UNIHI - SEA GRANT -MR- 76 - 02

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STUDENT WORKBOOK

a project of
the SEA GRANT COLLEGE PROGRAM
UNIVERSITY OF HAWAII

Dear Boys and Girls:

This booklet is designed to provide some interesting additional information and activities related to the bicentennial Makahiki Kai '76. We hope you enjoyed the special bicentennial Makahiki Kai '76 at the Blaisdell Memorial Center Exhibition Hall, which was made possible by funds provided by the Office of Marine Affairs Coordinator, State of Hawaii, the University of Hawaii, and the University of Hawaii's Sea Grant College Program which additionally coordinated the exhibits.

We welcome your comments on both the exhibits and this workbook. You may send any comments to the address below:

Makahiki Kai '76
Sea Grant College Program
University of Hawaii
2540 Maile Way, Spalding 253
Honolulu, Hawaii 96822

The University of Hawaii Sea Grant College Program

Since 1966, the University of Hawaii has received a grant from the National Office of Sea Grant which is currently under the National Oceanic and Atmospheric Administration in the Department of Commerce. Because of its comprehensive programs in research, education, and advisory services, the University of Hawaii was designated as the sixth Sea Grant College in 1972, only one of eight such colleges in the nation.

Some of the many needs that the Sea Grant College Program is addressing is applying scientific approaches and knowledge to the study of several animal aquaculture species including the well-known giant "Hawaiian" prawn and popular sportfish, moi. Several species of seaweed are being cultured in Hawaiian waters to determine their ability to grow and yield commercial quality by-products.

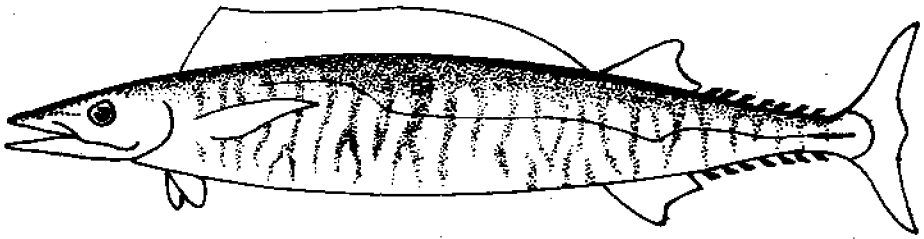
Other areas in which research is currently being conducted are: ocean engineering, diving physiology, fisheries, education, marine transportation, and marine resources.

aku: a unique hawaiian fishery

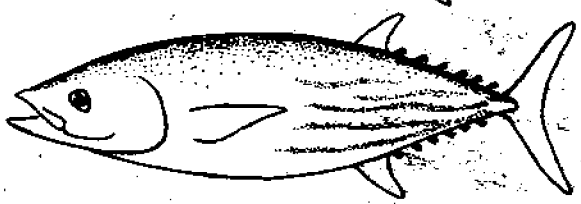
Aku, the fishery, its fishermen, the auction, and the fresh fish market, is shown via film and exhibits which will capture the sound, smell, and excitements of the ongoing auction.

The major central exhibit in the Exhibition Hall presents the aku fishery and the people and other aspects that are related to it. Exhibits showing tuna as a world resource, the experimental skipjack bait fisheries, the aku boats in Hawaii, fishing gear, a heroic-size photo mural of Hawaii's own aku fishermen, and the ancient Hawaiian methodology of fishing for aku are parts of Sea Grant's Bicentennial tribute to Hawaii's commercial aku industry.

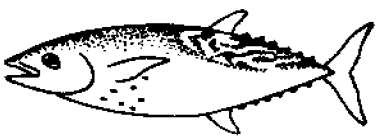
COMMON VARIETIES OF TUNA



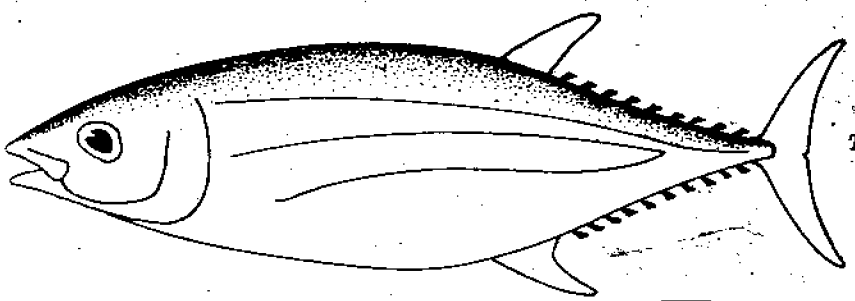
Acanthocybium solandri
WAHOO
ONO



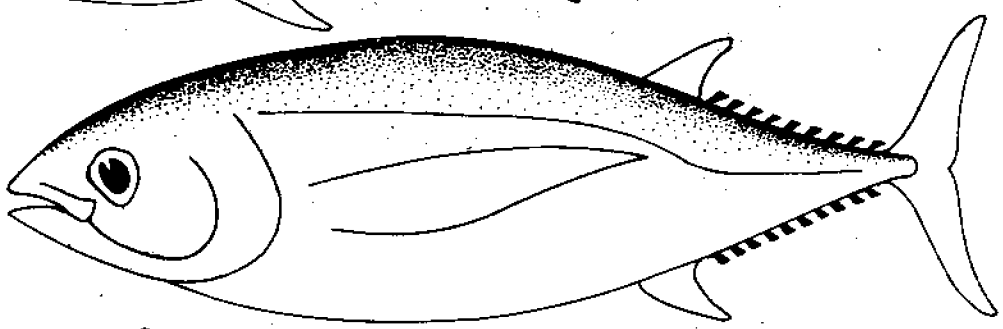
Katsuwonus pelamis
SKIPJACK
AKU



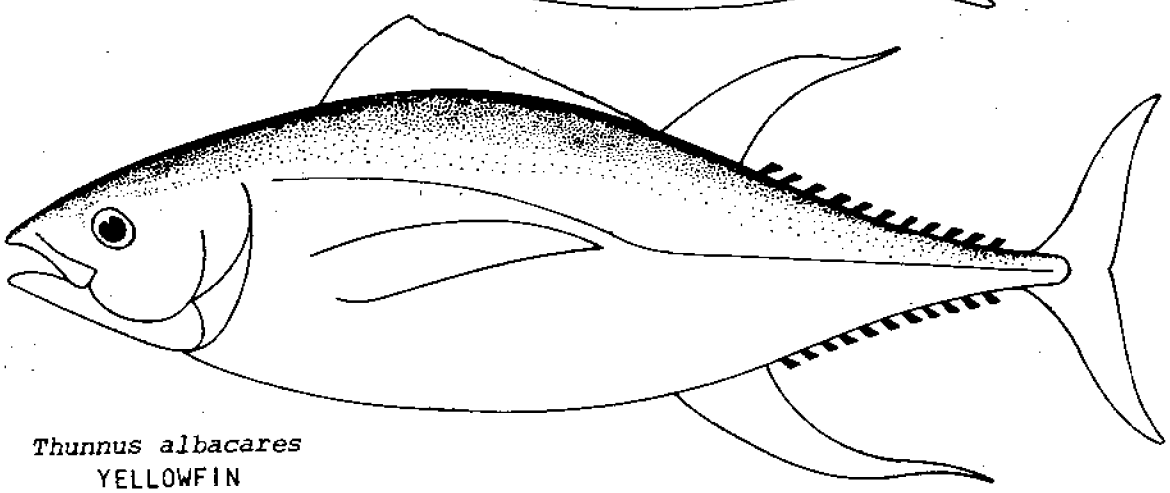
Euthynnus yaito
BONITO
KAWAKAWA



Thunnus alalunga
ALBACORE
AHIPAHALA

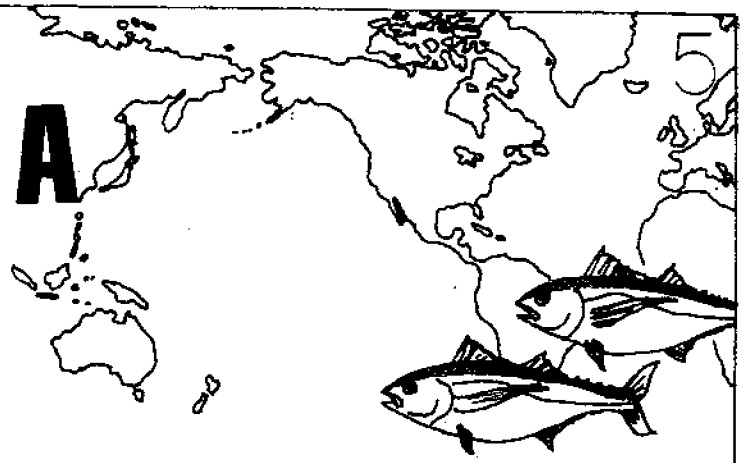


Thunnus obesus
BIGEYE
PO'O-NUI



Thunnus albacares
YELLOWFIN
AHI

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 100 cm (aku) to 300 cm (bluefin).

CHARACTERISTICS OF THE DIFFERENT TUNAS

Albacore *(Thunnus alalunga)*

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.

Big-eye *(Thunnus obesus)*

These medium-sized fish, about 180 cm in length, are found in cool temperatures at about 100-meter depth. They are found 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 *(Thunnus albacores)*

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.

Bluefin *(Thunnus thynnus)*

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.

Skipjack *(Katsuwonus pelamis)*

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.

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.

FISHING METHODS

Fishing methods are related to the depth at which fish are usually found and the behavior of the fish.

Albacore are caught by longline and pole and line.

Big-eye are caught by longline fishery.

Yellowfin and bluefin are caught by pole and line and purse seine in shallow depths and longline in median depths.

Skipjacks are caught by pole and line in Hawaii and the Trust Territory and purse seine in California.

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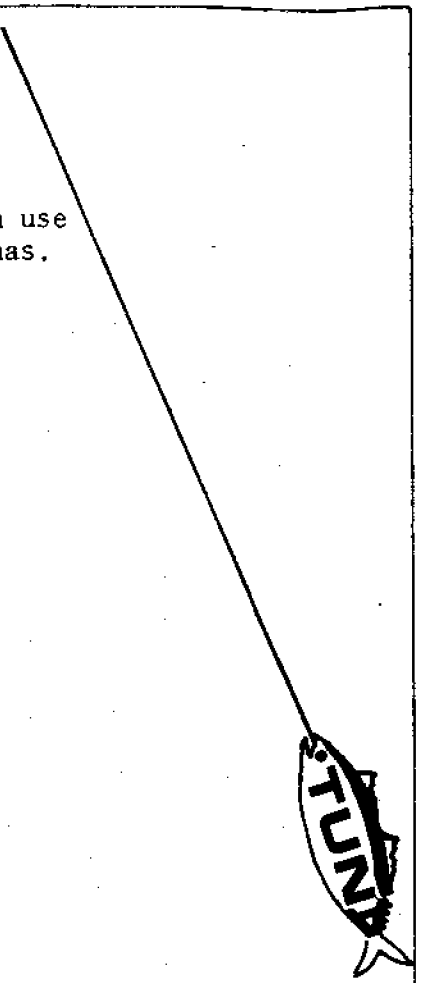
METHODS OF FISHING VARIETIES OF TUNA

Draw in the various methods commercial fishermen use to catch different tunas.

