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About the Author

Ed Murdy is presently a Smithsonian/Peace Corps Volunteer working as a Research Associate for the Marine Sciences Center of the University of the Philippines. His thesis work on the reproductive biology and natural history of the Eastern pirateperch, *Aphredoderus sayanus* earned him a masters' degree from Old Dominion University in 1977. He then worked for the U.S. Army Corps of Engineers in Virginia as a Marine Scientist evaluating and assessing projects from an environmental impact standpoint. Since July 1978, he has been in the Philippines and has been concentrating his efforts on the fishery aspects of artificial reefs.

The Commercial Harvesting of Tuna-Attracting Payaos: A Possible Boon for Small-Scale Fishermen

NATURAL and man-made objects which drift in the sea often serve as attractants for certain species of pelagic fishes. Commercial and sport fishermen alike have made use of this knowledge to successfully exploit this phenomenon. Commercial fisheries based on associations of pelagic fishes with objects in the sea have been reviewed by von Brandt (1960) and Hunter and Mitchell (1966). The recent development of offshore oil drilling platforms has also proven to be effective in aggregating schools of fishes (Treybig 1971; Hastings et al. 1976).

Off certain islands of the Philippines (Mindoro, Negros, and Mindanao) anchored floating bamboo rafts (payaos) have been used for many years by tuna fishermen on a local level to aid them in concentrating schools of yellowfin tuna *Thunnus albacares*, skipjack *Katsuwonus pelamis*, and little tuna *Euthynnus affinis*. The tuna were caught from bancas mainly by hook and line, a system that is not extremely efficient in harvesting great numbers of fish.

Quite recently, an alliance has formed between commercial purse-seiners and local fishermen.

This is a report of a 2-d payao harvest aboard a commercial tuna catching vessel.

The harvest took place from 29 to 30 April 1979 aboard the *Hornet*, a 778-t commercial tuna catching vessel

of the Eastern Shipping Lines. Harvested were two payaos located 11 km west of Mamburao, Mindoro in the South China Sea.

The payaos were anchored in approximately 1100 fathoms and had been in place for almost 1 mo. They were placed about 10 km apart along the same isobath. A caretaker who occasionally visited the payaos noticed large concentrations of tuna swimming underneath both payaos after they had been in place for 3 wk. This was an indication that the payaos were ready to be harvested. He alerted the payao owners who immediately contacted the shipping company. A few days later the *Hornet* arrived and made the harvests. The April 29 harvest yielded 36.3 t, while the 30 April harvest consisted of 3.6 t, both predominantly skipjack.

The two payaos harvested were of a different design than those previously used, and I think it important to provide a descriptive account of this fish-attracting device.

The raft was made of two layers of bamboo lashed together in a V-shape (Fig. 1). The raft was approximately 4 m in length, 1.5 m at the widest end. There was a slight elevation between the two layers designed to lessen the resistance to water flow. The V-shape also aided in this. The anchor line was

attached to a tire secured to the bamboo about 3 m from the apex. As stated earlier, these payaos were anchored in 1100 fathoms; consequently, the anchor line was the major expense in this venture, comprising about 90% of the total cost of the structure. The first 40 m of the anchor line was made of wire to prevent cutting by vandals and this was attached to a swivel which in turn was attached to a 16-mm nylon rope extending down to a swivel connected to a 40 kg counterweight. The counterweight acts as a shock absorber and takes some of the strain off the anchor line. The main anchor (400 kg) was connected by 5 m of nylon rope to the counterweight.

Because of the high cost of the anchor line and since strong winds and currents tend to destroy the bamboo raft portion of the structure, a buoy was added so that the anchor line would not be lost even if the raft was. The buoy, an 80-gal water tank, was secured by nylon rope to the swivel where the wire meets the nylon rope.

The most important feature of the payao is a hanging line with coconut leaves tied to it at 2-m intervals. This

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weighted hanging line or haybong, normally about 20 to 25 m long serves as the fish attractor. The mechanics of attraction are stepwise. The coconut leaves tied to the line become colonized with algae. This vegetative growth attracts small, pelagic fishes that orient to the haybong for food and shelter. The small fishes, in turn, attract the free swimming, schooling tuna. The number of tuna underneath the payao grows steadily. Occasionally, large predators such as swordfish (*Xiphias gladius*) and sharks would forage among the fishes, dis-

rupting their schools. The time period from the day the payao is anchored up to the time there are enough tuna for a commercial harvest is from 3 to 4 wk.

As previously mentioned, the payao caretaker occasionally visits the payao from the day it is anchored. If local fishermen using hook and line are seen in the area of the payao it is a good indication that tuna are present. If the water clarity is good, tuna can be seen near the surface at sunset and sunrise. The caretaker for these particular payaos had noticed tuna activity 3 wk after placement and the commercial

tuna boat was subsequently notified.

