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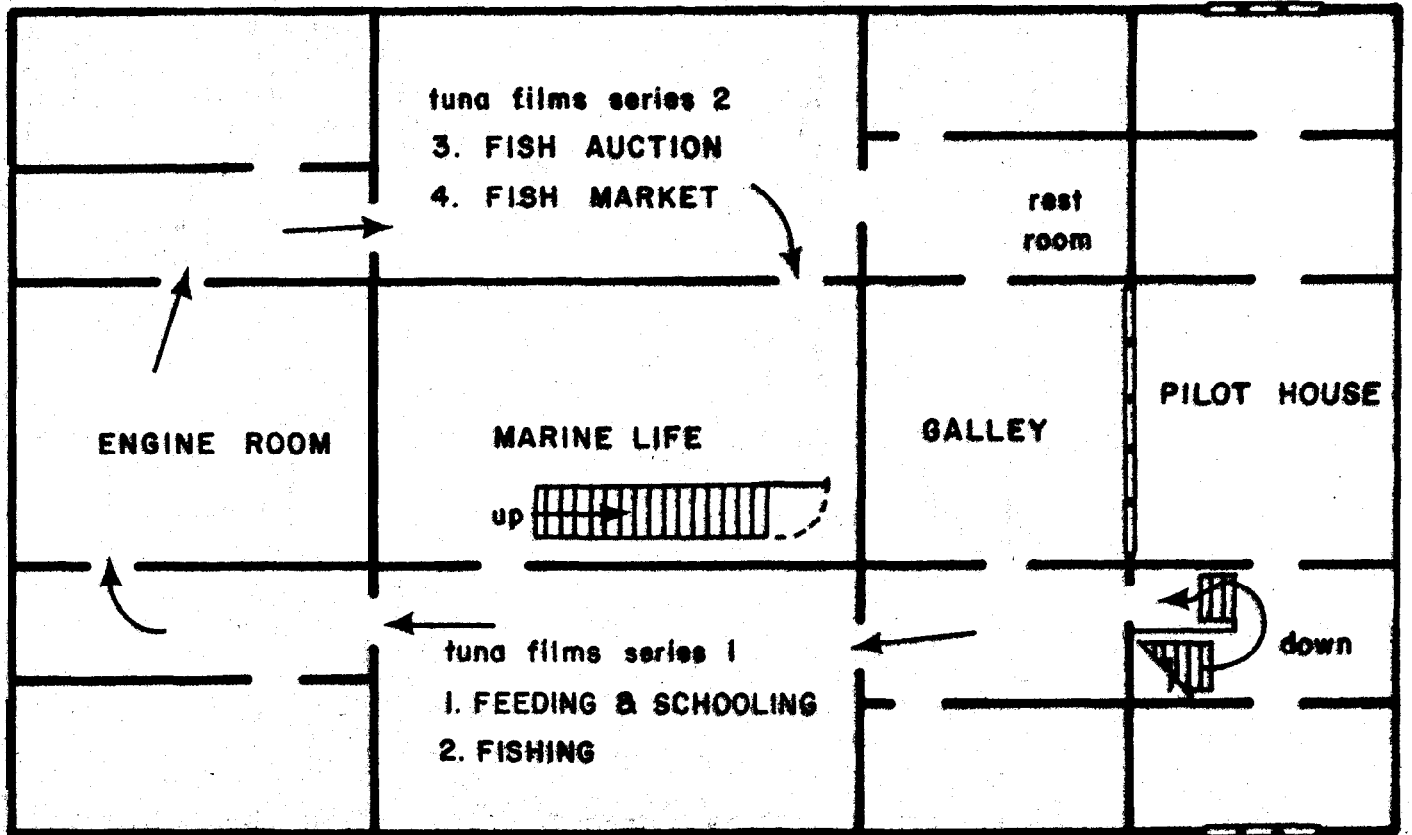
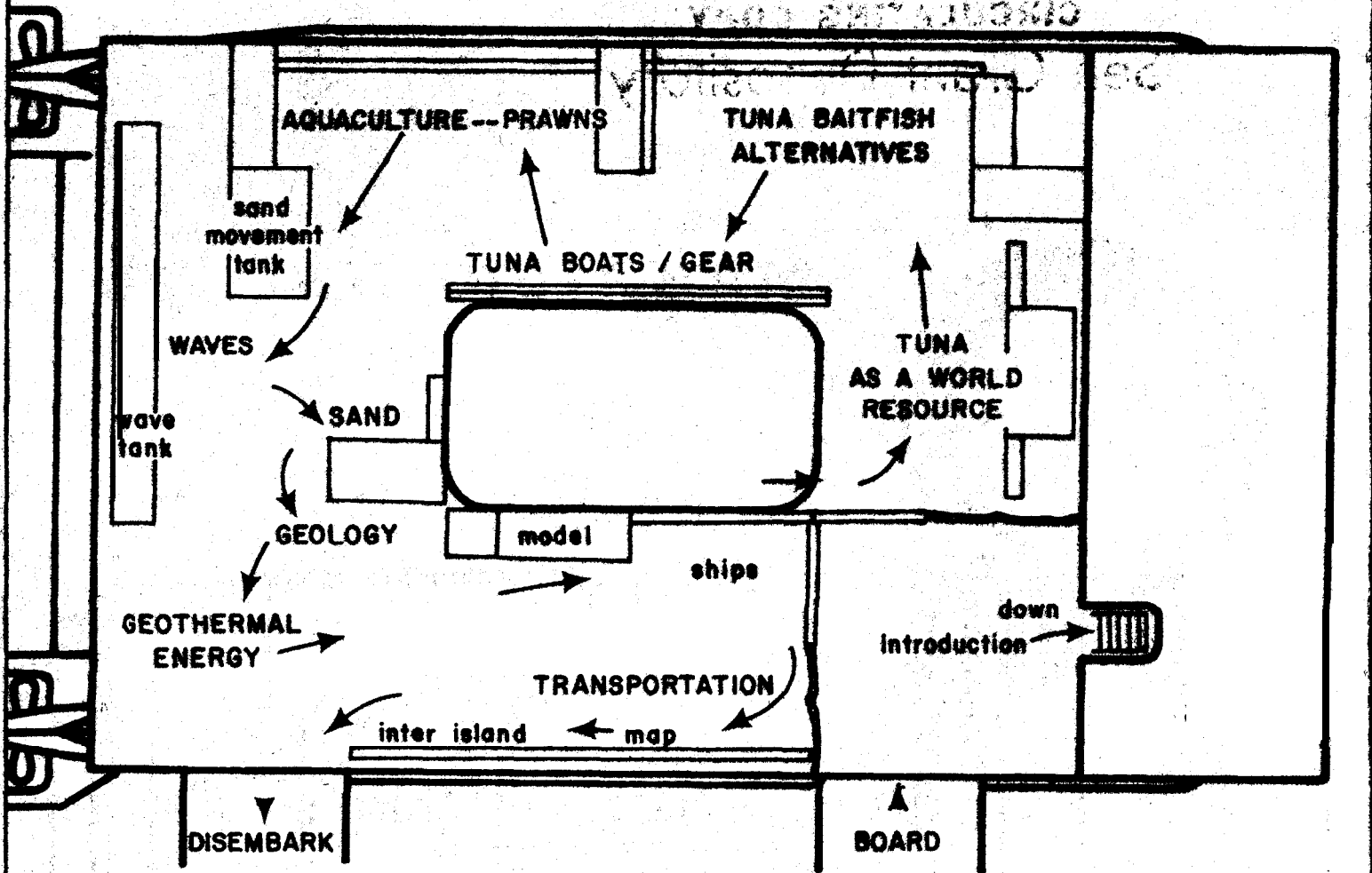
# **MAKAHIKI KAI '76**

