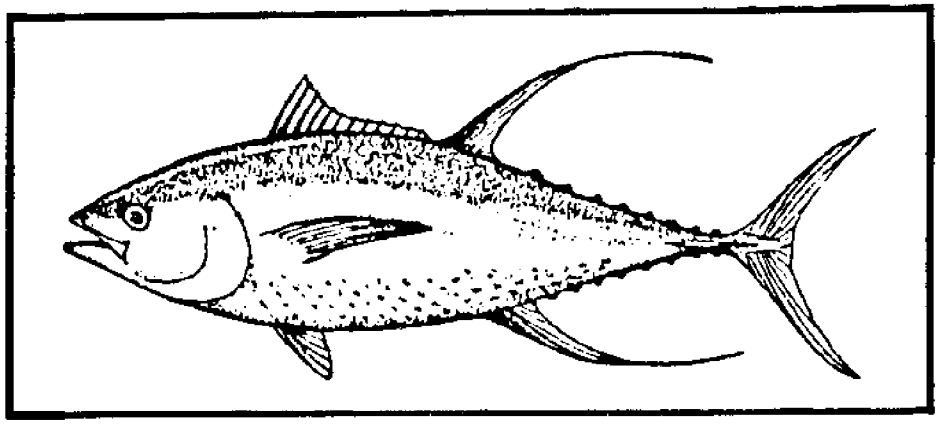
BIG ISLAND TUNA CONFERENCE



Proceedings

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This publication was edited by Mr. Howard A. Takata, Hawaii County Extension Agent with the Sea Grant and Cooperative Extention Service Programs, and Dr. Robert T. Nishimoto, Aquatic Specialist - State of Hawaii Department of Land and Natural Resources.

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WELCOME

Mayor Herbert T. Matayoshi
County of Hawaii

We on the Big Island, particularly Hilo, would like again to be the center of all the tuna fishing activity as it was in the past. Many of you probably weren't here, but there was a cannery here in Hilo many, many years ago. I certainly look forward to it being back again. So we are very much interested in the tuna industry.

If you recall, the County first initiated the study of the tuna burn problem and we have funded the initial program, I think for which we will be having the initial report here this afternoon. As I understand it now, the Federal and the State governments are funding further studies in that particular area and I think it's very significant and I hope that we all come to a certain kind of discovery or a system that will prevent the tuna burning situation that we have been encountering.

The County also is very much interested in the fishing that takes place on the southern areas of this Island and so we want to push very much for the Kaulana Bay (boat ramp) development. We hope that if you're out there down past South Point, you could come back, in case there is problems, to the closest port. Unfortunately, that has been sidetracked for a little while but the Army Corps of Engineers, as I understand, has completed its design plans. Now OHA (Office of Hawaiian Affairs) and Hawaiian Homes (Commission) need to get together to be able to make that move forward. The countywide has been very supportive and I, myself, am very supportive of the Kaulana Bay (boat ramp) development. I certainly hope that it will come to fruition very soon to be able to help our fishing industry.

Also here in the city of Hilo, I think you've noticed a little sand bar that's forming at the entrance of Wailoa River where all the fishing fleet comes in. The State (of Hawaii) is going to temporarily dredge it to open it up again. This is the second time, by the way, that the State and County (of Hawaii) has worked toward temporary relief. But we are working again, with the (Army) Corp of Engineers to work out a permanent solution to the problem. We hope that we would be able to get it going towards the end of this year. And in that mind, I've also included in my Capital Improvement Program budget a $200,000 appropriation so we can work together with the Corps for finding a permanent solution to keeping Wailoa River mouth open for our fishing fleets. If some of you are not familiar with it, you might drive by this morning and observe what's happening there. We

recognize the problem and we are trying to do something about it.

We also recognize that there is very much concern and I just hope that you are, as well as we are, in the case of the proposed manganese mining process. I see a circular going out addressing this concern. We too are concerned. And so you will find that I am now sending a letter out talking about environmental impact statements being made about manganese mining out there in the ocean so it does not affect all of you in fishing. I am sure that all of us who are interested in economic development for the Island and the State are interested in manganese nodule mining and also concerned about the fishing industry. So we would certainly insist upon impact statements being made. And I hope that when it's all presented that you, who are involved in the fishing industry, would also be very concerned and to look at it as not to block the mining situation but to be constructive and to be able to work together. Because I certainly think proposals can become compatible in the future and be able to create jobs for all of us here in the Islands. And so I certainly look forward to your cooperation in working together with the Agencies who are making the study on the impact.

