TRACKING OF YELLOWFIN TUNA

By

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The Honolulu Laboratory of the National Marine Fisheries Service and the Hawaiian Invitational Allison Tuna Tournament (HIATT) have agreed to jointly embark on the tracking of yellowfin tuna. Mr. Winfred Ho, chairman of HIATT, thought that it would be a good idea for me to inform you, the members of HIATT, of this cooperative research project by writing an article about it for the Official Tournament Program. This article contains a description of the terms of agreement, a brief history of how the agreement came about, a description of the materials and method involved in tracking yellowfin tuna, the objectives of this study, and some noteworthy results from tracking experiments on other game fish species.

Before getting into the subject matter itself I feel it is necessary to explain the scheduling of three events to give you a time context in which to read the article so that you will not be thoroughly disoriented. The deadline for this article to be at the printers was May 15; the tracking was scheduled for June 14-19; and you will probably be reading this article on July 16 at the earliest. So please realize that as I am writing this article the tracking experiment of yellowfin tuna is an event of the future and you are reading it as an event of the past.

In the agreement between Honolulu Laboratory and HIATT, the former will provide the scientific personnel, supplies, and equipment to track yellowfin tuna for 5 days and the latter will charter the *Kamalii Kai Too* for the purpose. The *Kamalii Kai Too*, a 44-ft Striker based in Pokai Bay, was selected because it has the capacity to stay out at sea for 5 days, has living facilities for six people, and is equipped with loran A and a source of electricity to power the scientific equipment. The Honolulu Laboratory will submit a report within 30 days after the conclusion of field work.

The alliance of HIATT and the Honolulu Laboratory on this project originated in the fall of 1975 with a telephone call from Mr. Ho requesting a meeting of representatives from both organizations. At the meeting of Mr. Ho, Senator Kenneth Brown, treasurer of HIATT, Mr. Richard Shomura, director of Honolulu Laboratory, and myself, the HIATT officers offered financial support of research projects of mutual interest. HIATT had done the unthinkable of making a profit on its first two tournaments and wished to rectify that by supporting research.

The solution of the profit problem, like all solutions have a tendency of doing, created a new problem, that of finding a suitable project. The first suggestion was to have a yellowfin tuna tagging event in which a flotilla of recreational fishers would tag and release as many fish as possible when they appeared at the beginning of the season off Kauai. Subsequent recoveries would yield information on the paths and timing of their movements. The possibility that some,

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perhaps many, of the yellowfin tuna would not survive the rigors of being caught, tagged, and released made this suggestion even more atrocious than having a profit, however, so the idea was rejected. Tracking was eventually settled upon because it could provide details on behavior and short-term movements that would be of value to recreational fishers and scientists. It could also provide important physiological data and a measure of the survival rate of tagged fish.

Attempts at launching a tracking trip in 1976 failed because no boat owner was willing to have the bulky tracking hydrophone installed on his boat. Since then smaller, streamlined equipment has been acquired, thus making possible the present tracking venture.

The procedure used in tracking a fish involves attaching a small, ultrasonic transmitter on the fish and following the signals of the transmitter with a receiving system mounted on a boat. The transmitter we are using for yellowfin tuna tracking comes in the shape of a cylinder 9.2 cm (3.6 in.) long and 1.6 cm (0.6 in.) in diameter. It is sensitive to pressure and transmits, at a frequency of 50 kHz, pulses at a rate of 60 per min to 150 per min depending on its depth. It has an active life of 3 days.

The receiving system consists of a hydrophone and a receiver. The hydrophone is 20.3 cm (8 in.) wide, 11.4 cm (4.5 in.) high, and 12.7 cm (5 in.) deep. It is mounted on a shaft designed to be versatile enough to be attached to the bow of most small boats. An antenna rotor at the top of the shaft provides scanning capabilities. The signal from the transmitter is detected by the hydrophone and relayed to the receiver which converts the 50-kHz ultrasound into audible range. With this system the transmitter can be detected at a range of approximately 3 km (2 miles).