NEIGHBOR ISLAND EDITION

## **Teacher's Guide Sheet**

WORKING PAPER NO. 20 A

MARCH 22, 1976



## TEACHERS' GUIDE SHEET

Dear Teacher:

As you already know, Makahiki Kai '76 will feature the very unique Hawaiian aku (skipjack) fishing industry. It is an industry that has both potential for development and several real problems that stand in the way of the realization of its potential. But the industry is uniquely Hawaiian and deserving of special recognition as the central theme of the exhibits of Makahiki Kai '76.

We are pleased that you have decided to participate in Makahiki Kai '76. This collection of activities should make the visit of your students to Makahiki Kai more meaningful and exciting.

Rose Pfund, Coordinator  
Makahiki Kai

Some housekeeping information:

- \* You and your students will be invited to board the "Kaimalino" at the invitation of the U.S. Navy. The Kaimalino, as you know is the prototype of the semisubmersible ship which our State Department of Transportation is considering as the vessel for the proposed inter-island ferry system.
- \* Some intermediate grades will have the opportunity to take a short cruise aboard the "No'ii", a ship provided by the Hawaii Institute of Geophysics to enable students to do some simple oceanographic experiments while aboard a moving vessel. Separate information is available for this cruise for those classes which will participate in the cruise itself.
- \* We are planning to schedule your classes at about 10 minute intervals so that a busload of students, divided into two groups of approximately 25-30, will be through the exhibits on the "Kaimalino" within 10 minutes of each other. The time aboard the "Kaimalino" will be about one hour.

## PRE-VISIT ACTIVITIES FOR MAKAHIKI KAI '76

Since Makahiki Kai '76, as was true for the previous two held in '74 and '75, is an educational program, maximum value to your students can only be obtained if you provide pre- and post-visit activities. The activity suggestions that follow will give students background information that will make the exhibits they will be seeing more meaningful.

### MAKAHIKI KAI '76 OVERVIEW

The exhibits fall into two large divisions: Aku (Skipjack tuna) as a unique Hawaiian fishery and other marine related displays.

The central theme of the commercial aku fishing industry is divided into a four-part audiovisual as well as other presentations of the aku fishery and its utilization by man.

To enable us to present the various aspects of marine resources and the variety of uses of those resources, static and live displays and pelagic and a reef animal tank containing live animals, including sharks, have been set up on the "Kaimalino".