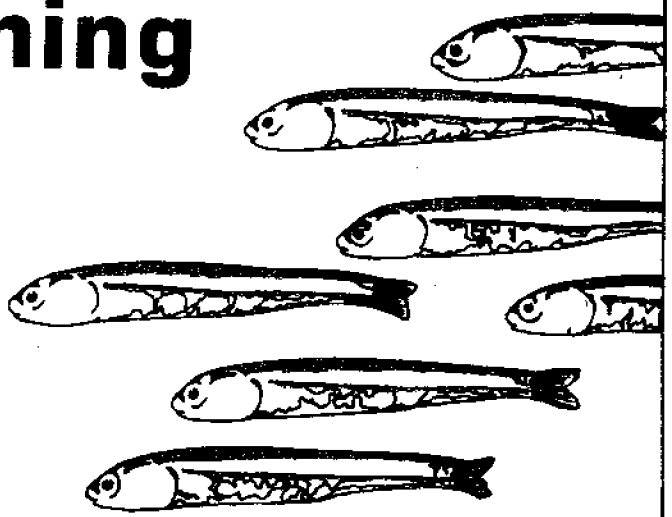
1) purse seining



2) long line

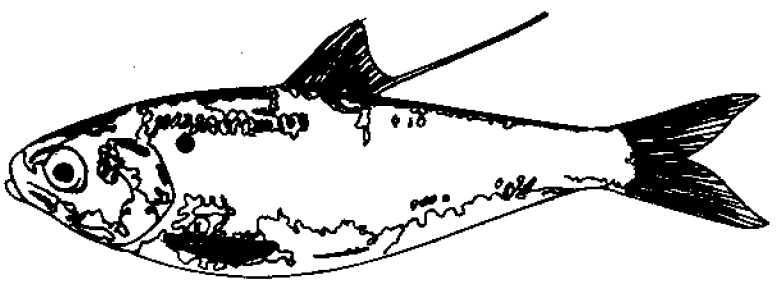
3) pole & line

Alternative Baitfish for Aku Fishing

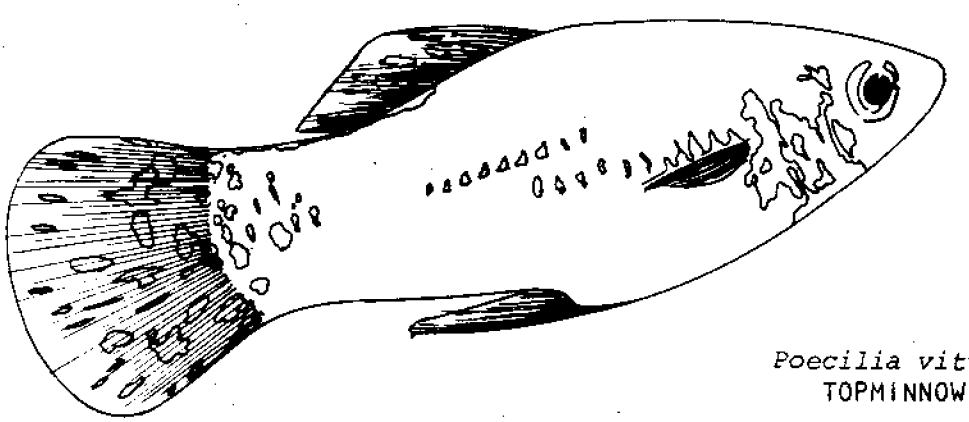


Stolephorus purpureus
NEHU

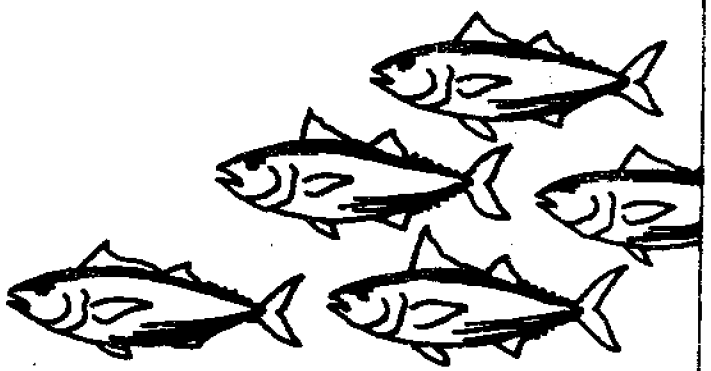
Tilapia mossambica
TILAPIA



Dorosoma petenense
THREADFIN SHAD



Poecilia vittata
TOPMINNOW



tunas and sharks

B R S N I F W O L L E Y
W H I T E T I P Q U P B
K C A J P I K S B S F L
E K X M A T V I H A E U
R A C F M J G A K U E E
O W T I G E R M L A R F
C A N O Y K R B U N Y I
A K U E S O D H I U A N
B A R M N N A Z E T R L
L W S O G A P A L A G P
A A E N K M F S A N D Q
E T I H W T A E R G B U
D E L S B L A C K T I P
A M R Q U P O T I N O B

ALBACORE

BIG EYE

BLACKTIP

BLUE

BLUEFIN

BONITO, KAWAKAWA

GALAPAGOS

GRAY REEF

GREAT WHITE

HAMMERHEAD

NURSE

SAND

SHARKS, MANO

SKIPJACK, AKU

TIGER

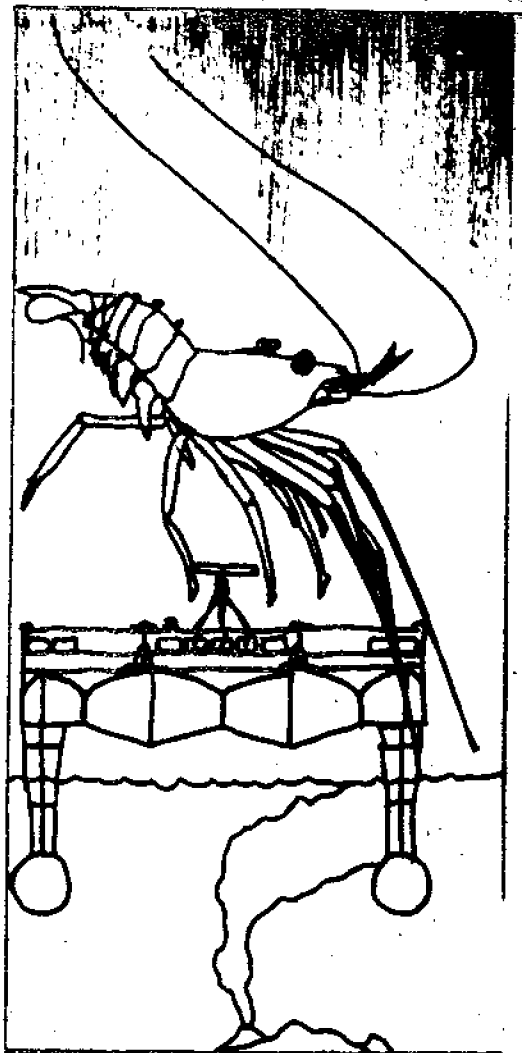
TUNA

WHITETIP

YELLOWFIN, AHI

After completing the Word Search see if you can find (from the list) the different types of TUNAS and circle them.

(Answers on page 31)



the marine education center

The Marine Education Center which presents separate *see-and-do* mini-modules of various marine-related subjects showcases physical oceanography, geology, recreation, marine biology, aquaculure, Hawaiian algae, and marine transportation.

The marine biology component consists of giant murals and live animals.

Live demonstrations using two media is part of SeaArt, a major showing of student art coordinated through the Department of Education.

limu! limu! limu!

Did you know that all that yukky stuff on the rocks at the beach is more than what you think it is? Did you know that limu is very important to the marine life cycle and to our fish? (Makes fish grow so we can eat 'em). Did you know it can make a hearty meal for US too as well as having other practical uses such as art??!! Yes, it's true and MORE!!!!!

Some interesting things to know about it is that limu, scientifically called algae can be classified in three different groups: green algae, red algae, and brown algae. The green kine are usually found in shallow waters. This is a very versatile algae and is also the most difficult to classify because it often looks green or brown in color. Tricky limu!!! Brown limu can also be found in shallow or deep waters. Kelp, a famous brown limu is made into iodine supplement tablets. Some of the limus are even used in medicine. Neat yeah??!!!

In actuality almost all algae found in the oceans are edible. However, most of these algaes or limus do not appeal to man's senses such as sight, smell and touch. Therefore man misses out on one of nature's not only *"ONO"* (DELicious) but nutritious foods. Many limus are found to be rich in protein, iodine and vitamins.

Forty or fifty years ago it was a common sight in periods of low tide to see many small groups of Hawaiian tutus in muumuus and hats cleaning limu along sandy beaches. What were they cleaning limu for? Well, in the old days of Hawaii, limu was the third component of a nutritionally balanced but monotonous diet consisting of fish and poi. Together they furnished the necessary protein, carbohydrate and minerals for adequate nutrition. Also while limu primarily supplied variety and interest, it also added significant amounts of vitamins and other mineral elements to those contained in poi. The famous limus that were traditionally eaten were ogo or manauae, limu kohu, and wawae'iole. HEY, not only the native Hawaiian can enjoy eating limu because WE CAN TO!!!!! There are some excellent recipes going around too! VERY ONO!!!

OGO KIM CHEE

(Korean: modified after the Korean methods of their famous pickled cabbage)

2 lbs. ogo ("limu long manauea") chopped into 2-3 inch pieces
Handful of coarse Hawaiian salt
2 cloves garlic (chopped) per quart of wilted seaweed
1-2 chopped round onions, or 1/2 c. chopped green onions
Chili pepper, chopped (to taste) or 1/2tsp. cayenne to taste
1/2 tsp. paprika

Wash and clean the limu. Salt and wilt by standing over night. Next day, drain off any liquid, add garlic, onions, chili pepper and paprika. Pack tightly in jars, seal and refrigerate. Let stand a few days before using.

wait! get more! ⇨

GULAMON SALAD

(Filipino)

1 lb. or about 3 c. packed limu wawae'oile or limu manauea
3-4 c. boiling water
4 large tomatoes
1 tsp. salt
chopped green onions
chopped fresh ginger
2 tbs. shoyu

Wash and clean seaweed. Pour boiling water over the cleaned seaweed; let stand for a few minutes. Drain well. Chop or mash tomatoes and add to seaweed; add remaining ingredients. Serve cold.

HEY! TRY LIMU KOHU WITH STEW OR WHATEVER TURNS YOU ON! (Yummy)

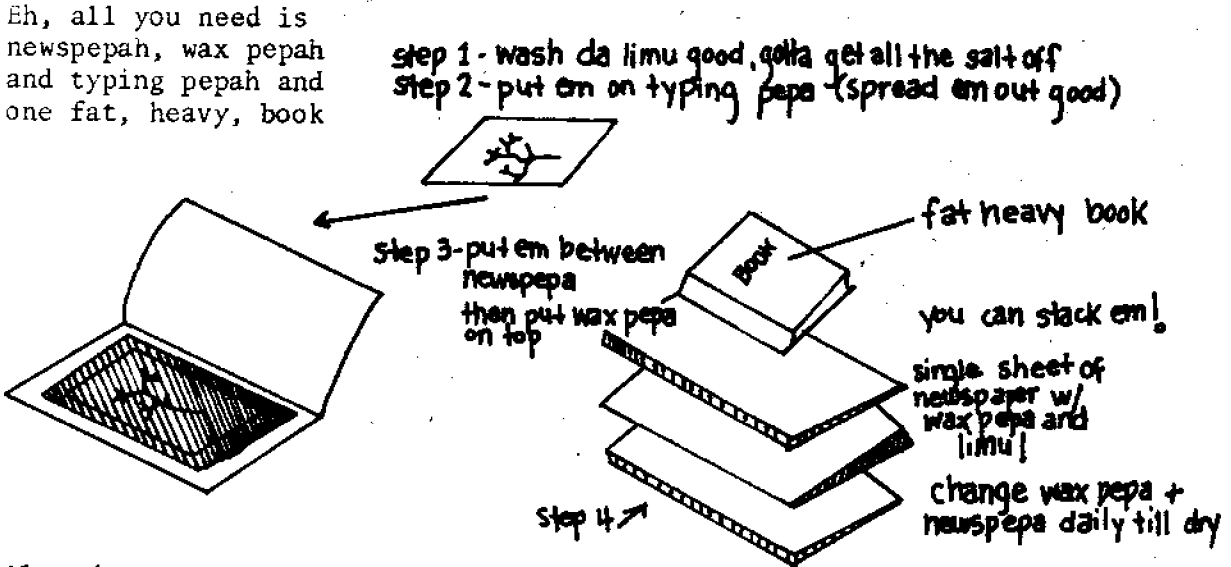
YOU GOTTA TRY OGO WITH MISO SAUCE TOO! IT'S A WINNER

MISO SAUCE

1/4 cup miso
2 tbsp. vinegar
2 tbsp. sugar
1/2 tsp. MSG

Limu is not only good to eat but also terrific to collect and to use as art work. YES, ALGAE ART!!!!! We are so lucky to live in Hawaii where our reefs and shorelines are blessed with the abundance and fantastic variety of the beautiful algae. Why don't you start a collection NOW!!! (Some collectors pay as much as 200 dollars for a good algae or limu press!!) How do you do it? Well, by making algae presses. It's fast, easy and BEAUTIFUL!!!!