With that I'd like to end and say that I hope you all enjoy the fine scenery. Too bad Madame Pele stopped and some of you who are from off-island could not observe the eruption. But we are happy on the Big Island that she has stopped for a little while because she was giving us a scare. But if it does start again that you have a chance to see the spectacular performance that Madame Pele holds for some. But we also hope that you enjoy all of the beautiful sights on the Island and have a good time.

We do, however, caution all of the people coming to the Islands that we do have the police very active in roadblocks. We check on people who happen to drink a little bit too much. We do give tickets for speeding and don't bring it to me because I don't fix any tickets. We collect fines. One of the reasons that we do that and I assure you, to all of us, that the police are quite active in the area simply because we are interested in your welfare. You might not look at it that way, but I do. The same caution is to stay within the speed limits and don't drink too much. We want you to be healthy and get back home again. And so as I always tell people if you happen to be speeding, the policeman stops you and gives you a ticket, thank him for being concerned about your welfare and telling you to stay within the speed limits. I think this is very significant.

I want very much to say that here in Hawaii with all the beautiful scenery and the weather and everything else that

goes with it, the most interesting and I think the most significant part is our people. I notice that you have the happy hours and socializing hours and I hope you take advantage of that and get to meet all of our people. You will find that the Big Island has the nicest people in the whole world. So we want you all who are from off-island to come back and visit us as often as you can and bring your friends and relatives and anybody that you know. We need the business.

I hope you have a very successful Conference and as far as the Administration is concerned for the tuna industry, you can be assured that we will do whatever we can to help you produce.

Mahalo.

OVERVIEW OF PACIFIC TUNAS

Witold Klawe, Ph.D.
Senior Scientist
Inter-American Tropical Tuna Commission

I am very, very happy to be here and be able to share with you some of my views about tunas. That's why we are here. I will try to introduce the fish. Much of you know tuna, one way or other, may it be in the form of a sandwich or a slice of sashimi or the actual fish, because many of you are fishermen who catch the fish. Will it be aku, will it be yellowfin tuna or some other fish which perhaps some of us don't think of them as a tuna, but they are closely related species. Like for example, marlin.

Tuna are fish which live in tropical waters. They are wanderers. They wander great distances, sometimes from one side of the Pacific to the other or even can move from one ocean into another ocean. Often they form large schools.

We will first look at family album of tunas. Those are not photographs but are paintings. The paintings were done by my good friend, George Matson, who spent years and years working as the administrator for National Marine Fisheries Service working with fish. Those paintings which I am showing you here, which I will refer to as the family album, may not be scientifically accurate. However, they have the correct number of spines, number of finlets and body shape. It may interest you that George Matson, who is the artist I am talking about, came to this Island by himself and spent several weeks working perhaps with some of you. I remembered he started with Bob Leslie, I believe. You perhaps met him when he was painting some of the fish I will be showing you. So I'll start with this just to give you an example.

Now, this is an albacore tuna. Everybody knows that and this is for a housewife that would eat white meat tuna. Now, albacore is a tuna and tuna belong to a larger group of fish or a family we call the mackerel family. This is the mackerel, that would be the "saba," I think. I don't know if there is a Hawaiian name for mackerel, but if there is, I'm sorry, I don't know. This is a relatively small fish, and, the fins are slightly different, especially the tail. It's very, very different. I'll mention about the tail of the tuna when we start talking about tuna themselves.

Right here is another fish. Now this fish is not a tuna but is one of the spearfishes, one of the billfishes. This happens to be a shortbill spearfish. I think sometimes it's caught in Hawaii, but is not very common. The Japanese name is "furakajiki."

That's a broadbill swordfish. A fish which perhaps is much more better known than the previous one. It's closely related to the tunas but not in the same family but it's a close cousin of our tuna.

There is always some strange creature in the family album and here is one, the butterfly king fish. It doesn't appear here in Hawaii, you have to go way, way down towards the Antarctic before you can see this fish. It has a lot of blubber so I think it wouldn't survive very well here. It lives in very cold water.

