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REVIEW OF FISH HANDLING TECHNIQUES IN HAWAII

By

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INTRODUCTION

The Hawaiian Islands, by virtue of their volcanic origin, have steep-sided bases which limit the shelf zone to a narrow band that surrounds each island. The geological formation of the islands is vitally important to fishing in Hawaiian waters, because unlike the continental shelf that characterizes most of the world's great fishing areas, these island shelves are narrow, poorly developed, and do not offer the marine environment conducive to high fishery yields.

Hawaii's existing commercial fisheries consist of an offshore segment for pelagic species such as tuna, billfish, wahoo, and mahimahi, and a nearshore one that concentrates on a variety of demersal and bathypelagic fish and shellfish. Of the 680+ species found in Hawaiian waters, only about 60-70, mostly occurring on the reefs and inshore areas, are commercially exploited. Many species occur only seasonally; the result is that Hawaii's fishermen are unable to supply the demand for fresh fish on a continuing basis.

Hawaii's per capita consumption of fish and shellfish in 1970-77 varied from 8.8 to 11.7 kg whereas the U.S. consumption rate varied between 5.2 and 5.9 kg or roughly twice the national average (Hudgins 1980). Many of the people living in Hawaii come from a wide variety of ethnic backgrounds including Hawaiian, part-Hawaiian, Caucasian, Japanese, Chinese, Filipino, Korean, Portuguese, and Samoan. This combination of high consumption rate and ethnic preferences for traditional fish dishes makes the consumers in Hawaii unique.

Fish is a luxury food that prosperous consumers in Hawaii could well afford, not a daily necessity as it is to many people living in other South

Pacific island communities (Manar 1969). Whether prices are high because of the existing market structure or because the fish industry operates in a manner to stifle competition has been the subject of several studies in the past few years (U.S. Department of Commerce 1971; Peterson 1973; Garrod and Chong 1978; Adams[1]).

Whatever the real causes for the excessively high prices charged for fresh fish and fishery products in Hawaii, there is still a steady demand for fresh fish and the local fishermen go to great lengths to preserve their catch to satisfy this particular need. This paper reviews some of the methods used by local fishermen to bring their catches to the market in ocean-fresh condition.

THE RESOURCES

Hawaii's commercial fisheries, which have been described in general by Manar (1969) and Uchida (1979), can be divided into two major categories--the offshore, pelagic fisheries conducted by the larger vessels such as those used in tuna fishing and the inshore, benthopelagic, and demersal fisheries prosecuted by smaller crafts such as those engaged in mackerel purse seining, handline fishing, lobster and fish trapping, and crab netting.

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[1]M. F. Adams. 1981. Competition and market structure in the Hawaii fish industry. Southwest Fish. Cent. Admin. Rep. No. H-81-5, Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96812, 20 p.

The Offshore Resource

The offshore fisheries is conducted in the open ocean in depths beyond 200 m where pole-and-line sampans harvest almost all the Hawaiian landings of skipjack tuna, Katsuwonus pelamis, and longline boats catch deep-swimming tunas including yellowfin tuna, Thunnus albacares, bigeye tuna, T. obesus, and albacore, T. alalunga; billfishes such as striped marlin, Tetrapturus audax, blue marlin, Makaira nigricans, black marlin, M. indica, swordfish, Xiphias gladius, shortbill spearfish, T. angustirostris, and sailfish, Istiophorus platypterus; and other species such as wahoo, Acanthocybium solandri, and mahimahi, Coryphaena hippurus.

A relative newcomer to the offshore fishing scene is the "ika-shibi" or night handline fishery for tuna (Yuen 1979) and to a lesser extent, the "palu-ahi" or "maki-dogu" fishery, which is essentially a daytime handline fishery. Also contributing to catches of offshore pelagic fishes are the trollers which in recent years have caught significant numbers of albacore in the North Pacific north of Midway Islands.

The Inshore Resource

The inshore fisheries in Hawaiian waters are for a wide variety of demersal and bathypelagic species which are caught by handline, traps, and nets. In the handline fishery, the major species include opakapaka, Pristipomoides filamentosus, kalekale, P. sieboldii, gindai, P. zonatus, ehu, Etelis carbunculus, onaga, E. coruscans, uku, Aprion virescens, kahala, Seriola dumerili, ulua, Caranx spp., weke, Parupeneus spp., and hapuupuu, Epinephelus quernus. The most important benthopelagic species is akule, Selar crumenophthalmus, which is second only to tuna and billfish in total landings (Uchida 1978). Akule are commonly taken by three types of gear--bag net, handline, and gill net, which account for nearly two-thirds, 20 and 13% of the annual landings, respectively (Kazama 1977). Also of importance in the inshore fishery is the opelu, Decapterus macarellus, which is widely distributed in the tropics and is found in small schools just outside the breakers and off coral reefs. The gear used to catch opelu are the hoop net, which accounts for slightly more than half of the opelu landings, and handline, which produced roughly 45% of the catch.