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### ACTIVITIES RELATED TO AKU: A UNIQUE HAWAIIAN FISHERY

1. Aku (or Skipjack tuna) is but one of the tuna species. Have children research the different species of tuna. Especially have them note the size of different varieties of tunas. A child can become the "resident expert" on one of the tuna species. What are the scientific names for 'tunas? The popular names? Note the generic name: Thunnus. Is there a relationship between the common name "tuna" and the generic name Thunnus? If your school has the Oxford English dictionary some one can do a search into the origin of the word "tuna".
2. Tunas are found all over the world. One of the exhibits at Makahiki Kai will show geographically the range of the more common species of tunas. A team of children can work on a plotting project of the scope of the range of tunas on a map of the world.
3. The amount of library based information on aku fishermen is limited. As a comparison, have children do research on fishermen in other parts of the world. (There will be a film clip of Hawaiian aku fishing and photo murals of Hawaii's aku fishermen at Makahiki Kai '76.) Children may be instructed to make a comparison with what they found and what they will see at Makahiki Kai'76 as a post-trip activity.
4. If you are really ambitious you can take your class on a field trip to the local fish auction. You need to get there by 6:30 or 7:30 a.m. So there must be very strong interest or perhaps you can persuade some of the children to get their parents to take them. If interested in pursuing this, call and ask for permission to take your class there. Students can write or make an oral presentation, or do a large mural on the auction..

5. A trip to the fishmarket might be fun and profitable for the children. Especially because they will be able to see many species of fishes they ordinarily would not see. Most of them see only the cooked fish at the dinner table. Arrange these trips by calling the markets you want to visit. Consult yellow pages of the telephone book.  
(We have not made contact with any market, so you're on your own.)

#### OTHER DISPLAYS

1. Baitfish: Because fishermen need bait in order to fish the food fish, baitfish is an important aspect of commercial or any kind of fishing. The favorite baitfish for aku fishermen is nehu, often called the Hawaiian anchovy (Stolephorus purpureus). It is one of the factors which makes the expansion of commercial aku fishing very difficult. Although it is an excellent baitfish in terms of its behavior and ability to attract tunas, it is short-lived. The exhibit on baitfish will show the expanded fishing ranges possible with several alternative experimental baitfish. Classroom activity may be in another dimension of baitfish to enable students to appreciate the importance of baitfish to fishermen.

If there are several children who have dads who are fishing enthusiasts, let these students involve their parents in this project. Ask the student to work together with his or her dad to make a list of fishes (or crustaceans) and the bait that he uses to catch those fishes. There should be alternative baits to each species. Have the child ask his dad to indicate the preferred bait and write down his dad's reasons for his preference. Having done this exercise, the choice of the aku fishermen for nehu will become more relevant. A post-visit activity (for 6th or upper level 4th and 5th grades), might be the pursuance of this aspect of the aku fishing industry. Such questions as: tradition and its effect on the fishermen's stubborn adherence to age-old methodology can be developed to include other traditions related to other occupations: Butcher has a set way of dressing beef, etc., secretary types a letter in a certain way (why, "Dear Sir:" or "Gentlemen"?), why do schools have principals and teachers? why do universities have "colleges"?

2. Do an art project with a marine-related theme.
3. One of the displays will be on sand. Have a student bring a cupful of sand to school and have a group of students separate the grains into various components to sand: coral pieces, shell fragments, etc. They might compute the percentage of each kind of component and see how accurate they were by checking with the information given in the student workbook (which we will be giving you for your class at the exit) for Makahiki Kai '76.
4. Seaweed is plentiful and easy to pick up at the beach. Have a student gather common varieties in the shallow waters of any beach and bring them to class to identify. Be sure to instruct the student to bring the seaweed to school in a bucket of seawater. If your school library has resources in Hawaiiana, the students might be asked to find out the Hawaiian name for the seaweed varieties they found along with the scientific name. They might also determine which is edible and which is not. Further study can be made in the botanical aspect of

seaweeds and their chemical composition (depending on your class level). A fun activity would be for some of the students to ask mothers for ethnic recipes for fixing edible seaweed and the recipes can be tried in class, if you have willing parents who will provide the necessary ingredients.

5. Geology: The physical processes that are involved in the birth and death of an island will be shown as one of the Makahiki Kai '76 exhibits. Your class might want to study the process in relation to our islands. Which is the oldest island? Why? Which is the youngest? Why? How did the Hawaiian Islands come to be? What are the forces that are working to age our islands? (Sterns: Geology of the Hawaiian Islands is a good resource).
6. We will have a life-size mural of the more common Hawaiian sharks. Have students research names, including scientific names, and the characteristics of the sharks. We have two of the more celebrated sharks, the great white and the odd-looking hammer-head in Hawaiian waters. Sharks are biologically interesting animals. The mural will picture the following species: Great white Shark; Scalloped Hammer-head; White-tipped Reef Shark; Grey Reef; Black-tip Reef; Black-tip; Sandbar and Tiger Shark. Assign one child to each species so that he becomes the expert in that particular species and can put together a booklet with a sketch of the "critter" and a description of the shark, size, color, etc., along with information on the biology of the species. After the reports are presented, it will be possible for the children to see the similar bio-physical traits that make up the family of sharks.
7. The semi-submersible ship which you and your children (and the general public) will be invited to board is one of the ships that is being considered for use as an inter-island ferry. One of the Makahiki Kai '76 exhibits is a large map of the islands showing proposed routes for the ferry system.

Proponents of the inter-island ferry point to Hawaiian heritage which used the ocean as the corridor for trade and interaction. The Department of Transportation, State of Hawaii, has just completed a study entitled "Hawaii Marine Highway System Study", which you might be interested in referring to. The level of text is technical and can not be used by elementary students. Secondary students might get something out of it, however.