Eh, all you need is newspepah, wax pepah and typing pepah and one fat, heavy, book



When done, algae presses are works of art! Soon they may turn into occasion cards, stationary etc. It's fantastic. There are tremendous uses of limu AND YOU THOUGHT IT WAS JUST DUMB THINGS CLINGING TO ROCKS?!!!!!!!! end

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 and algae 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.

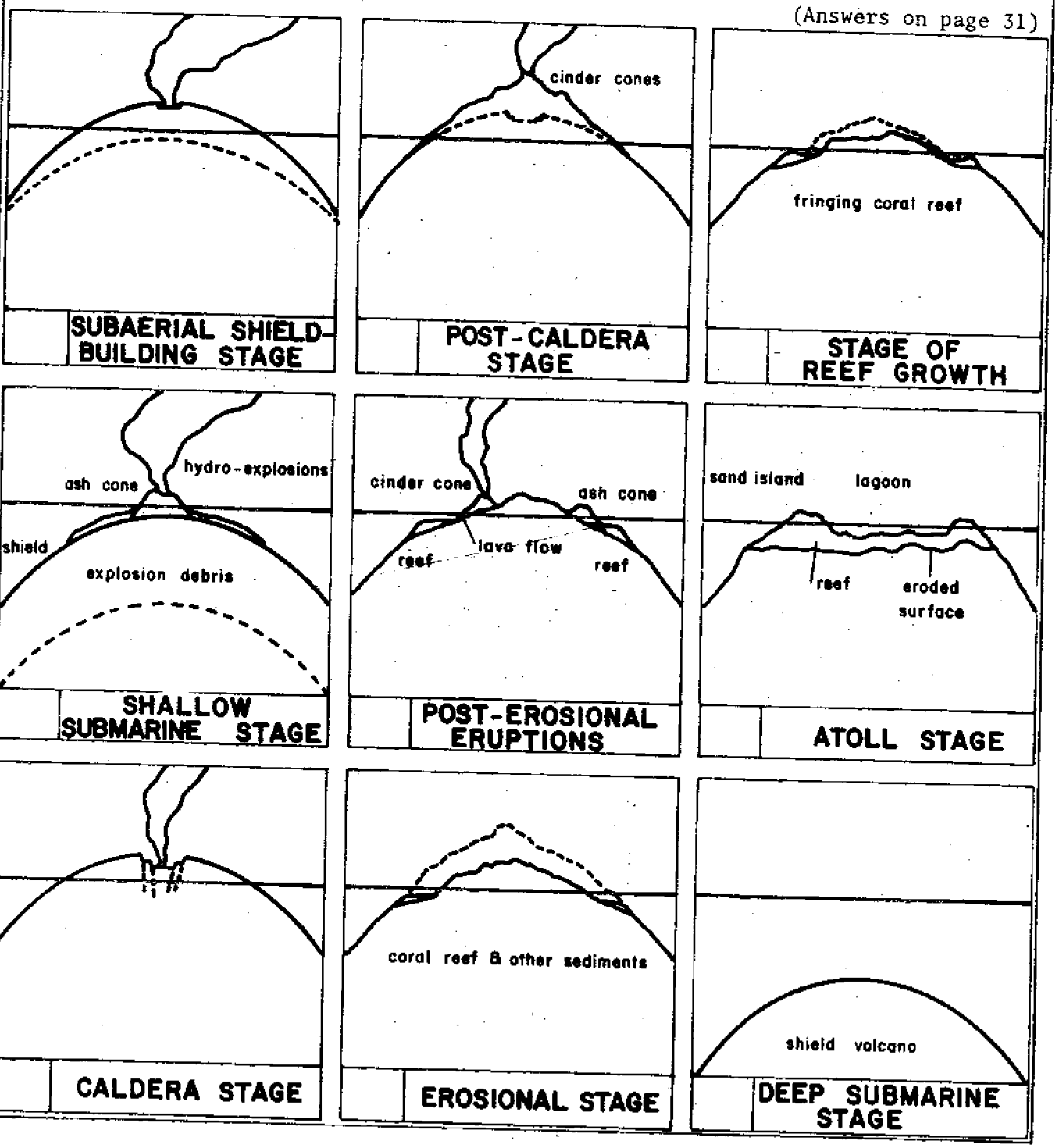
GLOSSARY

Ash Cones	Tip of volcano consisting of particles of mineral matter
Atoll	Coral island consisting of a reef surrounding a lagoon
Caldera	Large crater formed by collapse of central part of volcano
Cinder Cones	Tip of volcano consisting of fragments of red hot lava
Erosion	The process of wearing away
Geology	A science that deals with the history of the earth and its life especially as recorded in rocks
Glacial Period	Referring to the time when a large portion of the earth was was covered with ice
Hydro-explosion	Explosions caused by a substance coming into contact with water
Lagoon	A pond that is near to a larger body of water
Post	After
Sediments	Materials deposited by water or wind
Shield Volcano	A broad turtle backed mountain formed by eruptions of lava on the sea floor
Subaerial	Something that happens on, or next to, the surface of the earth

INSTRUCTIONS

There are nine stages in the life history of an island. Look at the following pictures and using what you have learned from reading about the geology of the Hawaiian Islands, put them in sequence by marking the correct number in the box at the bottom left hand corner of the picture.

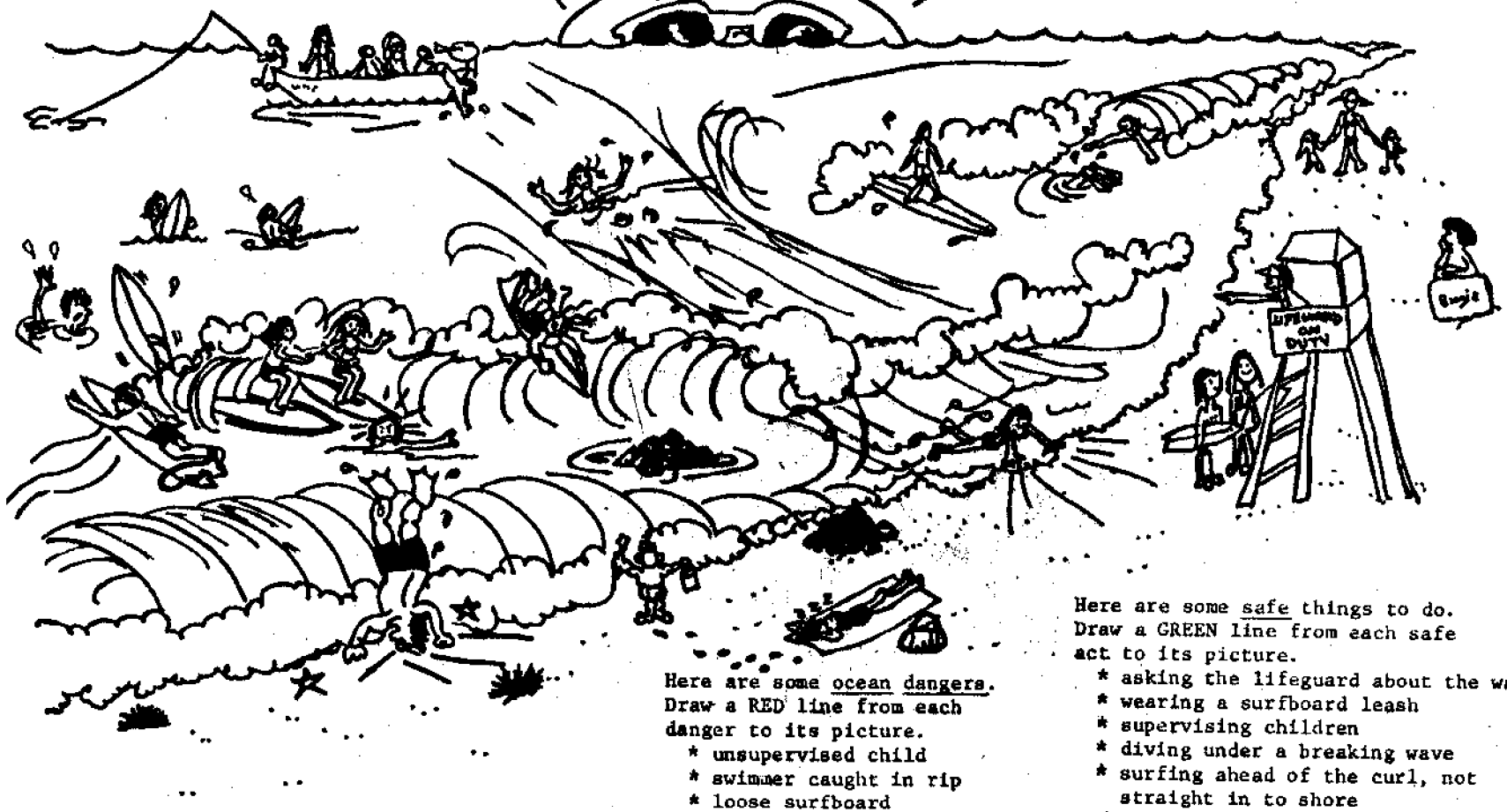
(Answers on page 31)



THERE ARE MANY WAYS TO

HAVE FUN IN THE OCEAN!

The ocean is a wonderful playground. But it can be dangerous, too. The only way to have fun in the ocean is to be careful and safe.



Here are some ocean dangers. Draw a RED line from each danger to its picture.

* unsupervised child
* swimmer caught in rip
* loose surfboard
* going "over the falls"
* crowded waves
* rocks

Here are some safe things to do. Draw a GREEN line from each safe act to its picture.

* asking the lifeguard about the water
* wearing a surfboard leash
* supervising children
* diving under a breaking wave
* surfing ahead of the curl, not straight in to shore
* staying out of the water if the waves look too big for you

Next time you go to the beach, look out for these dangers -- and find new ones of your own!