Preparations for harvest began the night before the morning of the harvest. As soon as the vessel was stationed near the payao, a small boat was dispatched to remove the haybong from the payao and attach it to the free floating small boat. This was done at around 2100 hr and the small boat with haybong drifted for the remainder of the night. However, due to a slight current and the drag of the haybong, it did not drift far. The small boat was equipped with four 500-watt lamps that were turned on to help draw the tuna closer to the surface. At around 0430 hr, or just before sunrise, the *Hornet* began to set the purse seine by slowly circling the drifting boat while letting out the net. The net was between 90 and 100 fathoms deep. When the circle was completed, the purse seine was tied off and the harvest begun. With the net in place, the haybong was lifted onto the small boat and the boat moved out of the encircled area. Because of the enormous size of the net, it was not until around 0500 hr that the fish were seen (Fig. 2). As the net was brought on board, numerous small tuna were seen caught in the mesh (Fig. 3). At 0830 hr, the winch on board could no longer pull in the net. The winch can only pull a maximum of 3 t and it is a sign of a good catch when the winch no longer responds. The rest of the catch had to be scooped out (Fig. 4). A visual estimate of the catch was made by a deckhand who swam along the surface peering into the enclosed net. The visual estimate was 30 t, the actual tonnage was 36.3. This harvest was completed at 1130 hr, 7 hr after the net was set.

In this particular catch, the skipjack outnumbered the yellowfin by about 4:1. Most of the fish were in the 2-3 kg range, although there was an occasional yellowfin in the 10-12 kg range. Skipjack and yellowfin are the only species that the cannery for this vessel will accept and the fish must be a minimum of 2.5 kg. The smaller, other varieties will be sold in local