Activity Suggestion: you might have your students poll their parents and other members of their family on whether or not they favor the inter-island ferry. Have them tabulate the data and work out percentages of those who favor and those who do not favor an inter-island ferry system. If the survey is broken down into occupation groups of the children's parents, you will have data that can be cut in still another way.

The students can also plot the information (by occupational groups vs. number in favor - or not in favor -) on a graph.

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This list of activities is not exhaustive by any means. But it should be the base from which I'm sure you'll generate other ideas and activities.

Please take a few minutes and drop us a note as to whether you found this TEACHERS' GUIDE SHEET ON MAKAHIKI KAI '76 useful or not. If you found this to be useful, which activity suggestions did you use. If your reactions were negative, let us know why -- so we can improve.

Write to: Mrs. Rose Pfund, Co-ordinator, Sea Grant College Program,  
University of Hawaii, 2540 Maile Way, Spalding Hall 255, Honolulu, Hawaii 96822.

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NOTES ON MAKAHIKI KAI '7G EXHIBITS, \_\_\_\_\_



## TUNA AS A WORLD RESOURCE

Did you know that the well-known Hawaiian tuna, aku or skipjack, is not the only variety of tuna?

The family name of tunas is Thunnus. The most common tunas in the Pacific Ocean are: albacores, big-eyes, yellowfin, bluefin, and skipjack. The Hawaiian name for the first four species is ahi. Tunas vary in size from aku which measures 100 cm to bluefins which measure 300 cm in length.

Tunas are found in oceans all over the world in addition to the Pacific Ocean. Albacores are found at depths of about 150 meters in abundance in the Northern and Southern Pacific, Indian, and Northern and Southern Atlantic Oceans, and the Mediterranean Sea. They are also found in lesser numbers near the equator.

The Big-eyes are medium-sized fish, about 180 cm in length. They are found in cool temperatures at about 100-meter depth in the temperate and tropical regions of the Pacific, Atlantic, and Indian Oceans. Big-eyes are most often found in the currents bordering the sub-tropical counter current and the tropical cold current.

Yellowfin are medium size fish about 180 cm in length which prefer warm waters. They are found in the tropic and sub-tropic regions of the Pacific, Atlantic, and Indian Oceans and approach Southeast Australia and Northeast Japan on the warm currents.

Weighing nearly 500 kg, bluefins are about 300 cm long and are found close to the surface of the ocean. They are found in the temperate zones of the Northern Hemisphere to the sub-Arctic in the Pacific and the Atlantic Oceans. They are also found in the Mediterranean and Black Seas, and on both the eastern and western waters off Japan.

This heavily fished tuna is the only one of the five species that is not being fished to the limit of the fishery. They are surface fish.

## TUNA AS A WORLD RESOURCE=-2

Skipjacks are found in abundance in the Pacific Ocean off Japan and in the Trust Territory; lower California, Mexico and the upper regions of South America; off the coast of Africa in the Atlantic Ocean; and around the Hawaiian Islands.

## SCHOOLING AND FEEDING

Aku, which is the common Hawaiian name for skipjack tuna, is one of the smaller varieties of tunas. Because of its small size and for other reasons, aku travel about in large schools or groups. "Schooling" is a common behavior pattern in fishes because there is safety in numbers to protect them from predators as well as to simplify spawning.

Fishermen usually look for whirling birds overhead when they are spotting aku. This is because schools of aku chase smaller fish which aku eat to the surface. The birds are attracted to the smaller baitfish.

Schools of aku are usually made up of fish of the same size. Research has found that aku schools tend to follow whales or basking sharks or even floating logs. The larger objects, living or non-living, seem to act as substitute reefs or schooling companions.

The pictures you are seeing show aku in a feeding frenzy. Look very carefully at the aku. Do you see a broad stripe on the body of the aku from the gill to the tail? This stripe appears only when the fish are in a feeding frenzy. When the feeding frenzy stops, the stripe disappears.

Hawaiian aku fishermen rely on this type of behavior of the aku to catch the fish by pole and line. They use live baitfish called "Nehu" which swim close to the surface of the water and lead the aku to the fishing boat.

Handfuls of the baitfish are tossed into the water. This is called "chumming." The darting and very rapid movement of the baitfish attract the aku and because the baitfish swim toward the boat and lead the aku to the fishermen they are able to catch the aku.

## FISHING FOR AKU

Aku was first caught in the Hawaiian Islands on a small-scale as a family food source by the early native Hawaiians. It was developed as a commercial fishery of today mostly by fishermen of Japanese ancestry. From the earliest times, Hawaiian fishermen sought the skipjack in the waters lying adjacent to the small villages scattered throughout the major islands in this group. The methods of fishing and fishing gear used by the Hawaiians were similar to those employed in other parts of Polynesia. The outrigger canoe which was used for fishing in Hawaii varied from about 15 to 35 feet in length. The smaller canoes usually carried but a single fisherman; however, when fishing specifically for aku, frequently several fishermen would combine forces. Two of the large canoes from which the outriggers had been removed were lashed parallel to each other with two cross-pieces. This simple arrangement provided a much safer sea-going craft than a single canoe carrying a lone fisherman, for the search for the skipjack often carried the fishermen far offshore. A double fishing canoe carried a crew of three in each hull, although only one man in each was actually occupied with the fishing; the others managed the canoe. The canoes were sometimes rigged with a single sail, but paddles were the most common means of propelling the canoes.