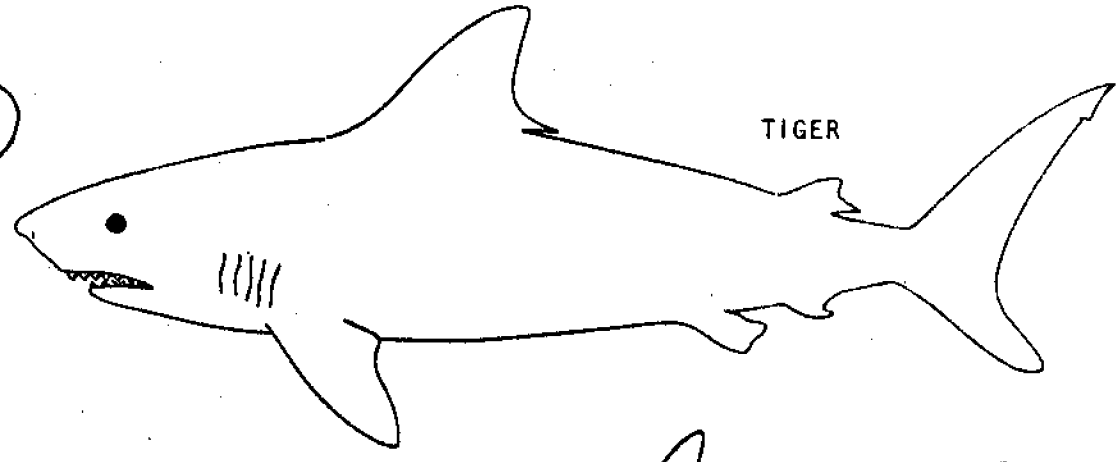
SHARKS TEETH MATCHING

1 _____

2 _____

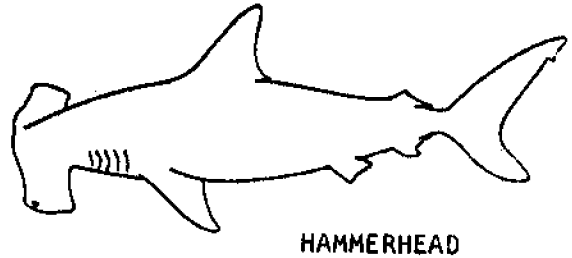
3 _____

4 _____

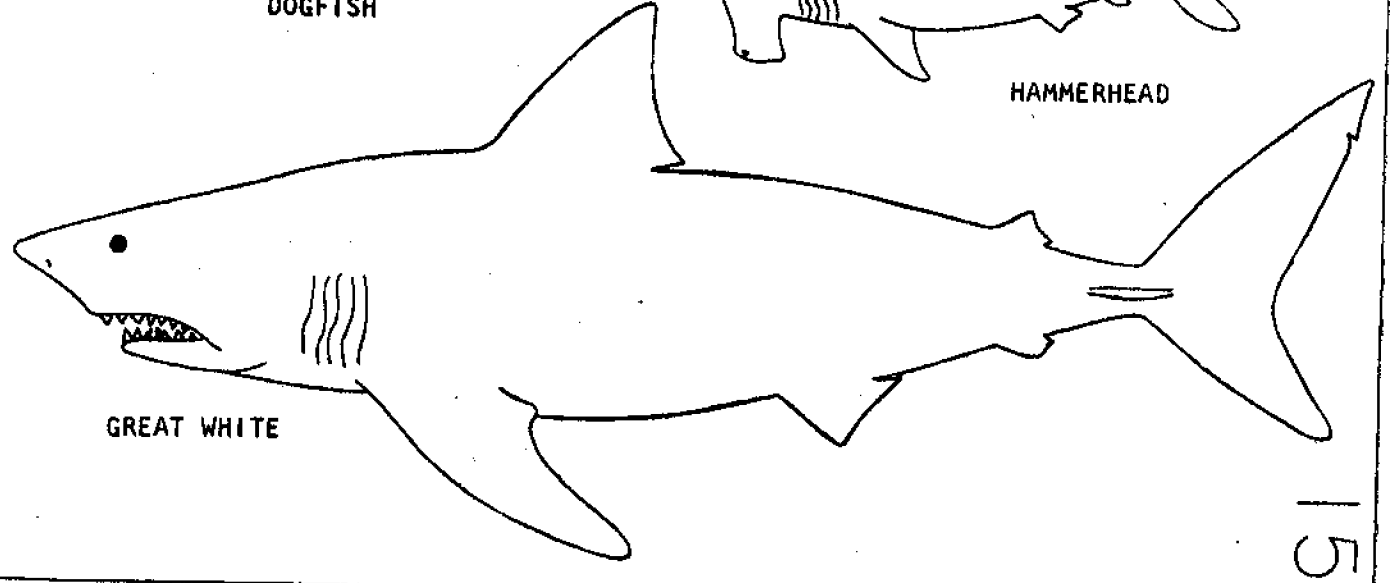


TIGER

DOGFISH



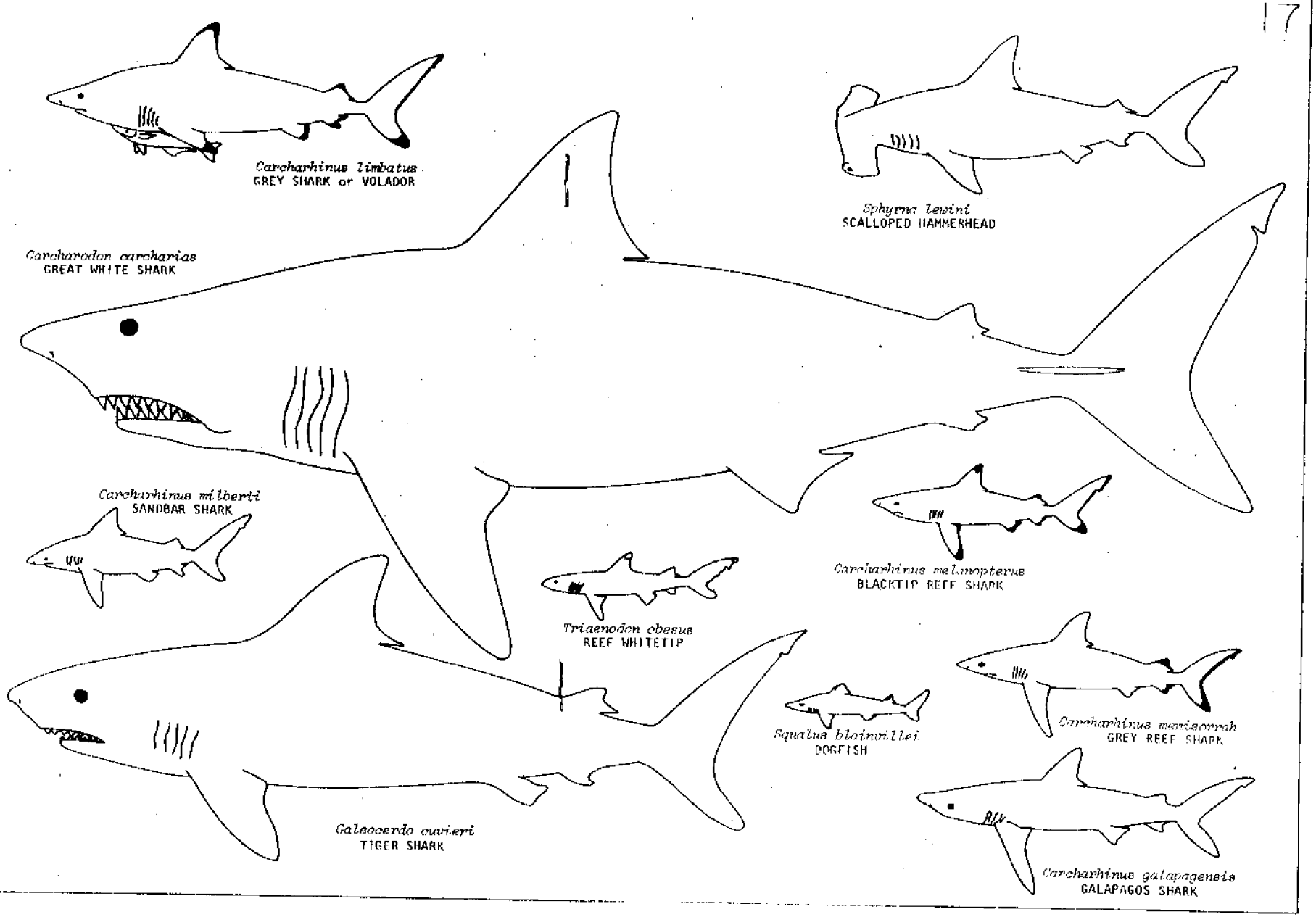
HAMMERHEAD



GREAT WHITE

(Answers on page 31)

SHARKS FOUND IN HAWAIIAN WATERS



Voyage to Tahiti and Back

Hokule'a is the name of a Polynesian double-hulled canoe that will sail a 6000 mile voyage from Hawaii to Tahiti and back, beginning in April of this year. The voyage will recreate ancient voyages taken by early Polynesians.

Hokule'a means 'Star of Gladness' in Hawaiian. This is how Polynesians saw the star that guided their voyages to the land we know as Hawaii. Another name for this star is Arcturus.

Hokule'a was designed after the ancient Polynesian voyaging canoes. As on earlier canoes her sails are made of woven pandanus and she is lashed together with ropes of sennit. She was launched from Kualoa Beach Park on Kaneohe Bay on March 8, 1975 by chants and old ceremonies that dated back to earliest Hawaiian times.

Since March *Hokule'a* has sailed 1500 miles between the Hawaiian Islands. On her last inter-island voyage, sailing from Kauai back to Oahu, she ran into trouble and was swamped. The mishap taught us some important things, however, that helped us make *Hokule'a* stronger for her long voyage.

On February 7, 1976 final crew members were picked for the voyage. Except for one member from Australia and another from Micronesia, all of these people are from Hawaii. They will use no charts, instruments, or motor power to navigate on their trip. The sun, stars, winds, currents, and ocean swells will be used to guide them just as they guided the ancient Polynesians.

During the voyage both fresh and dried fruits will be eaten. Fish, taro, breadfruit, bananas, sweet potatoes, yams, coconuts, octopus, medicinal herbs, and Hawaiian red salt have been dried in old Hawaiian ways and made ready for the trip. The crew will also fish for fresh food along the way.

A little dog named *Hoku* will also go along on the voyage. This dog has been specially bred by Mr. Throp from Honolulu Zoo to be as much like the original Hawaii 'Poi" dog as possible. Hoku, other animals, and some plants will be taken along to see how they survive the long voyage. The questions being asked are how some of our plants and animals got here, and how so many varieties were brought by canoe.

In early March *Hokule'a* will sail for Maui and then to Hawaii. Depending on the weather she will leave from there on her journey to Tahiti. Her progress can be followed through the newspapers and radio. It is hoped that she will be back in Hawaii in July.

The voyage is more than an experiment in ancient Polynesian voyages and migrations. It renews important things in Hawaiian culture. By bringing living examples of that culture to our attention, it gives all of us the chance to develop an appreciation for the customs and unique skills of its people.

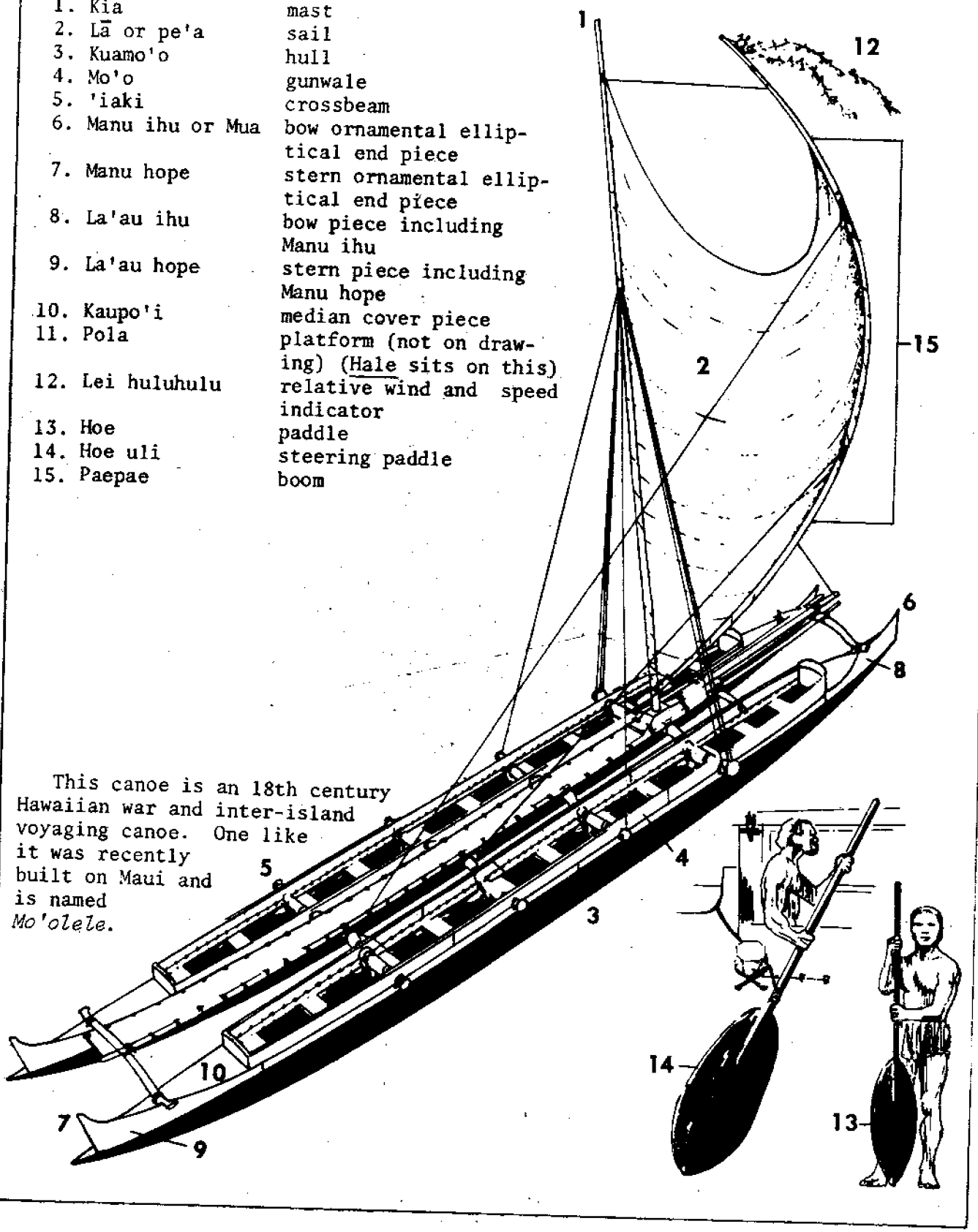
THINGS TO DO

If you would like to join us in wishing *Hokule'a* and her crew a successful voyage, you and your classmates can write letters to the crew before they sail in April. Please send your letters to Polynesian Voyaging Society, P.O. Box 6037, Honolulu, Hawaii 96817.