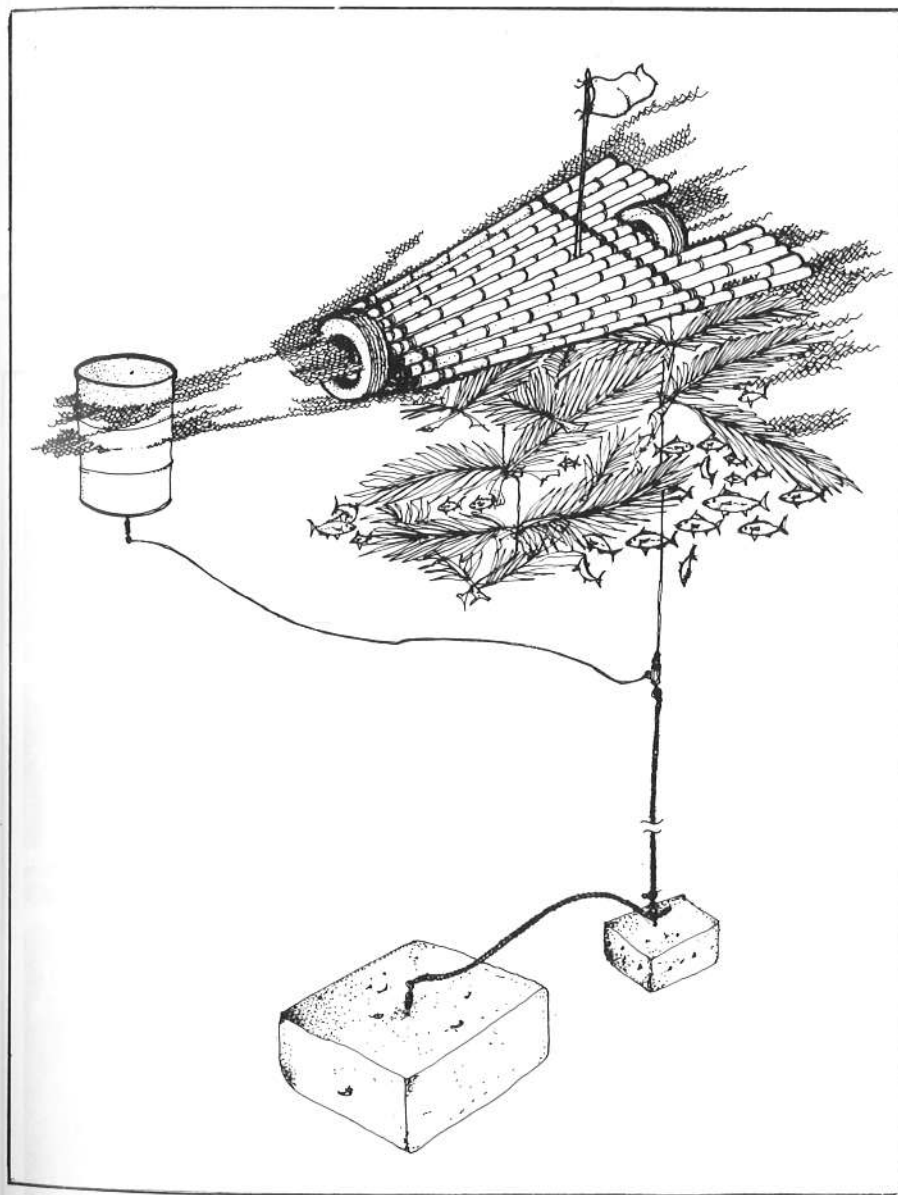


Fig. 1. The payao, a raft made of two layers of bamboo lashed together in a V-shape, is used by tuna fishermen off certain islands of the Philippines to attract schools of yellowfins, skipjacks, and little tuna. The payaos studied were each about 4 m long, and 1.5 m at the widest end.

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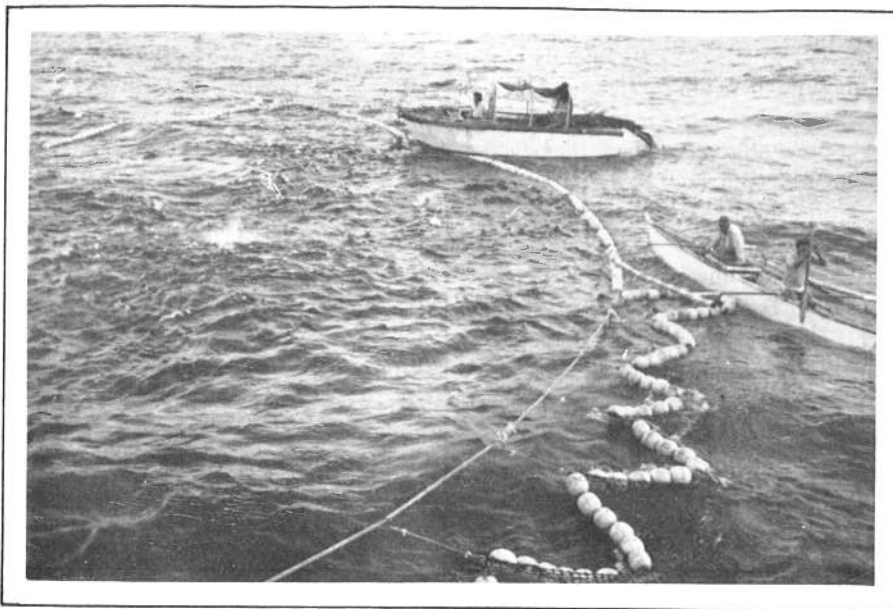
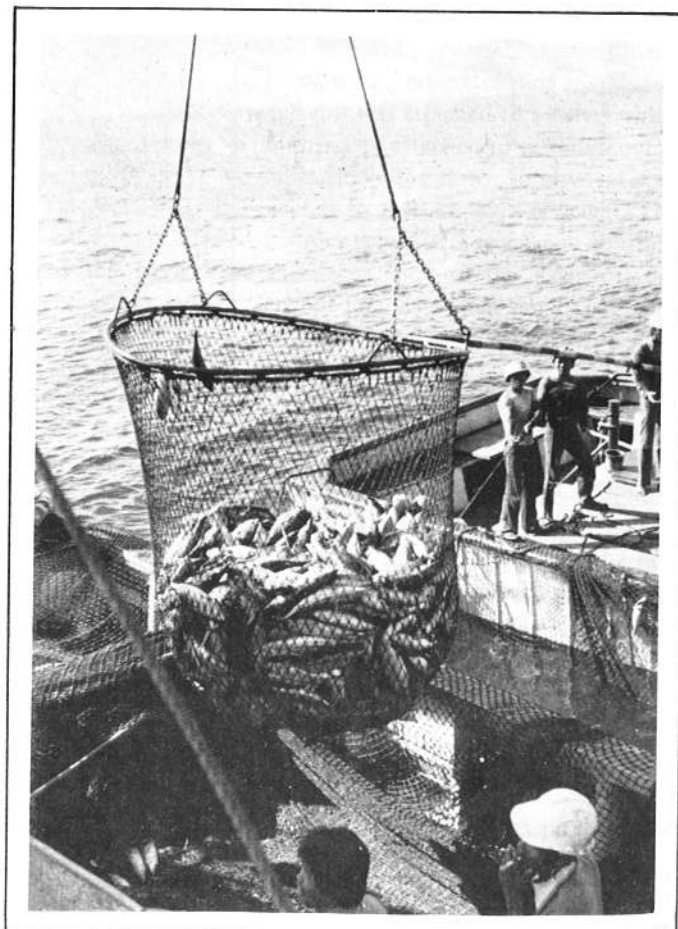


Fig. 2 (above). The net was set at 0430 hr. Because of the enormous size of the net, it was not until 0500 hr that the fish were seen. Fig. 3 (below, left). As the net was brought on board, numerous small tuna were soon caught in the mesh. Fig. 4 (below, right). At 0830 hr, the winch on board could no longer pull in the net. The rest of the catch had to be scooped out.

markets. At the time of this harvest, skipjack were ₱1.50 per kg, yellowfin ₱2.50 per kg, and the little tuna ₱1.00 per kg.