The fishing technique used by the Hawaiians for catching the pelagic skipjack were, in certain respects, similar to those practiced in Hawaii today. The following description of the method used by Hawaiians was written by John Cobb in 1903:

"On reaching the fishing ground the fishermen locate the fish by watching the sea gulls... as soon as the school has been sighted the canoes are worked around in front of it, and the fish are attracted toward the boat

## FISHING FOR AKU--2

by means of a handful or two of small live bait thrown into the water...

Two men stand up in the stern of the boat, holding in their hands a bamboo pole about 12 feet long with a line of the same length attached, and the pearl hook tied to the end of this line. By a quick movement the line and hook are slapped violently on the surface of the water and then drawn toward the boat.. . as soon as the fish is hooked, the line is swung up over the fisherman's head so as to make almost a complete revolution. It is very necessary that the line should be kept taut, as, owing to the fact that the hook has but a slight barb, the fish would shake itself loose should the line slacken in the least... as the hooked fish is describing this revolution the fisherman swings around to meet it as it nears him, bowing out his right arm. When the fish comes between his arm and side he closes them up and the fish is caught, unhooked, and dropped into the boat ."

Today aku is fished not only in Hawaii but also in other parts of the world by pole and line by a method known as bait-boat fishing. Japan is the world's largest bait boat fishing nation. The Japanese have bait boats ranging in size from under 50 gross tons to 400 gross tons. The smaller boats fish in coastal waters and the larger ships are the best and fish in the offshore waters of Japan and in their southern fishery or fishing grounds.

The United States and France and Spain have also developed bait-boat fishing methods, which fished for aku and yellowfin tunas in the eastern tropical Pacific Ocean.

The Hawaiian aku sampan which was designed in the early 1900's is modelled after the Japanese sampan. They are very effective in the choppy Hawaiian waters.

Bait-boat fishing actually requires a double operation. The fishermen first need to fish for bait and then for the aku. This method of fishing

### FISHING FOR AKU--3

does not require a large amount of money to begin. Fishermen do not need to know how to operate complicated equipment or gear. Furthermore, since the boat is relatively small, it can operate out of small harbors.

The other method used to catch aku is known as purse seining. This method is used mostly by fishermen along the West Coast of the United States and became very extensively used in the 1950's when bait-boats were converted to purse seiners. The "tuna clipper" is the type of ship that came into being as the result of the changeover from bait-boating to purse seining.

Purse seining has the advantage of not needing live bait and requiring less fishermen because it relies heavily on very complicated equipment. Purse seining is a very efficient method of catching aku and other tunas. However, this method cannot be used in choppy waters and a great deal of money is needed to buy the fishing gear required.

## BAITFISH

It is often said that one of the reasons why the Hawaiian aku fishermen cannot catch the aku that fishery experts say are plentiful in the Central Pacific Ocean is because of the bait, What does this mean?

It simply means that the Hawaiian anchovy, nehu, is one of the reasons why aku fishermen rarely venture beyond 100 miles from land. For the most part, the aku fishermen fish during the daylight hours and return home at night,

Scientists have been at work for many years to identify a more suitable baitfish that will allow aku fishermen to go out further and remain at sea for longer periods.

In the past some work has been done on threadfin shad and tilapia. Unlike the short-lived nehu, these two varieties are long-lived but according to the fishermen neither has the ability to attract aku,

A current Sea Grant project is culturing top minnow for a full-scale field test in American Samoa. Top minnows can withstand handling and can easily be cultured in ponds, Test have shown that there needs to be some changes in the methods used to catch aku.

If tests are successful, top minnows will enable fishermen to expand their fishing range to the limits that are imposed by the bait, and fuel carrying capacity of the boat.

One other experimental baitfish is the northern anchovy which is plentiful along the West coast of the United States, The National Marine Fishcry Service is conducting field tests to see how well the northern anchovies survive and more important,how effective they are in drawing aku to the sampan so that the fishermen can catch the aku.

## AKU FISHERMEN

The early commercial development of the skipjack fishery in the Islands was due primarily to the efforts of the Japanese immigrants. According to a report, "Investigation on Fishing in Foreign Countries," published in 1938 by the Japanese government fisheries bureau, the first Japanese to be engaged in commercial operations in Hawaii was a man named Kametaro Nishimura, who began fishing here in 1885. It is not definitely stated, however, that Nishimura fished specifically for skipjack. In 1899, Gorokichi Nakasuji, a native of Wakayama-ken brought a fishing boat and gear from Japan to Hawaii and began fishing commercially for skipjack. Following the introduction of Japanese fishing methods and gear, the aku fishery expanded rapidly.

The skipjack boats used by the early Japanese fishermen were modelled like the Japanese sampan. These boats were typically about 20 feet in over-all length, with a 4 1/2 foot beam, and a 16-inch draft. They were usually propelled by a scull, or a large oar, although many of the boats were also rigged for sails. Each was fitted with an overhanging stern which contained the rudder. There was a series of wells built into the center of the boat in which live bait was carried. The wells were from 12 to 15 inches deep and fitted with screened holes along the bottom to allow sea water to enter and circulate in the wells when the boats were under way. Most of the sampans carried a fishing crew of from 4 to 6 men.