HARVESTING

The offshore harvesting methods have been described in detail in several reports, for example, June (1950, 1951); Yoshida (1966); Yuen (1979); and Dotson (1980). Inshore fishing methods, for example, handline fishing and trapping, have never been adequately described for the commercial Hawaiian fishery. Kazama (1977) provided a detailed description of the fishing methods used for akule; for opelu, the reader is referred to Powell (1968).

Briefly, the handline gear, which consists of a 1,100-m length of 118-kg hard-braided nylon line to which a terminal rig is attached, is either hauled by hand or hydraulic gurdy. The terminal rig consists of a drop line, hook lines, hooks, and weight. Usually, four hooks are fished but the number may vary up to six or seven depending on personal preference. To each hook line, a recurved Hawaiian "oio" or "Tankichi" hook is attached, the size usually depending on the target species. For most bottom fish species, hook size No. 28 is most ideal. The weight used to take the line down to the bottom is usually about 1.4 kg but this may vary depending on the strength of the current.

For trapping, there is no set standard for traps with respect to size or shape. Some are rectangular, single-chambered, and have one or two entrances, either conical or oval. Others are half-moon shaped with a single entrance. Frames for the traps are usually of 0.9- or 1.3-cm reinforcing steel. All traps are covered with 2.5-cm chicken wire mesh. Traps may be baited with chopped fish or left unbaited; attractive objects such as white porcelain dishes are hung in unbaited traps as lures. Traps are pulled periodically and the fish removed. Hawaiian trap fishermen do not mark their traps with surface buoys as is commonly done in other parts of the world. Some use submerged buoys; others use no buoys at all. Experienced fishermen usually locate their traps by triangulating on prominent objects or landmarks along the shoreline.

HANDLING THE CATCH AT SEA

In pole-and-line fishing, when a tuna school breaks off from the stern of the vessel and is considered no longer fishable, the crew stows the catch immediately in baitwells that have been emptied of bait during fishing. The temperature of the seawater in the baitwell is lowered by adding crushed ice, the amount added depending on the size of the catch. On some vessels, those fish that are destined for the fresh fish market are given special handling. Each fish is individually stowed head down and crushed ice is packed into the spaces between the fish. This method of handling prevents damage that may occur if fish are simply stowed in the chilled seawater one on top of the other.

Upon return to port with the day's catch, the crew unloads by hand if the catch is small or if part of the catch is consigned to the fresh fish market. Market fish are unloaded into galvanized metal cans and sorted according to size. After the market fish are unloaded and each can weighed, the crew uses a conveyor to unload the balance of the catch into trucks for sale to the cannery. At other ports, for example at Kaneohe Bay, the entire catch is unloaded by hand. Garrod and Chong (1978) have estimated that about 4,500 kg of skipjack tuna can be absorbed daily by Hawaii's fresh fish market. Annually, this amounts roughly to 1,650 metric tons.

When the catch is inadequately refrigerated, a condition known as honeycombing can occur (Otsu 1957). Honeycombed fish have pitted and cellular-like flesh. Studies by Frank et al. (1981) demonstrated that honeycombing occurred at an optimum temperature of 32.2°C and was even present when antibiotics were used to inhibit microbial activity and histamine formation. They also found that freshly caught skipjack tuna had tissue that was practically devoid of histamine; however, this compound formed readily when whole fish were left to incubate at higher temperatures. The optimum temperature for histamine production was 37.8°C. At still higher temperature (43.3°C), tissue deterioration was very extensive.

In the longline fishery, the entire catch is stowed over ice and covered with wet burlap. Among the steel-hulled longliners, a constant temperature can be maintained in the reefer using a Freon[2] refrigerant. On these boats, the catch is first packed in ice and then the temperature gradually lowered to maintain a constant -3.9°C.

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[2]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

In the "ika-shibi" and "palu-ahi" handline fishery, albacore, bigeye, and yellowfin tunas caught by the fishermen are simply chilled with ice to preserve their quality. This method of preserving quality, however, appears to be inadequate.

A condition known as burnt tuna has now become a major economic concern in the night "ika-shibi" fishery. The problem apparently is not new. Peterson (1973) documented the fact that longline-caught tunas are affected by a burnt condition from time to time. The fishermen believe that deterioration begins when a fish dies on the line before it is hauled aboard the longliner. This deterioration, which begins in the stomach of the fish, is described as a burn-like appearance. Cramer et al. (1981) described burnt tuna as "raw tuna which is paler and softer than normal." High-quality tuna, on the other hand, is translucent, red, and firm. Although edible, burnt tuna is undesirable for raw consumption as "sashimi" because the flesh has a poor texture, color, and tastes slightly sour. Cramer et al. determined that the burnt condition results from muscle cell degeneration which begins prior to the death of the fish. Degeneration proceeds more rapidly after death in burnt than in normal fish. The occurrence and severity of burnt tuna were found to be positively correlated with females, fighting time, and improper refrigeration.