A set of four childrens' books is also being written about Polynesian voyaging. Although the books focus on voyaging, many things about Hawaiian culture are revealed through the stories and illustrations. All the experiences of preparing for a voyage and then taking one are presented through the eyes of children.

Wa'a Kaulua

1. Kia	mast
2. Lā or pe'a	sail
3. Kuamo'o	hull
4. Mo'o	gunwale
5. 'iaki	crossbeam
6. Manu ihu or Mua	bow ornamental elliptical end piece
7. Manu hope	stern ornamental elliptical end piece
8. La'au ihu	bow piece including Manu ihu
9. La'au hope	stern piece including Manu hope
10. Kaupo'i	median cover piece
11. Pola	platform (not on drawing) (Hale sits on this)
12. Lei huluhulu	relative wind and speed indicator
13. Hoe	paddle
14. Hoe uli	steering paddle
15. Paepae	boom



This canoe is an 18th century Hawaiian war and inter-island voyaging canoe. One like it was recently built on Maui and is named *Mo'olele.*

SOME INTERESTING SEA STORIES

FILMS

The Golden Fish (20 min/color/silent) 1962 McGraw-Hill

The Fish That Nearly Drowned (10 min/color) 1966
Animated--fish making nest in aquarium.

Underwater Hawaii (11 min/color) 1955 Cine-Pic Hawaii
View of Hawaii's coral reefs and underwater caves and life that inhabits them. Shots of sharks, eels, tropical fishes.

Fishing on the Coast of Japan (14 min/color) 1963 Int'l Film Foundation
Japanese fishing village and its fishermen from the early morning departure of the boats, the catch, and the return home. (Jr. High level)

Life in the Ocean (16 min/color) 1955
Photos from inside of an oceanarium. This film depicts the many plants and animals of shore, shallow H_2O and ocean depth relating them to each other and the environment.

Sea Sorcery (15 min/color) 1970 McGraw-Hill
Focus on barracudas, sting rays, school of anchovies, banded butterfly fish, the hawkbill turtle, porcupine fish and a gray angel fish as well as on undersea caves.

FICTION

Juv. Buck, Pearl *The Big Wave*
Jiya, a fisherman's son, learns to accept death and tragedy when his family is swept out to sea by a huge tidal wave. (Gr. 4-6)

Juv. Tabrah, Ruth *Red Shark*
When Stanley Sasaki accidentally stumbles across a sacred stone altar in the form of a shark he becomes enmeshed in a frightening supernatural legend of the red shark. A tale of modern Hawaii. (Gr. 5 & up)

NON-FICTION

J551.46 Brindze, Ruth *The Sea; the Story of the Rich Underwater World*
Examines the ocean's natural resources and its usefulness to man.

J639.2 Floethe, Louise *Fishing Around the World*
Describes fishing around the world where fishermen use different methods but share common problems. (Gr. 4)

J910.4 Graham, Robin *The Boy who Sailed Around the World Alone*
Recounts voyage of a 16 yr-old boy who spent 5 years sailing around the world in his sloop, the *Dove*.

FOLKLORE

J398.2 Andersen, Hans Christian *The Little Mermaid* (Gr. 3 & up)
A little Mermaid suffers great hardships in order to become human.

J398.2 Rockwell, Anne *Tuhurahura and the Whale*
A Maori folktale. When Tuhurahura is stranded far out in the deep ocean by a wicked sorcerer he is befriended and rescued by Tutunai, the great whale. (Gr. 3 & up)

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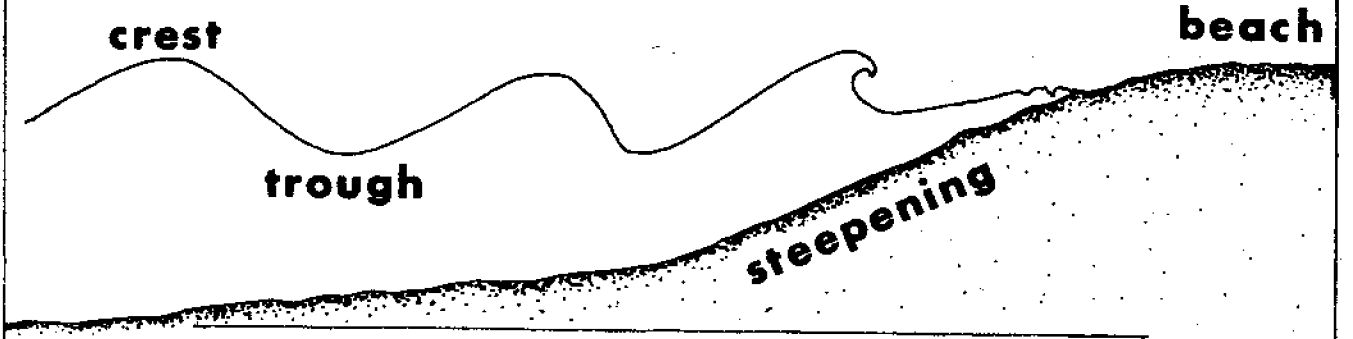
Waves



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, monsterous 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 and can be attacked by tsunami waves from such places as Chile, Alaska, or Japan.

Beach Erosion

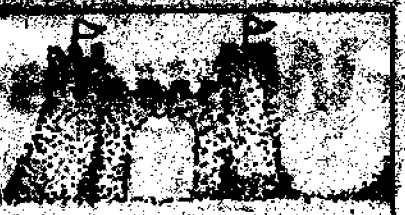
Waves are constantly at work to reshape coastlines. When a wave enters shallower and shallower water, the back and forth motion of the water on the seabed becomes greater. This water motion is able to push the sand back and forth, and if the water motion is strong enough, it can also push large stones 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 within them some quantity of 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.

ACTIVITY: The underlined words are words which you need to understand and add to your personal vocabulary if you are to begin to understand oceanography. Find the meanings of the words in the dictionary in your classroom. When a word has several meanings how do you decide which is the correct one for the word in the context of oceanography? (Note to teacher: There is no answer to this exercise on the answer page. We bow to Webster and your guidance.)

hawaiian SAND



Definition:

Sand grains are particles of sediment between 1/16 and 2 mm in diameter. Larger particles found on a beach are usually called pebbles, cobbles, gravel or boulders, and smaller ones, silt or clay.

Where does it come from?

Our Hawaiian sand comes from lava formed by volcanoes, and from the limy skeletons of reef organisms.

Black sand -- When hot lava flows into the sea and hits the cold water, it is cracked into fragments. These particles of black lava are carried ashore by waves and currents to form black sand beaches. The island of Hawaii, where volcanoes are still active, is the only Hawaiian island that has black sand beaches.

White sand -- Coral reef organisms die, are ground against each other by wave action, and are carried ashore to form white sand beaches.

Dark sand -- Dark particles of fresh lava and brown sand from weathered lava are carried from the land to the sea by rivers. Olivine is the name of the sparkling green particles in the sand.

The sand composition of our sand beaches contains very little coral because Hawaii does not have as much coral as elsewhere in the Pacific. Our sand is composed mainly of other reef organisms which construct hard skeletons of lime (calcium carbonate). The average composition of sand on Hawaiian beaches contains:

- 27% Foraminifera (one celled animals of which paper shells are one species)
- 17% mollusks (fragments like puka shells or small whole sea snails)
- 16% red algae (algae which grow into the reef and cement it together with their limy skeletons)
- 14% Fragments of lime that are too small to be identified
- 8% sea urchin tests (plate-like part of urchin shells)
- 7% lava (black basalt and green olivine from active or extinct volcanoes)
- 6% coral
- 5% Halimeda (a green alga which form a plate-like skeleton)

How does man use it?

Sand is used in thousands of ways. It is mixed with cement for the construction of houses and roads. Our beaches provide a number of recreational activities such as sun bathing and body surfing. The larger components of sand such as puka and paper shells are used for jewelry. The olivine jewelry sold in Hawaii comes from the Southwestern United States. Art forms such as sand castles and sand candles are fashioned out of it.

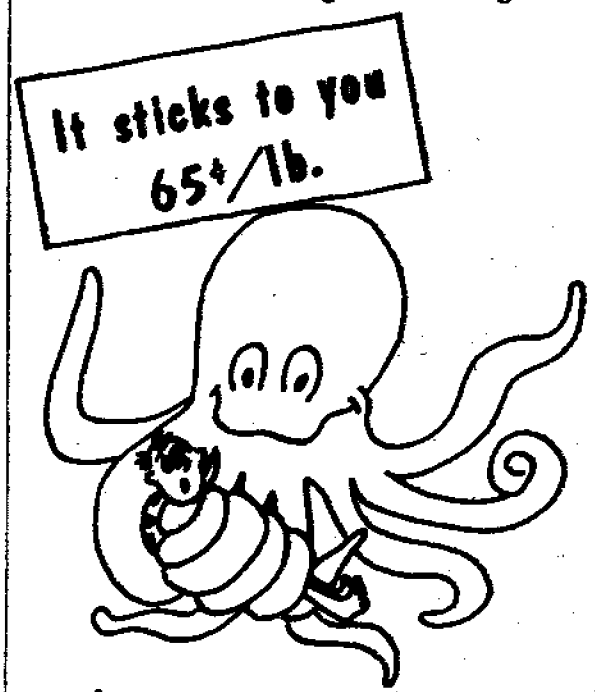
How do animals use it?

Many animals live in the sand both above and below the water line. Below the surface, the kona crab, heart urchin and miter shell bury in it and crawl through it. Feather duster worms construct their tubes out of sand and mucous. Many wrasses dive into it for protection and sleep there at night. Above the water line, ghost crabs dig burrows and rest there when not feeding on the debris along the tide marks.

A MARINE "HANABATA" FUN QUIZ

At the local fish market...
What is being advertised by these signs?

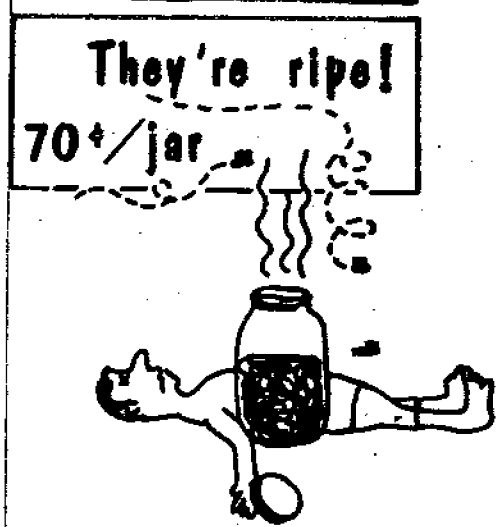
Match the following to the signs: limu, tako, poki, taegu, bagoong, opihi.



