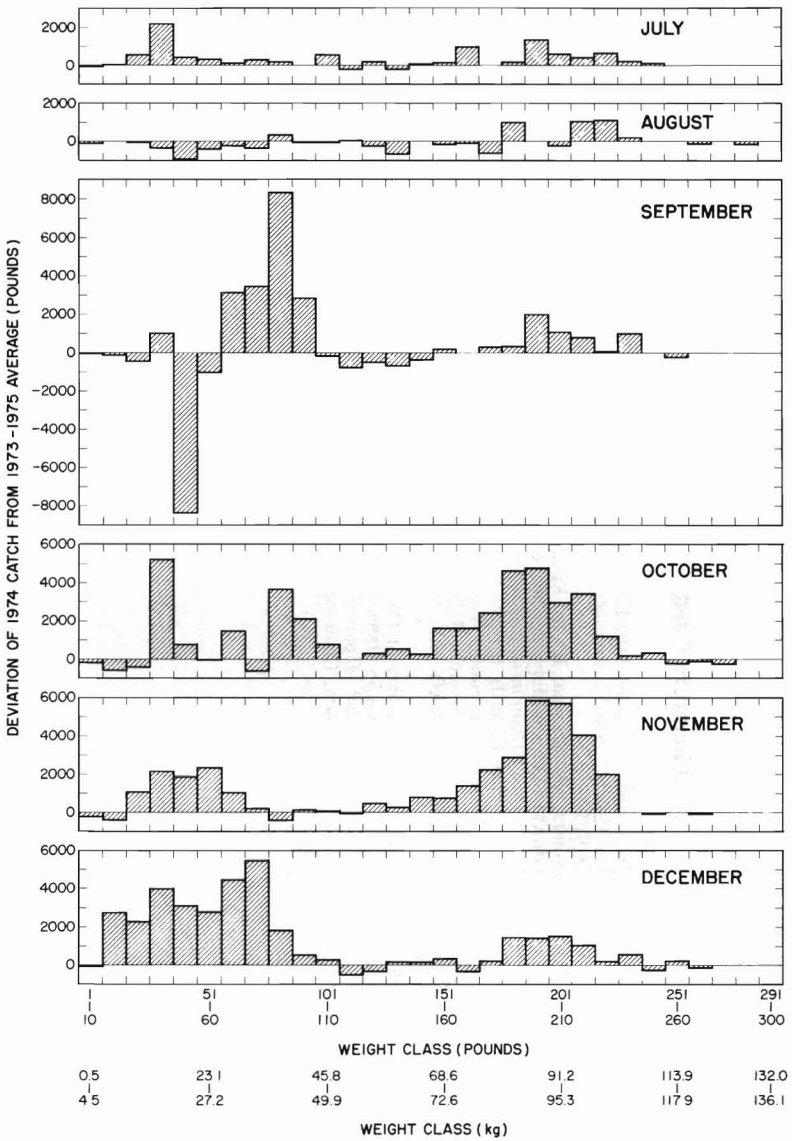


Figure 10.—Deviations of the 1974 catch from the average catch of 1973 and 1975 for bigeye tuna.