The mackerel family forms a group, the light blue color there is the tuna. Next to it would be the bonito. And then it would be the spearfishes. Spearfishes are a fish, which you may not know here, except one example and that is the "ono" or wahoo. Wahoo is a spearfish. Then there is the mackerel. We talked about that. And there is also the butterfly king fish that we just mentioned. There are several kinds of tunas; the yellowfin tuna, bluefin tuna, albacore. Then we have all the skipjack. Now, the skipjack is a tuna to us. Maybe not necessarily tuna to everybody in the world. I am talking now about fishermen or common usage of the word because in Japan that would be a bonito. "Katsuwo" is, of course, the bonito and they put it together with other bonito, the other kind of bonito you catch in Japanese water. Sometimes you can also see the Oriental bonito or whatever type scientists call it, in the waters here.

The tuna forms a group which include bigeye, yellowfin, albacore together with the skipjack and also the "kawakawa." Kawakawa is in the same group of the fish. Also in the group is a very small tuna, the "keokeo," a tuna which is so small that some of which is six pounds and I think six pounds would be a world record. I never saw a keokeo that size. On the other extreme is the bluefin tuna which may weigh 1,500 pounds. That's very, very sizeable fish. So there is a big size spread within the family itself.

What is interesting about tuna is their growth potential. Tuna eggs are very small, I would put 2,000 of those eggs if you arrange it in a line, that would be one inch. So each egg averages .04 inch in diameter or something like that. It is a very, very small egg. The hatched tuna larva is only one-tenth of an inch. That small tuna, if it would be northern bluefin tuna, can grow to let's say 1,500 pounds; that's a big fish. It would grow 1 billion times. But how big for us?

If we will take a chicken, everybody know chicken. Don't take the biggest one, take the medium-sized egg. And a chick hatches from that. Let's assume that by some magic we can make the chick grow one billion times. That would be a

very big chicken, believe me. Two of those chickens, just two, would be enough to feed a nice big meal to everybody in the United States. And there will be still some left for people in Canada and perhaps south of the border to Mexico.

So those cells which start in the chicken egg and the tuna egg, are the same cell. The germ cells, the actual spark of the life, that's the one cell which eventually develops into the tuna or into the chicken. They are the same. The difference is that the chicken has much more yolk, has much more volume to provide for the offspring. In case of the tuna, there is hardly any food. Just barely starts the tiny, tiny thing. The tuna hatches at one-tenth of an inch and then it has to fend for itself. But chicks hatch at a relatively larger size. Chicken lays only one egg per day. Tuna produces an enormous amount of eggs.

Ten female tunas, averaging 50 kilograms apiece, will produce enough eggs (if they all hatch and grow to 50 kilograms each) to produce something like 2½ million metric tons of tuna. Now that's more than everybody hatches in one year in the whole world. But that is not the case. So what's happening? Those tuna, the young tuna are eaten by other things. They are eaten by their own brothers and sisters too. That's the way nature takes care of that. No one will hardly touch an adult tuna, maybe sometimes a marlin, maybe a shark, but otherwise it's a predator. Well that's fine, when it's big, but when it's small, even nehu will eat the little ones. And there are jellyfish, there are other tunas, there are squid. Anything that can lay teeth or tentacles on a young tuna will eat it. So they are not a predator in the same sense as a tiger or a lion. Because lions have small offsprings, literally small, so is the tiger, but they take care of their young ones. Here, tuna produces millions of eggs and "hopes." But anyway tuna does not protect their yound and out of those millions of eggs only a few will survive.

If you start to think in order to keep the population at the same level, only two (from each spawn) have to survive. Because otherwise if many more would survive, we could walk from here to Japan or from here to the mainland on the backs of tunas.

So, the potential, the growth potential is enormous. The production potential is enormouse but obviously their mortality is astronomical to keep their population at the level we see it. Of course, we know there are fluctuations in the level.

Now tunas are very well adapted to the way they live. Their body shape is such that it allows them to attain great speeds, they can swim fast. Their body pattern is well functional. They are a beautiful fish. But the beauty, perhaps is in our eyes because to tuna, the body pattern is

very functional because they recognize each other. I think they definitely can recognize each other. By changing their body patterns, they can also communicate. It's a difficult way to communicate for fish. How can they communicate? We know they produce some sounds but not the same way as far as we know it. There is no evidence that they communicate the way the porpoise does. So they have to communicate. They are a schooling fish. They cannot help but to orient themselves on other fish. They can recognize maybe even their age, maybe their sex or for instance, like we do often through our emotions, our facial expressions. They are very limited to that because they do not have speech. They do not have a way to change their facial expressions. But they can change the vertical stripes as we notice often, for example on skipjack tuna. A just freshly caught skipjack will have vertical bars on the body in addition to the horizontal lines. Their body coloration changes quickly so when you take the fish out of the water, the pattern disappears very quickly.