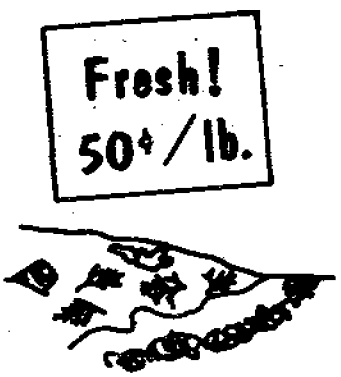
1 _____

2 _____

3 _____



4 _____



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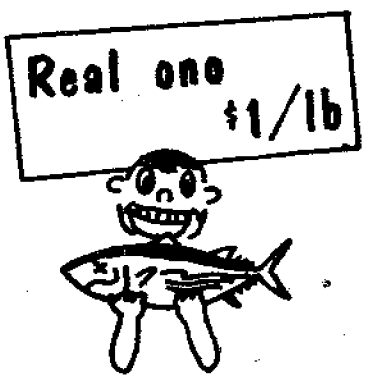
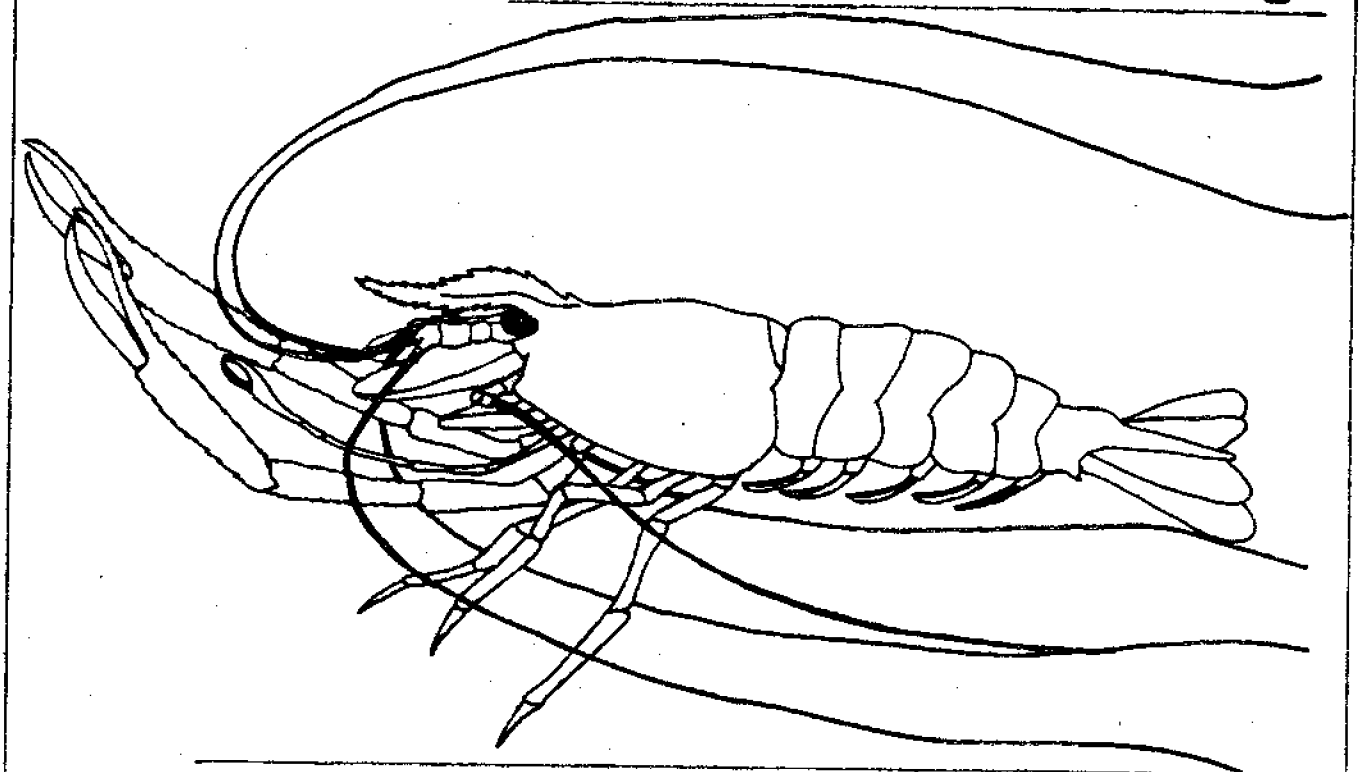


6 _____

(Answers on page 31)

AQUACULTURE:

Macrobrachium rosenbergii



The Malaysian prawn, *Macrobrachium rosenbergii*, is widely distributed in most of the tropical and sub-tropical areas of the Indo-Pacific Region. It occurs 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.

This prawn differs from the Tahitian prawn, *Macrobrachium lar* which is commonly found in Hawaii. It is believed that the Tahitian prawn which was introduced in 1959 established itself in Hawaii because its larval stage requires salt water, whereas the larval stage of the Malaysian prawn requires brackish water. Since Hawaii resembles Tahiti geographically, in that rivers empty directly into the oceans making brackish water rivers not as common as in Southeast Asia, the Malaysian prawn although introduced has never established itself. The temperature in Hawaii is also too low for the larval stages of the Malaysian prawn.

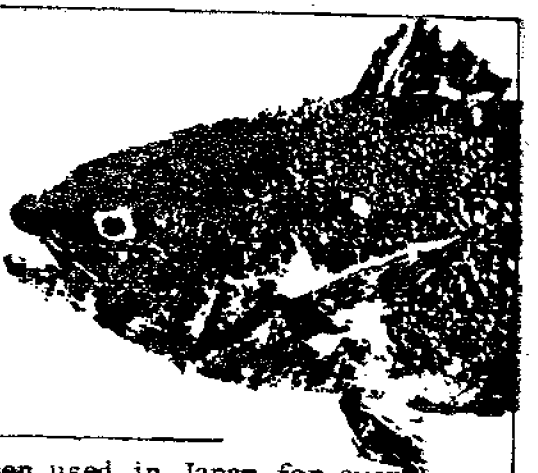
Common items of food include aquatic worms and insects, fish, other animals, grains, seeds, nuts, fruits, algae, and other plants. The diet of cultured prawns in Hawaii are supplemented by broiler starter (chicken feed) and processed shrimp shells.

After maturity, the prawns will produce eggs as frequently as every month. At each mating, there are as many as 7,000 - 20,000 eggs which are incubated on the 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^{O}F. The larvae are fed aku and newly hatched brine shrimp. When larvae metamorphose into juveniles, they can be put into freshwater. It is at this stage, the young juveniles are put into earthern ponds located in various places around the state. They will take 5-9 months to marketable size and are frequently found in Hawaii markets selling for 6-9 prawns/each. at $5.00 lb.

GYOTAKU

JAPANESE FISH PRINTING



The techniques of Japanese fish printing has been used in Japan for over 100 years to record catches of sports fish and to gain ichthyological (fish biology) information. These prints have been used at the University of Washington to study how the physiology of a fish is related to its surface area.

The art of gyotaku (pronounced ghio-tä-koo) is a good way to gain an understanding and appreciation of the beauty and great variety of marine organisms. You can also use this technique for making prints of shells, rocks, flowers and other items.

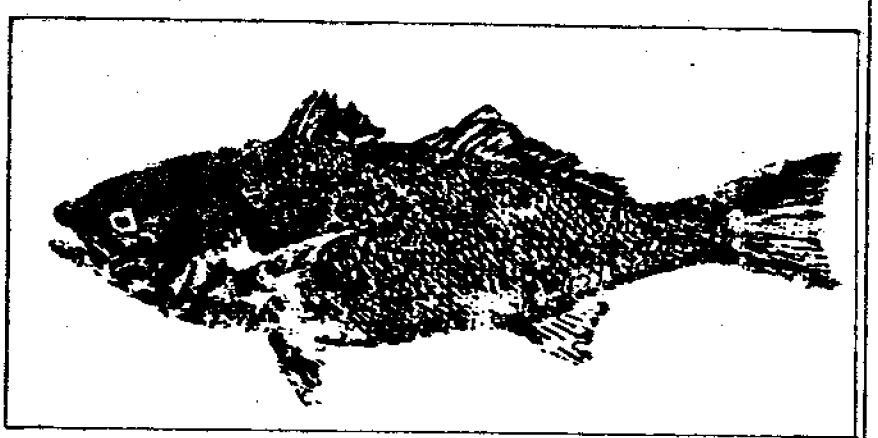
Before you make a print, identify the fish. What are the distinguishing characteristics of the fish? Study the life history of the fish. Where and how was it caught?

Materials

Obtain a very fresh fish - flounders, bluegills, or rockfishes are good to start with. If you buy the fish at a market, select one that has bright red gills, clear eyes, and a fresh smell. If the fish has been gutted, make sure that it has not been cut anywhere else on the body.

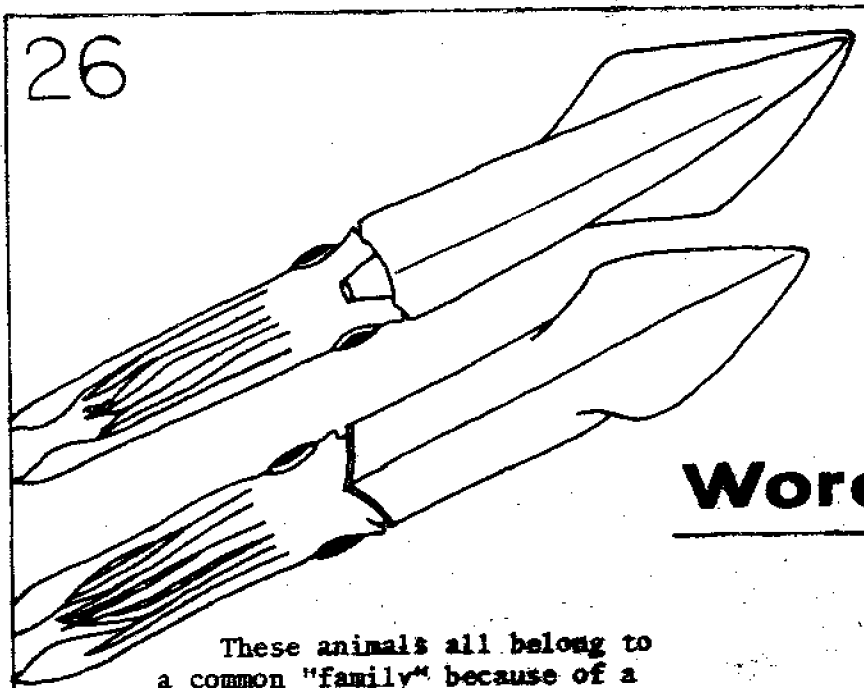
You also need:

* newspaper
* plastic modeling clay
* pins
* water base ink (linoleum block ink is best)
* a stiff 1/2 inch brush
* a very small brush
* rice paper, newsprint, or other moisture tolerant paper. Since rice paper is expensive, you might prefer to start with newsprint.



Method

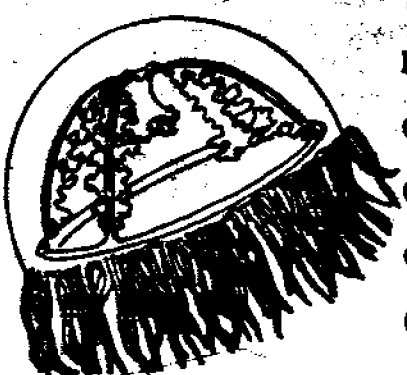
1. Use soap and water to clean the outside of the fish as completely as possible. The cleaner the fish, the better the print. Dry the fish well.
2. Place the fish on a table covered with newspapers. Spread the fins out over some clay and pin them in this position. Continue to dry the fish.
3. Brush on a thin, even coat of ink. Leave the eye blank unless you prefer to fill it in.
4. Place a piece of newspaper or rice paper over the top of the fish.
5. Carefully lay the paper over the entire fish. Use your fingers to gently press the paper over the surface area of the fish. Be careful not to move the paper too much since this results in double prints. Then remove the paper and you have a fish print.
6. Use a small brush to paint the eye.