Studies by Uda (1941) and Barrett and Hester (1964) have demonstrated that the body temperature of skipjack tuna and yellowfin tuna immediately after capture is generally higher than the seawater temperature. The relationship determined by Barrett and Hester indicates that length was of minor importance in the body temperature-sea temperature relationship for yellowfin tuna but for skipjack tuna, they found that small fish tended to have lower body temperatures than larger ones. From their study, it appears that a 60-cm skipjack tuna caught in 28°C water may have an internal body temperature as high as 34.2°C.

Otsu (1957) has suggested that it is this high body temperature which causes the baitwell water to rise, particularly when large numbers of freshly caught fish are placed in it all at once.

The catches are chilled in ice on almost all handline fishing vessels, but on one vessel in the fleet part of the catch is chilled and frozen. Certain small species such as menpachi, *Myripristis* spp., kumu, *Parupeneus porphyreus*, weke, *Upeneus arge*, *Mulloidichthys samoensis*, and *M. auriflamma*, akule, opelu, snapper, and other reef fishes are never frozen because of the preference of ethnic groups living in Hawaii for fresh fish. This is not to say that there is no market for frozen fish. Species such as ulua, *Caranx ignobilis*, when they constitute a large part of the catch, may be frozen for later sale in the thawed state.

During the past 5-6 yr, a fishery for spiny lobster, *Panulirus marginatus*, caridean shrimps, *Heterocarpus ensifer* and *H. laevigatus*, and kona crab, *Ranina ranina*, has developed in waters of the Northwestern Hawaiian Islands (NWHI). Spiny lobster, which has become one of the mainstays of this NWHI fishery, was initially all brought back to port alive in the vessel's baitwell, but because of the limited market for live lobsters, most of the vessels nowadays process the lobsters at sea, keeping only the tails which are brined then frozen.

Caridean shrimps are a relatively new product on the Hawaiian market. National Marine Fisheries Service experiments at sea have shown that deterioration sets in rapidly in caridean shrimps and that quick processing including removing the head, chilling, and freezing is essential to maintain high quality (Strusaker and Aasted 1974). Experimental packs by one vessel have included use of a combination of brine chilling and freezing to produce an acceptable pack.

Kona crab, another crustacean found in relatively good numbers at certain locations in the NWHI, has been targeted as a species for possible development. Traditionally, kona crab was usually sold live like most other species of crab caught in Hawaiian waters and sold locally; however, because of the distance between Honolulu and the crabbing grounds in the NWHI, attempts have been made to sell frozen crab. This approach to marketing kona crab is similar to what is being done with dungeness crab, *Cancer magister*, snow crab, *Chionoecetes bairdi*, and king crab, *Paralithodes kamtschatica*, all of which are imported into the State. One other species of crab that has only recently been sold in a frozen state is the white crab, *Portunus sanguinolentus*.

IMPORTS

In addition to dungeness, king, and snow crabs, Hawaii imports clams, lobsters, shrimps, chilled fish, frozen fish, cured fishery products, and fish pastes, balls, sticks, and roe from the Pacific Northwest, Alaska, New Hebrides, Philippines, Taiwan, Japan, Panama, Fiji, New Zealand, and Australia (Garrod and Chong 1978; Hudgins 1980). Foreign imports alone accounted for 54% of the total supply of fish, fishery products, and shellfish in Hawaii (Hudgins 1980).

FISH PROCESSING

Much of the processing of fish in Hawaii is done by the one existing tuna cannery that packs local skipjack tuna, and other imported frozen tuna species, such as yellowfin tuna and albacore. Locally caught skipjack tuna are also sold fresh, cured, or as bait.

Almost all the large tunas and billfishes are sold fresh; those that are considered surplus to the local market are shipped to lucrative markets in the continental United States and Japan.

Although a good proportion of the fish and shellfish landed in Hawaii are sold fresh, there is a growing trend toward marketing some of the local catches in a frozen state, for example, lobster tails, caridean shrimps, kona crab, and white crab. There is also a small market for cured fish: skipjack tuna, akule, and opelu are frequently sold in the cured state.

One of the last major processors of fish in Hawaii is the fish cake manufacturer. Whereas they relied heavily on locally caught billfish in former years, almost all the manufacturers now rely on imported Japanese "surimi," which is a semiprocessed wet fish protein prepared from Alaska pollock, *Theragra chalcogramma*. Billfishes and scrap fish are also ground and mixed with "surimi" whenever they can be obtained inexpensively and in large enough quantities. Smaller quantities of fish paste sold at the fresh fish market are usually obtained from locally caught awa, *Chanos chanos*, awaawa, *Elops hawaiiensis*, and oio, *Albula vulpes*.

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