The body shape of tuna is streamline. Even the fins can be folded against the body. They can move quickly. They can swim at great speeds and also they can swim for a long, long time.

There are many internal adaptations to the way they live. And it's kind of hard to say where we should start. But let's start to talk about the circulatory system. I'm not going to talk in great detail, but to kind of get a general idea. Many of you may have read somewhere that tunas are warm blooded. They are not warm blooded the way you and I are, but still their bodies are warmer, their body temperatures are kept at a higher temperature than the water. One of the functions of the circulatory system is to maintain the body temperature of the tuna; sometimes to get rid of the heat, sometimes to keep the heat in. The circulatory system is also a way to distribute the fuel, the food which they ingest/digest and to transport to the different parts of they body. Then comes one very, very important situation. A tuna can be thought of as a racing car. The fuel the tuna gets is the same fuel as different fish eat. So the problem is getting oxygen, getting a big supply of oxygen and that's how they compensate for the maybe not "high octane fuel" but how they can derive quickly a lot of energy by providing lots of oxygen. How do they do it? Through hemoglobin. We looked at the hemoglobin years ago. My wife was involved in that little project too. We found that the hemoglobin which is a pigment which captures oxygen from in our case, air or in the case of fish, water. The surface of our lungs is about the same for the same body weight as in tuna except the tunas don't have lungs. I am not trying to confuse you. But they have gills which functions as lungs. What's interesting is that tuna, in order to respire, in order to be able to capture the oxygen from the water, have to swim. We do it by breathing. Many fish ventilate their

gills by inhaling the water and pumping it over the gills. However, tuna has to swim in order to ventilate those gills. In order to respire, they have to swim. They cannot stop. There is another reason to swim, because in order not to sink, they have to swim. So they are just like the legendary flying Dutchman of the legend of the ship which was condemned to said forever. The tuna are just like that. From the moment they are hatched to the moment they die, they are swimming.

Let's look at something else. We know that tuna have dark meat or red meat, red muscles and white muscles. Now the white muscles are used for the burst or sudden burst of energy to capture a fish or to avoid a predator or to join a school. In that situation, they use energy starting in their white muscles. The red muscles is used if they want to swim for very long distances or for a very long time. The fish can swim very fast and very slow. So they really can be sort of a sprinter as well as a long-distance runner because they are capable of doing both. Both systems are very well developed.

Now when they swim, they have to always swim. A bluefin tuna of good size, of let's say three feet plus, could swim, perhaps in less than three months, across the Pacific. Just by the fact that it is just doing nothing else but just swimming. But, that is a nonsense, doing calculations like that. But it gives you some kind of feeling for the distances those fish have to cover in order to just breathe. Those fish have to feed too.

The tuna lives in a kind of an amorphous ocean. It is just like if this room was much larger and filled with haze. They are in a very different environment than we are used to. We are used to landmarks, such as street signs in the city. In the country, we see the trees, mountains, things like that. But we are disoriented when there is fog. Tuna lives all the time in the same fog. Because the visibility even in the clearest water is not too great, they have to depend on some other clues. They are hearing, or feelings of vibrations, smell, and to some extent, of course, sight too. But sight becomes important, perhaps, to the actual capturing of prey or orienting itself in relation to other groups in a school.

We talked about their ability to move from one side of the ocean to another side. From Hawaii to mainland or some places like that. Now how do they do it? They live in that very different environment. They cannot really come and look at the sky so readily as we can. For a long time, their migration was kind of a mystery. Now we are starting to understand certain things. We think that, perhaps, they obtain magnetic clues. Of course, they are able to get celestial clues to some extent. They may not be able to see north star or southern cross, but they are able to sense the passing of the sun. The magnetic thing is kind of interesting.

It was just discovered very recently that tunas have particles in the body which may assist them in detecting the earth's magnetic field.