Ancillary equipment have been included in the system to improve measurement accuracy and to make life easier on the scientific observers. A frequency counter provides rapid and precise measurements of the pulse rate. A portable computer and electronic clock are used to automatically record data on a time regimen. The computer is also programmed to convert signal pulse rates to depth readings and periodic position readings from the loran A into speed of travel which, in this case, is a measure of the swimming speed of the tracked fish. An XBT (expendable bathythermograph) unit is used to plot the depth-temperature profile to determine the temperature of the water in which the fish is swimming.

Once preparations have been made and all equipment are checked out, what needs to be done to track a fish is simple. Catch a fish; make a quick judgment on whether or not it is going to survive if released; if so, insert a transmitter and release the fish; listen to the pulses on the receiver and determine the direction they are coming from; when the pulses become faint steer the boat in that direction; and when the pulses become strong, stop the boat. Simple as it is, we do lose contact with the fish on occasion. In fact, the simplicity itself is the major factor in losing fish as tedium-bred carelessness sneaks up on the observer.

The objectives of this tracking trip are: (1) to describe the short-term movements of yellowfin tuna off leeward Oahu; (2) to determine if temperature, salinity, and bottom features influence the movement pattern; and (3) to determine the distance a yellowfin tuna swims over a prolonged period of time. The last objective is part of a study on the energy budget of tunas. In brief, 65% of the energy from a tuna's food intake is available for growth, reproduction, and swimming activity. Data obtained from tracking will make it possible to calculate the amount of energy expended for swimming. Together with information on the energy used for growth and reproduction these data will be used to estimate the rate of energy use and the food requirements to produce that energy. To accomplish the objectives the data collection regime as planned is: time and depth data at 10-sec intervals, position data at 30-min intervals, and temperature-depth profiles and salinity samples at 4-h intervals plus additional observations whenever the scientific observers judge them to be needed.

Fish tracking began a little over 20 years ago with the tracking of salmon in rivers. The tracking of oceanic fish was first attempted in 1969 when we at the Honolulu Laboratory tracked a small aku (skipjack tuna). We have subsequently tracked large aku, albacore, and blue marlin in the Pacific Ocean. Over in the Atlantic Ocean Mr. Donald Merten, a sport fishing enthusiast from New York, has become very interested in tracking game fish. He has equipped his boat with tracking equipment and has invited fishery biologists along the eastern seaboard to join him in this activity. To date they have tracked sailfish, blue marlin, bluefin tuna, white marlin (a species not found in the Pacific Ocean), kingfish, swordfish, and mako shark.

Much useful information has resulted from these tracks. I shall confine this discussion to the more exciting results, however. Small aku tracked off Kaula Island exhibited a daily pattern of remaining on the bank at the southeast corner of the island all day, going out to sea at night, and, after making a large clockwise circuit, returning to the bank at dawn. Moreover, the night circuit was different on each of the four nights of tracking. Large aku moved freely in a vertical zone between the surface and 270 m during daylight hours. At night they confined their swimming to a zone within 70 m of the surface. Of the three large aku tracked through the late afternoon and early evening within a period of 2 weeks, all of them made the transition from day swimming behavior to night swimming behavior within a minute of 7:45 p.m.! Albacore tracked off the shores of California did not enter water cooler than 15°C (59°F). The albacore also appeared to swim slower when they encountered a temperature front, which is defined as a change in temperature of 0.5°C or larger in a nautical mile. A swordfish that was tracked off Cape Hatteras in the Atlantic Ocean displayed a distinct day and night pattern. During the day it remained close to the bottom at a depth of 400-600 m. At sunset it ascended to the surface and stayed within 20 m of the surface most of the time although it did make excursions to about 200 m. At sunrise it went back to the bottom. On one occasion in 3 days of continuous observations, it left the bottom and went close to the surface at 2:30 p.m.

As of this writing the outcome of the yellowfin tuna tracking venture is unknown. Whether we successfully track a yellowfin tuna or not, this project marks a milestone in cooperation between a recreational fishing organization and a government organization. I wish to acknowledge the Hawaiian Invitational Allison Tuna Tournament organization for its contribution to game fish research.