The crews of the skipjack boats are predominantly of Japanese extraction. The larger boats maintain crews of from 9 to 13 men, while some of the smaller boats employ crews of only 3 or 4. The crew consists of a captain, an engineer, and the fishermen. Usually one of the more experienced members of the fishing crew does the chumming.



Fishing is done on a share basis. The crews are usually paid at the end of each week, after operating expenses, such as fuel, oil, and ice, have been deducted from the gross. The boat owner's share is 30 percent; the captain receives a 5 per cent bonus, and the remaining 65 percent is divided equally among the crew. Food expenses for the fishing trip are usually deducted from the crew's share. All other than the above mentioned expenses are paid for by the boat owner.

## AKU BOATS

The present-day Hawaiian skipjack boats have evolved from the Japanese sampan-type tuna boats which were introduced in these waters around 1900. The first gasoline-powered aku boat in Hawaii was successfully operated in 1907. Soon afterward, larger boats were designed with many new features, making it possible for practical fishing operations to be carried at increasingly greater distances offshore. Many of the improved features which were put into the development of these boats have been attributed to a Japanese fisherman named Kitayama, who was active as a fisherman in the 1930's. The first flying bridge was installed in 1931, and the first pump-spray systems, which are used during fishing, were added around 1935. Beginning about 1939, the design of the hull was altered to allow more freeboard forward.

Various modifications in design have given rise to a distinct type of vessel adapted to local needs and conditions. These boats have a high narrow bow, with moderate freeboard aft, and vary from 29 to 92 feet over-all. The majority of the boats in the fleet are from 70 to 88 feet in length, with a beam of from 13 to 16 feet. They are powered by Diesel engines of either the slow-speed, heavy-duty type, ranging from 135 to 250 h.p. or of the high-speed type, ranging from 165 to 330 h.p.

These boats are completely decked and fitted with a pilothouse and flying bridge amidships. The engine room and a low trunk cabin are forward, with sleeping quarters for the crew provided in the forecastle and the pilothouse. The boats are equipped with radio, but only a few have adequate navigational equipment to permit long-range sea trips. There are from 2 to 6 live-bait wells fitted below the main deck abaft the engine room.

A sponson extends along both sides of the after deck and across the stern. It is from 3½ to 4 feet wide and is raised about 2 feet above deck.

Storage space is provided here for food and water. The sponson usually also houses a gasoline stove, since very few of the boats have any sort of galley. The skiff is lashed along the starboard side of the raised trunk cabin.

These boats are equipped with a series of nozzles spaced at 4-foot intervals across the stern and along the after port and starboard gunwales through which sea water is pumped during fishing. It is claimed that the spray excites the skipjack into biting; in addition, the spray may also serve to screen the boat and movements of the fishermen.

Storage for the catch is provided in the bait wells as they are emptied of bait during fishing. Since most boats operate on daily runs out of port, refrigeration is not essential. However, an ice load of about 3,000 pounds is usually carried to insure preserving the catch should a fishing trip last several days. The total carrying capacities of the boats vary from about 10 to 30 tons.

## FISHING GEAR

The gear used for catching skipjack consists of a bamboo pole, to which a line and a hook is attached. The poles, the largest of which are from 2 1/2 to 3 inches in diameter at the butt, vary from 7 1/2 to 15 feet in length. The shorter poles are generally used for landing fish weighing over 20 pounds, while the longer poles are used for catching fish of smaller size. A small loop of linen is tied to the upper end of the pole, to which a 6 to 12-foot length of line is fastened. The line is fabricated by hand by twisting together 2 strands of size 40-3 or 50-3 Irish linen thread, with from 5 to 10 threads to a strand. A 12- to 16-inch length of galvanized or piano-wire leader, which bears the hook, is attached to the lower end of the line. The leader is fastened by a short length of linen line in such a manner that it may be rapidly removed and changed during fishing. A 2-inch loop of linen line at the lower end of the leader provides for attachment of the hook.

Galvanized barbless hooks are used in various sizes to suit the size of fish taken. A plain hook is used for fishing with live bait when the skipjack will not take the more commonly used artificial jig or striker. The jig consists of a hook, the shank of which is embedded in tubular lead or brass. Various colored feathers or threads are added to make an attractive lure. A bit of dried "mahimahi" (Coryphaena hippurus) skin or a short length of quill is fastened around the base of feathers to prevent fraying.

## THE FISH AUCTION HOUSE AND TUNA CANNERY

When the fishermen bring in their catch the aku they have caught is disposed of in one of two ways: the fish may be sold to the Hawaiian Tuna Packers, Ltd. (packers of Coral Tuna) or taken to the local fish auction.

The cannery is located at Kewalo Basin and is currently a subsidiary of Bumble Bee Seafoods a division of Castle & Cook Foods. The fishermen who dock at Kewalo Basin are in close proximity to Hawaiian Tuna Packers' main packing plant.