The arrangement between the payao owner and the commercial vessel had the former receiving 20% of the catch. The owner did not get his percentage in fish, but instead got a receipt which he could claim at the main office of the shipping company. The percentage that the payao owner receives may seem low; however, the commercial vessel assumes most of the risks, i.e., ripped nets, little or no catch at all. Since these fishing vessels are not equipped with sonar, they have to rely solely on the word of the payao caretaker who determines when it is time for a harvest. The stochastic nature of this type of venture was evidenced by our next day's harvest which amounted to only 3.6 t. The same procedure of the previous day was followed except we were at a dif-

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ferent payao located about 10 km to the north. The fish of this catch were a little bigger and contained more yellowfin, the more valuable species. Also in this catch were leatherjackets, *Aluteres monoceros*, triggerfish *Canthidermis* sp., and several rainbow runners, *Elegatis bipinnulatus*. Observed at the surface near the payao were the sergeant-major, *Abudefduf saxatilis* and the pilotfish, *Naucrates ductor*. Two dolphin, *Coryphaena hippurus*, were seen swimming in the area.

Several factors could have caused the smaller second day harvest. It is possible that the purse seine encircled only a small side of the school if the school was not in a circular pattern around the haybong or the largest portion of the school might not have drifted with the haybong after it was transferred from the payao to the small boat. Another possibility is that predators disrupted the school. There are many reasons behind a small catch which is one of the chance factors inherent in this business.

At present, the payao harvesting

months are from January to June during the dry season. Local fishermen say that tuna are present year round. If the payao could be made to withstand typhoons and associated forces, there is no reason harvesting could not be done year round at a rate of once a month. If a local family owned one or two payaos, it could prove very lucrative since commercial harvests are averaging about 15 t.

My recommendations to improve the system and to make it more durable and efficient are:

1. Dispense with the bamboo raft portion of the payao; use only an anchored buoy with an attached haybong. The bamboo is subject to rotting and must be replaced every few months. Storms can also damage the raft. Also, the shadow effect of the bamboo raft has been shown to be negligible in attracting pelagic fishes (Hunter and Mitchell 1966).

2. Lengthen the haybong and substitute relatively inert materials such as plastic or rubber for the decomposable coconut leaves.

3. Wait until minutes before the purse seine is set to transfer the haybong. In this way, it is less likely that the fish will not be concentrated around the haybong and the net should be able to encircle a large segment of the schooling tuna.

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decision-making affecting the production operations. For example, given the prevailing prices of inputs and outputs, it is possible to determine the most profitable quantity of milkfish to produce and how much of each input to apply. As the demand for inputs, such as land, water, fertilizers (organic and inorganic), fry/fingerlings and labor increases, these inputs become increasingly scarce, so it is important that they be used in the most economically efficient combinations. Further, the production function can also show which of the inputs contribute the most to total production and therefore where improvements in input utilization can be made to increase yield. It can also be used to show whether there are increasing, constant, or decreasing returns to scale of production operations.

The fitted production functions not only provide information on the marginal productivities of the inputs and

efficiency of input utilization but also on substitutability among inputs. For example, an appropriately specified production function can provide information on whether the relatively more costly input, such as inorganic fertilizers, can be substituted with a less costly input, such as chicken manure. To provide answers to the questions above, various functional input-output relationships will be specified and estimated. These functions will be estimated by province, climatic regions, pond ownership patterns (private vs. government leased ponds) and between high and low yield ponds.

Production function estimation as an analytical tool can be invaluable in the light of current enthusiasm and efforts to promote aquaculture in developing countries, especially as there have been recent changes in the relative availability of inputs needed for aquaculture.

It is hoped that the results of the study will help fish farmers and govern-

ment officials to organize fish production and the utilization of scarce inputs so as to improve the efficiency and performance of aquacultural operations. Data analysis will be completed in mid-1980. ●

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surveys conducted monthly throughout the Gulf of Thailand.

They agreed that such regular surveys were useful, not only to determine changes in the demersal community but also as a means to collect biological information needed for ecological study.

It was agreed that more meetings, such as the Bangkok seminar, should be held, to upgrade the knowledge and experience of various fishery scientists/institutions in the region on stock assessment methodology and to exchange views and technical knowhow on the various stages of demersal fishery management, which is what is most needed in the region today.