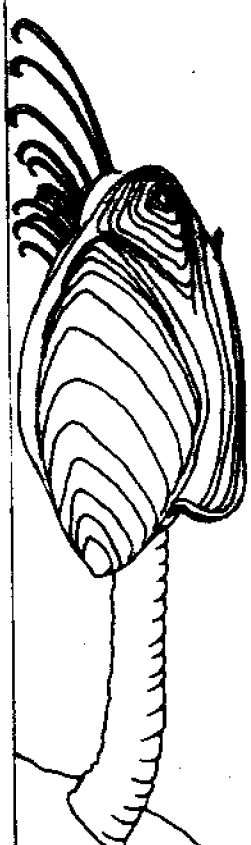


Word Search

These animals all belong to a common "family" because of a certain characteristic they all share. What is the name of this "family" and why are they called that name?

(Answers on page 31)





E	P	M	I	R	H	S	I	F	Y	L	L	E	J
L	C	R	L	P	Q	U	O	M	S	T	A	S	H
C	I	D	R	U	L	Y	C	R	E	Y	F	L	C
A	N	X	I	E	S	O	T	N	P	I	D	B	N
N	O	D	P	T	B	L	O	B	S	T	E	R	A
R	L	U	E	Y	G	M	P	T	N	R	Z	M	R
A	B	R	C	S	E	A	U	R	C	H	I	N	B
B	S	C	E	N	V	G	S	C	W	A	N	A	I
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S	H	S	D	I	L	O	L	A	O	S	E	E	H
J	Y	A	K	U	M	C	O	W	R	I	E	R	S

BANDANA PRAWN
(banded coral shrimp)
BARNACLE
CLAMS
CORALS
COWRIE
CRABS
JELLYFISH
LOBSTER, ULA
NUDIBRANCH
OCTOPUS, HE'E
OYSTERS
SEA ANEMONE
SEA CUCUMBER, LOLI
SEA URCHIN, WANA
SHRIMP
SQUID
SPONGE
STARFISH
WORMS

SKELETONS

in our "sea closet"

Match skeletons to the animals:

Slate-pencil sea urchin
('ina'ula)

Partridge tun shell

Sand dollar

Spiked prawn
('opae kakala)

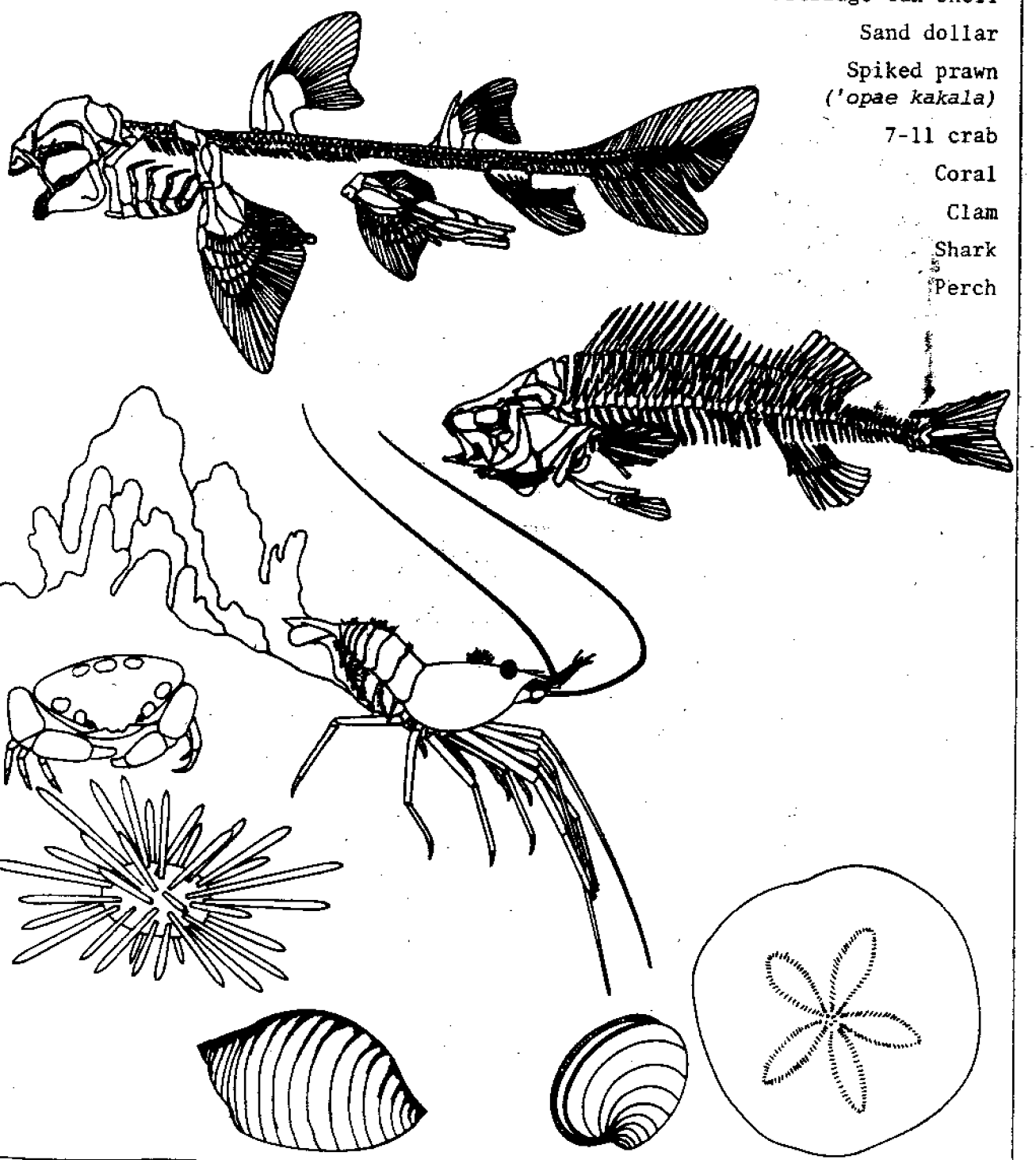
7-11 crab

Coral

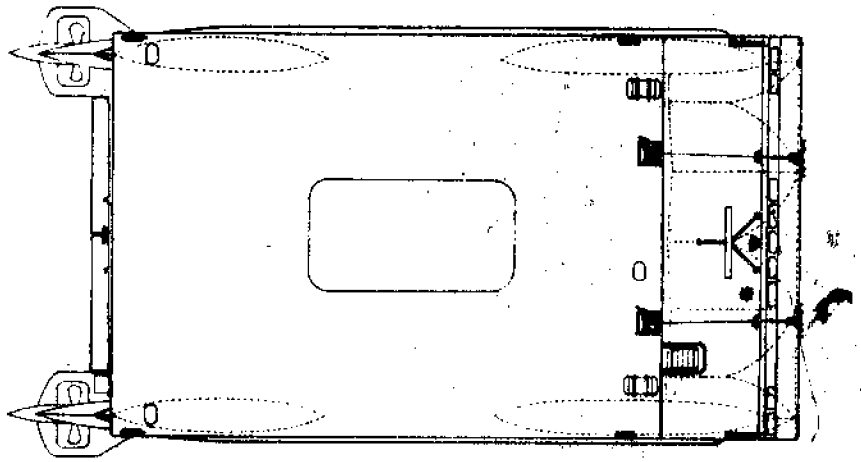
Clam

Shark

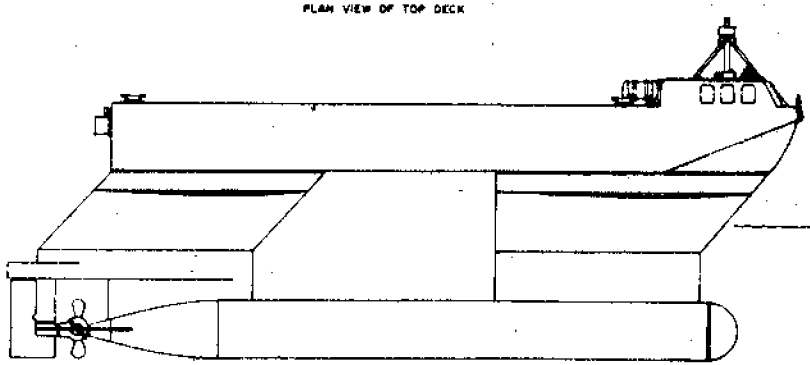
Perch

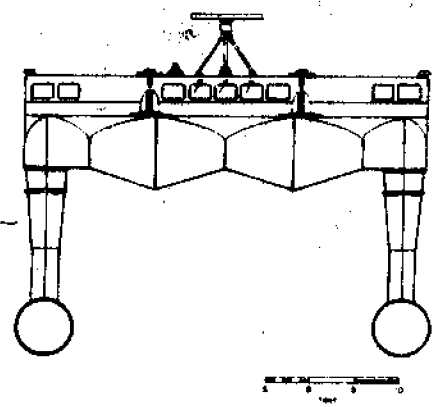


KAIMALINO
semi-submersible ship



PLAN VIEW OF TOP DECK





Displacement	190 tons
Length	87 feet
Beam	47 feet
Draft	15 feet
Power	4300 horsepower
Speed	25 knots
Range	450 miles at 16 knots
Pay Load	25 tons

ATTENTION NEIGHBOR ISLANDERS!

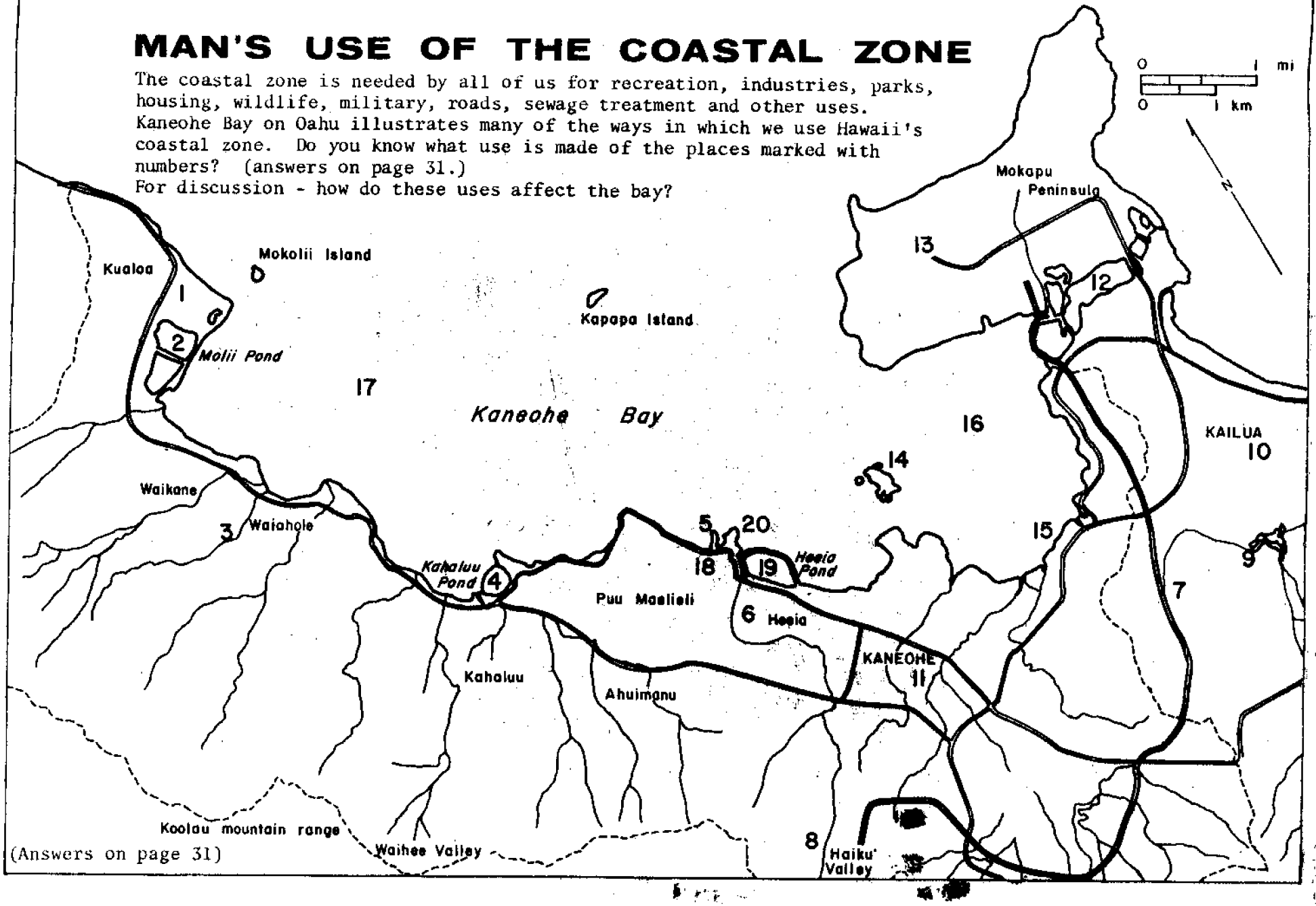
An appropriation by the 8th State Legislature has made it possible for Makahiki Kai '76 to be taken to the outer islands on the *Kaimalino*.