The annual average tonnage of aku sold by Hawaiian commercial fishermen to the cannery is about 4,000 tons. However, only 700 tons were landed in 1975. The Hawaiian tuna cannery has the capacity to can 16,000 tons of tuna annually but the actual tonnage canned ranges from 10-12,000 tons. A large amount of tuna canned is purchased from supply sources in the South Pacific, such as Tahiti. Yellowfin and albacore are the tuna species purchased from these sources. Hawaiian Tuna Packers maintains a transshipment facility at Hilo which ships aku caught by Big Island fishermen to Honolulu.

The other market for aku is the fresh fish market. Fishermen take their catches of aku to the local fish auction house where the aku is auctioned to the highest bidder. Only wholesale distributors are allowed to bid at these auctions. It is not possible for individual retail customers to purchase fish at the auction house,

The auction takes place very early in the morning anywhere from 6:30 to 7:30 a.m., depending on the *type* of fish and the location of the auction. Fishermen take their catch to the warehouse-like building and arrange the fish on "boards" in neat rows, from the largest to the smallest of each species of tuna. The bidders go through a ritual of testing the texture of

of the fish by extracting a small amount of tissue from an area near the tail which is expertly slit open by the auctioneer or his helper, a "trucker".

A bidder can determine the quality of the fish by many years of experience of going through the ritual of feeling the small amount of tissue with his finger tips. Besides the external appearance of the fish, it is on this basis that he may or may not opt to bid and if he does bid he will determine the price of his bid.

The auctioneer does not "give" the fish away. He usually has an "upset" price. He may withhold the fish, if the price is not "right." Because of his knowledge of the market, he will advise boat captains to withhold their catch from the market to enable them to obtain better prices.

Bidding is not only done by calling out numbers, but also seemingly non-relevant words, such as "poi" which means 55¢ to those who are regular participants of the daily large fish auction in Honolulu. (The number 55 refers to what was once the price of a bag of poi). Besides non-numerical terms, "body language" is also used. A shrug of the shoulders means "raise my bid by 1/2 cent."

The auction house receives a percentage of the boat's earnings as its share. In addition, there is a charge of 1/2 percent per lb. for trucking the fish from the boat to the auction house and a rental charge of 1 percent goes to the owner of the facility.

## HAWAIIAN GEOLOGY

The Hawaiian islands are almost completely volcanic.

Quiet eruptions of lava on the sea floor gradually built up broad turtle backed mountains called shield volcanoes. As the mountain top neared the surface, explosions occurred, but as it built above the sea level quiet eruptions resumed. Later, the top of the volcanoes sank to form craters called calderas. Over long periods of time eruptions continued and filled the calderas.

Further on in the volcanoes' history, eruptions became more explosive and a steep sided bumpy cap was formed on top of the shield.

As these eruptions died out, erosion took great bites out of the volcanic mountains and jagged mountain ranges were formed. The gravel, sand, and clay formed by the weather and erosion were washed down, some into the ocean and some deposited on the floor of the valleys and into the shallow water around the island. At the same time corals started to build fringing reefs around the islands.

During the glacial period, the sea level repeatedly rose and fell because the changes in temperature caused ice on the continents to melt and re-freeze. Hawaii was greatly affected and at different times sea level was as much as 300 feet lower and at other times 250 feet higher than it is now. When the sea level was 25 feet above the present level a broad coral reef was built along the south side of Oahu, forming the present Honolulu and Ewa plains. Later during lower sea level, streams cut valleys into the reef. and when the sea level rose again the mouth of the valleys were flooded. Pearl Harbor is an example of such a geological formation.

## WAVE FORMATION/BEACH EROSION

The two models you see in this section on physical oceanography demonstrate wave formation and beach erosion. The 25-ft plexiglass wave machine shows how waves are formed and how they break on the beach which is simulated by the diagonally placed board at the end of the chute.

Most of the waves that we are familiar with are caused by wind blowing over the water surface. When the wind is blowing over the waves this is called a sea. After the waves produced by the wind have moved far enough away, they become a swell which is characterized by regular surging movements. These waves sometimes travel thousands of miles to shore, and are then known as surf. The large waves that hit the southern Hawaiian coastline in the summer originate from strong winds blowing in the southern hemisphere, sometimes as far as 4000 miles away.

How big a wave gets depends on how strong the wind blows, how long it blows, and also depends on the exact length of water over which it blows. Under the right circumstances, monstrous waves can be formed, sometimes up to 100 feet high.

There are other kinds of waves besides waves caused by wind. Tsunamis or so called 'tidal waves' are caused by large undersea. earthquakes. These waves cross the ocean as long low waves, so low that ships at sea do not even feel them. When they come into shallow water near a coastline, they rise to great heights and can cause a great deal of destruction. Hawaii is very prone to this type of wave because it is in the middle of the Pacific basin.

When you push the paddle back and forth to "make waves" in the beach erosion model you are demonstrating wave action on a **typical beach**.

Beach erosion occurs because waves are constantly at work to reshape coastlines. **When** a wave enters shallower and shallower water, the back and forth motion of the water on the seabed becomes greater. This water motion is able to push the **sand**



## WAVE FORMATION/BEACH EROSION - 2

back and forth, and if the water motion is strong enough, it can also push large stones and rocks.

When the waves approach a shoreline so that the crests and troughs of the waves are parallel to the coastline, there is a tendency for the sand to be pushed directly on to the beach. This is because the waves steepen, and break and rush up the beach, carrying sand.

