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In the last 6 months, we have had to reorganize and realign our research programs in order to place major emphasis on high priority tasks. It has been decided that the Honolulu Laboratory's major thrust should be in the assessment and development of the skipjack tuna (*Katsuwonus pelamis*) resources. There is general agreement that the skipjack tuna resource is large and relatively underutilized. From the point of view of the American tuna industry, it is important to develop skipjack tuna fisheries in order to keep the industry viable, particularly the purse seiner segment of the industry. The tuna processors in the United States need new sources of raw materials, and they would like to see American interests develop the skipjack tuna fisheries. The Governments of Hawaii, American Samoa, Guam, and the Trust Territory of the Pacific Islands have raised a unified voice calling for skipjack tuna fishery development in their respective areas in order to expand their economic base. Thus, there is great interest in the U.S. very similar to Japan's current "skipjack boom."

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One of the major constraints today to the increased harvest of skipjack tuna by American interests in the central and western Pacific is the problem of live-bait supply. Although areas such as American Samoa, the Trust Territory, Guam and Hawaii all hold potential for greatly increased harvest of skipjack tuna, they are uniformly hampered by the problem of inadequate live-bait resources. The Hawaiian fishery for skipjack tuna experiences considerable fluctuations in landings from year to year. One of the reasons for the fluctuation is the shortage of live bait. The seasonal availability of the Hawaiian anchovy, nehu (*Stolephorus purpureus*), varies greatly, but in general the supply is insufficient to allow maximum fishing effort by the existing fleet of vessels. The problem is particularly serious during the peak skipjack tuna season, from around May to September, when many of the boats spend considerable time catching bait needed to fish skipjack tuna by the pole-and-line method. Obviously, if the boats could fish skipjack tuna instead of spending so much time in catching bait, the landings of the Hawaiian fishery would increase proportionately.

A slightly different situation applies to American Samoa and Guam. In these places, suitable baitfish are virtually nonexistent. Any fishery development would have to rely on a method of fishing that entirely foregoes the use of baitfish (e.g. purse seining) or baitfish would have to be made available (e.g. aquaculture of baitfish for pole-and-line fishing). The prewar experiences of the Japanese have indicated that bait supply was the principal factor limiting catches in the former Japanese Mandated Islands (present Trust Territory).

Purse seining may be the answer to what appears to be a universal problem of bait supply. However, experiences to date suggest that the highly developed U.S. purse seine technology needs considerable modifications before this method can work successfully in tropical waters of the central and western Pacific. Indications are, particularly from Japanese purse seine experiments, that purse seining can be made to work by modifications of the gear and by the development of new seining techniques in response to environmental conditions (clearer water, deeper thermocline) and fish behavior (smaller skipjack tuna schools, faster moving schools, etc.) in these tropical waters which are considerably different from the eastern tropical Pacific.

Both purse seining and pole-and-line fishing methods should be developed further if we are to fully realize the potential harvest of the skipjack tuna resource in the central and western Pacific Ocean. Our Laboratory, because of funding limitations, will probably not be able to carry out any extensive purse seine experiments. We feel that the U.S. tuna industry will soon begin carrying out these experiments, and we will then be providing them with whatever support possible. On the other hand, we hope to begin immediately by concentrating our efforts in the baitfish problem.

There are several possible solutions to the baitfish problem. These are 1) aquaculture of baitfish, 2) development of artificial bait, and 3) transportation of baitfish from areas of plenty to areas where they are unavailable or in short supply.

In Hawaii, some preliminary studies have shown that culturing of baitfish is not one of the better alternatives. The high cost of baitfish culture due in large part to the high cost of land acquisition is a major factor in this finding. Nevertheless, a more detailed study of the problem is needed before this alternative can be ruled out as a possible solution to Hawaii's baitfish problem. Artificial bait of various kinds has been tested in Hawaii, but results have not been too promising. The approach that seems to be most feasible at this time is to transport baitfish from California to Hawaii to supplement Hawaii's natural bait supply. If the northern anchovy (*Engraulis mordax*) from California can be moved to Hawaii on a regular basis in a cost-effective manner, this will permit the present fishing vessels to devote more time to fishing skipjack tuna, and enable them to increase their landings proportionately. Furthermore, the availability of bait would remove one of the major constraints to new investments in the fishery and there is every possibility that additional vessels would join the Hawaiian skipjack tuna fleet. The success of this approach requires: 1) a suitable vehicle with an effective life-support system that will permit transport of baitfish to Hawaii with little mortality, 2) a reliable bait supplier in California, 3) a reliable schedule of baitfish transport, and 4) acceptability of the baitfish by the fishermen for skipjack tuna fishing. The latter requires that the baitfish be effective in producing skipjack tuna, and that the fishermen be willing to pay for them in an amount that would make the transport program a self-paying venture. This type of action program with a good chance of immediate payoff to the Hawaiian fishing industry, and with application to other areas, is receiving our immediate attention.