Neighbor islanders will be in for a special treat because they will be allowed to board the *Kaimalino* to see the Makahiki Kai '76 exhibits.

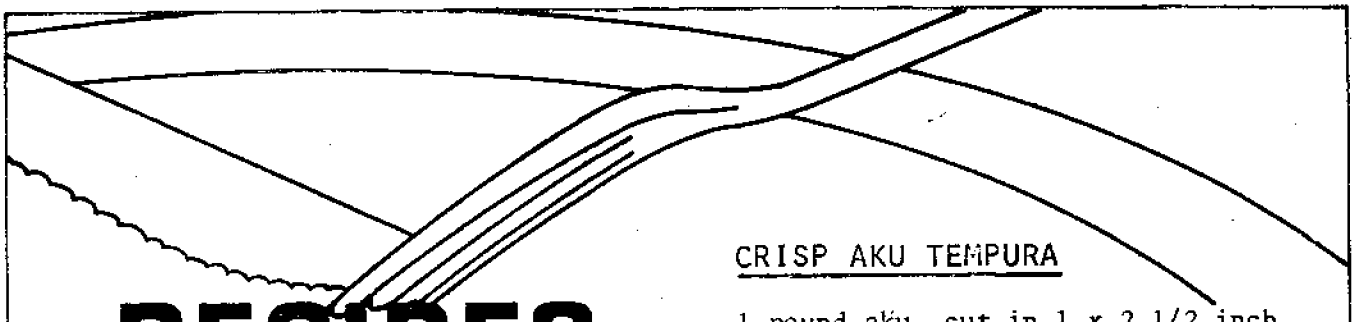
MAN'S USE OF THE COASTAL ZONE

The coastal zone is needed by all of us for recreation, industries, parks, housing, wildlife, military, roads, sewage treatment and other uses. Kaneohe Bay on Oahu illustrates many of the ways in which we use Hawaii's coastal zone. Do you know what use is made of the places marked with numbers? (answers on page 31.)

For discussion - how do these uses affect the bay?



(Answers on page 31)



RECIPES

LEMON SHOYU BROILED AKU

2 pounds aku fillets

Lemon Shoyu Sauce

3/4 cup butter or margarine
3 tablespoons shoyu
3 tablespoons lemon juice
1 tablespoon sake

Brush both sides of aku fillets with Lemon Shoyu Sauce. Broil 3 inches from flame for 5 minutes on each side. Baste with sauce during broiling. Serve hot with remaining Lemon Shoyu Sauce. Yield: 6 servings.■

POACHED SHARK REMOULADE

Shark fillets

sliced onion, optional
water
2 tablespoons lemon juice
2 tablespoons tarragon vinegar
2 tablespoons prepared mustard
1 tablespoon parsley
1 teaspoon paprika
1/4 teaspoon cayenne
1 cup oil
1/4 cup finely chopped green onion
1 tablespoon minced capers

Place shark fillets in deep baking pan. Top with onion slices, if desired. Add water until pan is half full. Bake at 400 degrees 45 minutes. Serve with Remoulade Sauce. To make sauce, mix lemon juice, vinegar, mustard, horseradish, parlsey, paprika and cayenne. Beat in oil, then add celery, green onions and capers.■

CRISP AKU TEMPURA

1 pound aku, cut in 1 x 2 1/2 inch

Batter

1/2 cup flour
1/2 cup cornstarch
1/8 teaspoon salt
1/8 teaspoon monosodium glutamate
1 egg
1/2 cup water

Sift dry ingredients together. Beat egg and add water. Add to dry ingredients and mix well. For thin lacy batter remove 1/2 cup batter; add 2 tablespoons water. The remaining portion of the thick dipping batter for fish. Heat fat to 375°F. Dip fingers in the thick lacy batter and sprinkle over fat. Repeat several times until a lacy network is formed. Dip fish in thick dipping batter and place on lacy network when lightly brown. When tempura is golden, break the network of batter and turn each piece. Drain on paper towel and serve immediately. Yield: 4 servings.■

HERB BAKED AKU

1 pound aku, 3/4 inch thick

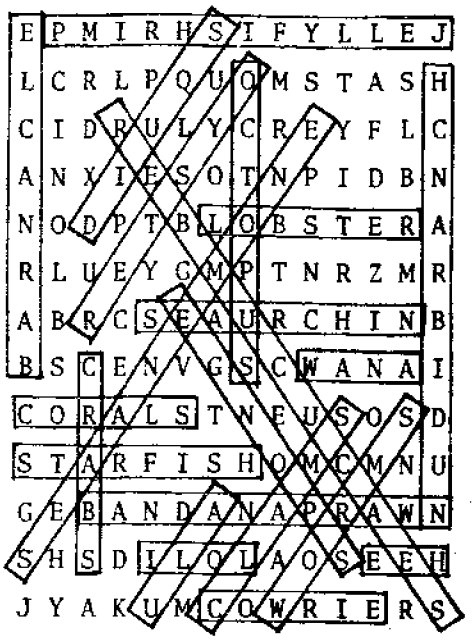
3/4 teaspoon salt
1/2 teaspoon garlic salt
1/2 teaspoon monosodium glutamate
1/4 teaspoon oregano
1/4 teaspoon thyme
1/8 teaspoon pepper
1 small bay leaf
1/2 cup thinly sliced onion separated into rings
3/4 cup light cream

Combine seasonings and herbs and sprinkle over aku; dot with butter. Add bay leaf. Arrange onion rings over top of aku and pour cream over all. Bake uncovered. Temperature 350°F. Time 20-25 minutes. Garnish with thin lemon slices and parsley.■

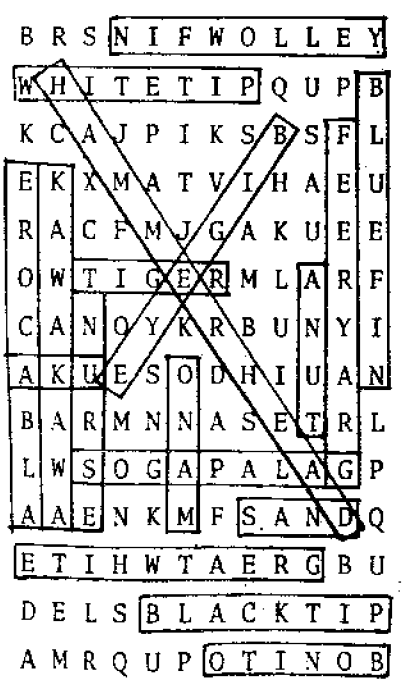
CHEAT SHEET

WORD SEARCH (pg. 26)

All of the animals belong to the "family" of invertebrates. Why? They have no backbone or spinal column.



WORD SEARCH (pg. 8)



MARINE "HANABATA" FUN QUIZ (pg. 23)

1. Tako
2. Opihi
3. Taega
4. Bagoong
5. Limu
6. Poki

HAWAIIAN GEOLOGY (pg. 13)

3 5 7

2 8 9

4 6 1

SHARK'S TEETH (pg. 15)

1. Great White
2. Hammerhead
3. Tiger
4. Dogfish

TUNAS AND SHARKS (pg. 8)

Albacore
Big Eye
Bluefin
Bonito, Kawakawa
Skipjack, Aku
Tuna
Yellowfin, Ahi

MAN'S USE OF THE COASTAL ZONE (pg. 29)

1. Kualoa Regional Park - camping, picnicking, swimming
2. Molii Pond - commercial fish pond
3. Waiahole-Waikane - agriculture
4. Kahaluu Pond - inactive fish pond
5. Heeia-Kea - small boat harbor
6. Heeia Meadow - proposed 5,000 homes in flood plain
7. Proposed H-3 highway
8. U.S. Navy - OMEGA radio station
9. Kawainui Swamp - bird refuge and proposed park
10. Kailua town - population about 20,000
11. Kaneohe town - population about 20,000
12. Nuupia Pond - waterbird refuge
13. Marine Corps Air Station
14. UH - Marine Biology research facility
15. Ahuimanu sewage treatment plant
16. South Bay - 99% coral dead from pollution
17. North Bay - relatively clean
18. Heeia - proposed electric power plant
19. Heeia pond - inactive fish pond
20. Matson point - proposed State Park

Mahalo

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Sea Grant College Program - Grant No. 04-6-158-44026
Special Legislative Appropriation for Makahiki Kai
to the University of Hawaii

Cooperating Agencies, Institutions, and Individuals

Don Aasted, National Marine Fisheries Service, Kewalo Lab.
Anela, Aku fishing vessel and her crew, United Fishing Agency, Ltd.
Anuenue Fisheries Research Center
Wayne Bladwin, Hawaii Institute of Marine Biology, UH
Charles Bretschneider, Chairman, Ocean Engineering Dept., UH
Tom Byles, National Marine Fisheries Service, Kewalo Lab
Frank Farm, Alii Holo Kai Dive Club
Dickie Fujie, Animal Science Dept., UH
Donald Fujii, Fiscal Officer, Office of Research Administration, UH
Sue Gardner, Info. Specialist, Transportation Services, C&C of Honolulu
Mary Lynne Godfrey, National Marine Fisheries Service
Frank Goto, Manager, United Fishing Agency, Ltd.
Hawaii Institute of Geophysics, UH
Ka Huina Kai members
Kamalii O Ke Kai members
Masae Kawamura
Lions Club members
McKinley High School Key Club
McWayne Marine Supply, Ltd.
Spencer Malecha, P.I., *Macrobrachium rosenbergii* project, Genetics Dept., UH
Herb Mann
Molokai High School students
Alan Muraoka, researcher
Robert Nakamura, P.I., *Macrobrachium rosenbergii* project, Animal Science Dept., UH
Yukio Nakano
Tomotsu Nakata, National Marine Fisheries Service
J.T. O'Brien, Director, Look Lab. of Ocean Engineering, UH
Lynne Peters, Polynesian Voyaging Society
Polynesian Voyaging Society
Sea Grant staff
Dick Shomura, Director, National Marine Fisheries Service, Honolulu Lab
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Sonny Takara, Alii Holo Kai Dive Club
Kiyoshi Tanoue, President & Manager, Tropical Fish and Vegetable Center
Von Hamm Young
Wakaba Kai Sorority, UH
Waikiki Aquarium
Stan Yamamoto, Dept. of Education
Young Brothers

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