If the waves approach the shoreline at an angle, then the sand is not pushed directly up the beach, but is also pushed along the beach. Then, when the wave recedes, it will also carry back some sand. If we look at just one grain of sand, we see that it is pushed up the beach at an angle and comes back. Then the next wave takes over, and it pushes the grain of sand up the beach, and so on. This grain of sand is moved about in a zig-zag motion. It is this continual process that is able to little by little move and reshape large beaches.

## INTERISLAND FERRY SYSTEM

For several years, there have been bills introduced in the State Legislature to establish an interisland ferry system to implement the romantic concept of a modern counterpart of the ancient Hawaiian mode of marine interisland travel which was used to exchange goods as well as unify the island kingdom. There is universal recognition and concern that there is an imbalance in the population distribution. Proponents of the interisland ferry system feel that one way to promote balance is to provide an economical transportation system to move people and vehicles.

Several issues, however, need to be resolved before the ferry system can become reality.

Interisland airlines and the existing barge service have lobbied against an interisland ferry system because they feel that it would be detrimental to their interests. Even if the concept were approved, there is still divergence of opinion as to schedules, rates, and types of vessels that should be utilized.

There is a further question raised by some county councilmen, the most vocal one being from the county of Maui. He questions the value of a large influx of automobiles congesting county roads which may not necessarily be geared to the additional volume of traffic.

The existing marine transit systems for Hawaii include the Seaflite passenger route and the Young Brothers barge service routes which transport freight to all of the neighbor islands.

The interisland ferry system is being proposed to provide a means to simultaneously transport people and freight. The most important "freight" is, of course, private automobiles. The ferry will provide "drive-on/drive-off" capability to every passenger. The effect of being able to

economically take themselves and their cars to the neighbor islands will mean that Oahu residents would be induced to visit the neighbor islands more often or even commute to work.

For the interisland ferry system, a very large ship, very similar to the Alaskan ferry, has been proposed by State Senator John Hulten. It is commonly known locally as "Hulten's ferry."

The other vessels are the semi-submersible ship and the Boeing hydrofoil. Makahiki Kai exhibits will be taken to the neighbor islands aboard the *Kaimalino* which is a semi-submersible ship.

## AQUACULTURE:

### *Macrobrachium rosenbergii*

One of the world's most advanced aquaculture species is the giant prawn, the Macrobrachium rosenbergii. Because it is a native species of Malaysia, the giant prawn is also called the Malaysian prawn. However, Hawaii's Anuenue Fisheries Research Center is the world's leading center for research and culturing of the giant prawn and, therefore, we feel that it should be re-named the Hawaiian prawn.

The giant Hawaiian prawn, is widely distributed in most of the tropical and sub-tropical areas of the Indo-Pacific Region. It is found the whole year round and is present in both fresh and brackish water. It is usually found in the lower reaches of rivers but is also present in lakes, mining pools, and paddi-fields.

Prawns eat almost anything they find, including, aquatic worms and insects, fish, other animals, grains, seeds, nuts, fruits, algae, and other plants. The diet of cultured prawns in Hawaii are supplemented by chicken feed and processed shrimp shells.

After maturity, the prawns will produce eggs nearly every month. At each mating, there are as many as 7,000 - 20,000 eggs which are incubated on the prawn's tail section for 20-25 days.

After hatching, larvae are raised in brackish water at Anuenue Fisheries for 35 days. Optimum temperature is 85-88<sup>0</sup>F. The larvae are fed aku and newly hatched brineshrimp. When larvae metamorphose or change into juveniles, they can be put into freshwater. It is at this stage the young juveniles are put into earthen ponds located in various places around the state. Prawns take 5-9 months to grow to marketable size.

## SHARKS

The most striking characteristic of members of the shark family is that they do not have an internal bony structures. They are related to rays. Sharks are feared, and rightly so, because they do attack humans on occasion, although the reason for such attacks is not because they think that people are good to eat. As a matter of fact, shark experts feel that humans are very low on the list of "good things to eat" - as far as sharks are concerned. They do not really know why sharks attack people, One possibility is that the shark may resent the intrusion in his "territory".

The ten most common sharks found in Hawaiian waters include the well-known great white shark, although this species of shark is not very common. They are pelagic or deep water animals and feed on large marine animals such as tunas and probably turtles and seals. Great white sharks are known for their serrated teeth and grow to more than 30 feet in length.

Several members of the shark family known as Carcharhinidae are found in Hawaiian waters, both inshore and offshore. The offshore species of this family sometimes are hooked on tuna long lines and tend to be a nuisance.

Perhaps the most distinguished of this group is the tiger shark which has prominent dark stripes and spots. Tiger sharks are active at night and specimens of nearly 30 feet have been caught.

Other species belonging to the Carcharinidae family are the Galapagos, grey, grey reef, blacktip reef, and sandbar shark.

Hammerhead sharks, which belong to the Sphyrnidae family, are frequently found in Kaneohe Bay. These sharks are one of nature's oddities and are characterized by having eyes on the flat extensions of their heads.

The reef whitetip, shark is a member of the family Triakidae, the only Hawaiian variety that has many rows of teeth in its jaw. It got its common name "whitetip" because its dorsal and caudal fins are white-tipped.

The dogfish belongs to the Squalidae family, one of the smaller species of sharks, usually less than 3 feet in length.