We have discussed this program with members of the Hawaiian tuna industry and with various researchers, and have received enthusiastic response. The industry members have assured us that they will purchase the anchovy and, if the bait-transport system is proven cost-effective, that they will take over the full-scale system under private enterprise. Of course, we have a long way to go before a full-scale system is realized.

As a means of transporting bait from California to Hawaii, we examined several possible alternatives. For example, we considered using California albacore fishing vessels to transport the baitfish in their bait tanks. We know that anchovy can be carried in bait tanks with little mortality from previous experiences with our research vessels. However, we found that these fishing vessels cannot be depended upon to carry our bait regularly, since they would prefer to go fishing for albacore during the peak seasons. They would only agree to transport bait during their off-seasons, and this, of course, would not satisfy the requirements of the Hawaiian fishing industry.

We have also considered several other alternatives such as using a barge to carry large amounts of bait across the ocean. The costs were prohibitive. Of the several possible alternatives, we decided that the method that seems most economically feasible, and one that can be reliably scheduled, employs a large tank that can be transported over the oceans by a commercial freighter. There is a freighter running between California and Hawaii that carries roll on/roll off cargo. Anything on wheels can be rolled on in California and be transported to Hawaii in 4 days. The ship makes a round trip to Hawaii every 10 days.

The next step was to locate a bait-transporting tank on wheels. We found a surplus U.S. Navy aircraft refueling tank that seems to meet the requirements. The tank is on a trailer and is towed by a tractor. We acquired both the tank-trailer and the tractor, and began modifying it for use as a bait transport. The tank has a 5,000-gallon capacity. Large hatch covers were welded over each of the three compartments in the tank for easy access. We then proceeded to build a life-support system consisting of a gasoline pump to circulate water in the tank, a filter, an aerator, etc. The tank is made to operate with both a closed, recirculating system ashore and an open system while in transit on the freighter. The water supply will be furnished through the ship's system.

We began working on this tank in November, and have essentially completed the modifications including cleaning of the tank, painting of the interior, building a life-support system. The schedule calls for testing of the system in Honolulu with a load of threadfin shad (<u>Dorosoma petenense</u>) before shipping the tank to California for additional on-shore tests with northern anchovy. One of the important tests in California will be to determine the bait-carrying capacity of the tank. When everything is found ready, we will make the first trial shipment. We hope that by early next month (March 1974) the first trial shipment can be made.

Some of the problems that need to be overcome include: 1) obtaining strong bait in California, 2) providing sufficient circulation and aeration of the water to insure sufficient oxygen since oxygen consumption increases markedly with increase in water temperature, 3) developing an efficient method of removing dead bait from the tank, and 4) developing a method of transferring the bait from the tank to the fishing vessel with little mortality. All of these are difficult problems but we are hopeful of solving them one at a time.

One of the most serious problems is the matter of circulation in the tank since this tank was not originally built for carrying fish and the shape is far from optimal. There is little that can be done about this. Oxygen consumption is another serious problem. We have based our oxygen requirements on some data published in the Katsuo-Maguro Nenkan, 1971 (data attributed to the Mie Suishi) and also on some of our own experiments at the La Jolla Laboratory. At the La Jolla Laboratory we have conducted oxygen consumption tests at temperatures ranging from 16° to 28°C or roughly the temperatures encountered in the crossing from California to Hawaii. Fortunately, the temperature change is rather gradual, unlike the abrupt temperature increases experienced by Japanese vessels when heading for the southern fishing grounds.

If we can transport anchovy from California to Hawaii in sufficient quantities and on a regularly scheduled basis, this will not only permit our existing boats to spend more time fishing, but will encourage new vessels to join the fleet. Already there is considerable interest in new investments, but these are discouraged by the problem of bait supply. If bait supply is no problem, it is very likely that new boats will come into Hawaii, and that there will be a considerable expansion of the fishery.

At the present time, a group of researchers is readying the tank for a trial shipment of anchovy from California to Hawaii. Before shipping the tank to California, the life-support system will be tested in Honolulu with a load of threadfin shad. If the shad can be held in a closed recirculating system, then the tank will be sent over to Los Angeles by way of commercial freighter for another on-shore test with northern anchovy. The optimum carrying density will be determined before the first trial shipment. I hope that this experiment works well, and that we can prove this system to be cost-effective. By demonstrating to the Hawaiian tuna industry that an adequate bait supply can be moved to Hawaii in this manner, we are hopeful that the industry will take over the system for a full-scale operation.