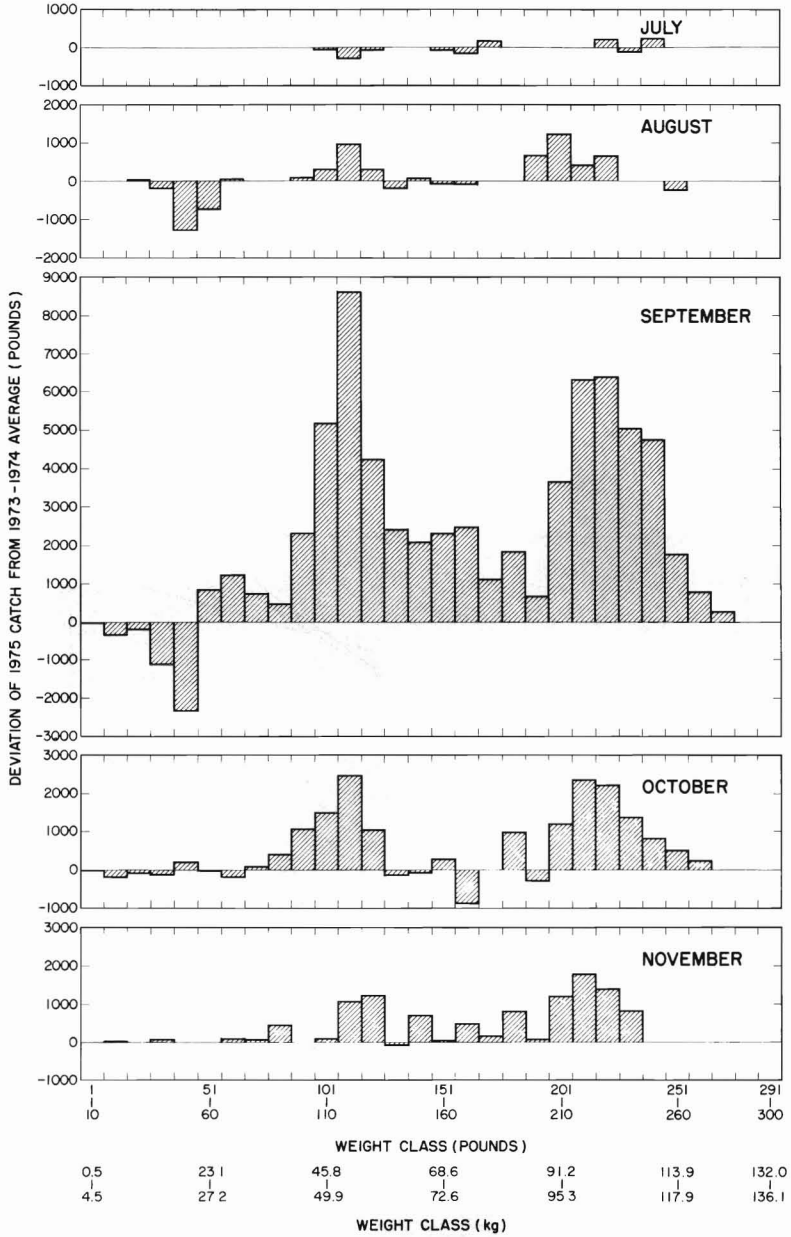


Figure 11.—Deviations of the 1975 catch from the average catch of 1973 and 1974 for yellowfin tuna.

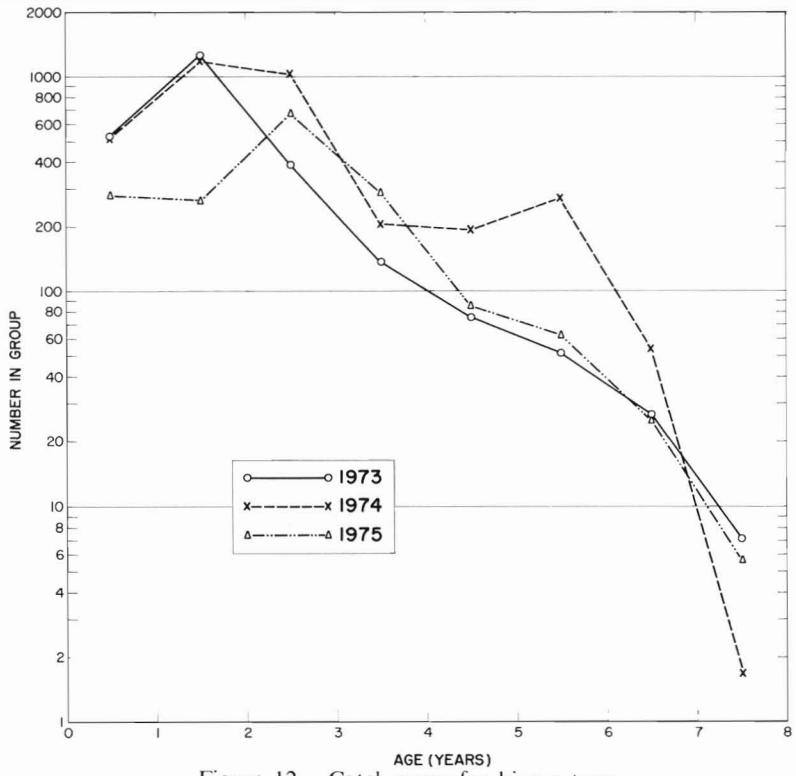


Figure 12.—Catch curve for bigeye tuna.

sell the catch to canneries. The second is to sell the fish on the sashimi market. The latter option is available if the flesh quality of the tuna is maintained by storing at -50° C.

Acknowledgments

The Suisan Company, Ltd., of Hilo, Hawaii, provided the catch and price data. I gratefully acknowledge the willing assistance of Zenso Kanai and Hiro Nishimura of Suisan Company, Ltd. Kanai made the records available. Both made arrangements for me to interview fishermen and to board fishing boats for field observations. Howard Takata, Marine Advisory Agent in Hilo, made a conscientious review of the manuscript.

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