Let's look at the fish as a resource. It's difficult to talk about Pacific tunas without looking at tunas in total, in the entire world. Why? Because many of the species live in all three oceans. Some of the species move from one ocean to the other as I will demonstrate shortly. And in addition, the markets for tuna are really international markets. The fish may be caught by Japanese vessels and may end in Honolulu or may come to California, or it could be caught by a Taiwanese boat in the South Pacific and end in Pagopago cannery or could go across the Panama Canal to Puerto Rico.

The amount of tuna caught in the world is not big compared with other fish. In 1982, I believe, 1.8 million metric tons of fish were caught. Their dollar value, however, is a different story. Tuna is worth quite a bit in dollars. And some of the tunas, of course, are very, very valuable in the sashimi markets in Tokyo. I think last year or was it two years ago, they sold some bluefin tuna which was calculated to be $42,000 per ton. Of course, that was in connection with the New Year festivities.

The world catches of the six major tuna species, yellowfin, skipjack, albacore, southern bluefin, northern bluefin and bigeye, have been recently leveling off.

In 1982, 44 percent of all global catches of tuna was the skipjack or the aku. The next is yellowfin tuna which represented 30 percent. Then comes albacore and bigeye. The southern bluefin and northern bluefin tunas amount to very small amounts of the total catch, only 3 to 4 percent.

Now, here is the same data but from a geographic perspective. I refer to the Pacific Ocean as the tuna ocean. Why? Because 70 percent of all tuna comes from the Pacific waters, about 20 percent from the Atlantic Ocean and the remaining 10 percent from the Indian Ocean.

Seven countries account for 75 percent of the world tuna catches. Japan and the United States are ranked numbers 1 and 2, followed by Spain, Korea, Philippines, etc. However, Japan and the United States tuna catches have been slipping in recent years.

Let's look at Pacific because we are more interested in the Pacific. Japan and the United States are again on the top followed by the Philippines and Mexico. These four countries account for 75 percent of the Pacific Ocean tuna catches. Look at Venezuela. Although Venezuela is an Atlantic country,

it catches quite a bit from Pacific. And since we have visitors from the Solomon Island, I am glad to see that they are on the chart too.

Now I will try to go back to our family album. Let's look at the tuna, not from a taxonomic viewpoint, but as a commercial fish.

Skipjack tuna, aku to most of you here, is number one in world landings. In 1982, it represented 44 percent of all tuna catches. This chart summarizes the distribution of the species, the spawning grounds and the arrows indicate the migration direction.

The yellowfin funa, the ahi, is number two. It's a fish familiar to everybody and grows much bigger than the skipjack. I think 300-400 pounds would be the limit, as the individual grows and the fins get longer. I believe this picture was painted from a specimen landed in Hilo.

Now this map shows the migration and the surface fisheries. Yellowfin tuna, the ahi, isn't perhaps as migratory as skipjack, however, don't mistake me and say that it's a non-migratory fish. Yellowfin tunas can move 3,000 to 4,000 miles like nothing, except it isn't going across the ocean. It just is less migratory than the skipjack. This chart shows it's distribution throughout the world and the spawning areas. They are extensive again but limited to more tropical waters.

Albacore tuna is number three in importance. They are highly migratory and they move from Japan to California and vice versa. Most are caught in the longline fishery. Their spawning area is much more restricted than the yellowfin or skipjack tunas.

This is our bigeye tuna. I am showing you two distributions, the yellowfin and the bigeye just to show you that those distributions often coincide in a two-dimensional distribution, however, if you would look in the water column or vertical distribution, then you would see that the bigeye goes deeper.

This is the northern bluefin tuna. The kuromaguro of Japan. This fish has been known for a long time to be a very highly migratory species. So it's recognized very quickly even as far back as Aristotle's time. He was looking at the migrations of the tuna in the Mediterranean and he was already aware of its highly migratory status.

This map depicts the migratory paths of bluefin tuna. We put together the southern and northern bluefin tuna. The red line in the southern hemisphere represents of the migratory routes of the southern bluefin tuna. One migration

starts from Australia, going down to Indian Ocean and all the way into the Atlantic. I am predicting that one of these days, we will get a fish moving from Argentina to Chile. I am not saying that the fish will go down the way the missionaries came to Hawaii, but it is capable of going all around the globe. Of course, it could go the other way. It could be from Argentina to Chile. I am not sure of that. But we can see now that the fish can move. Perhaps the northern bluefin tuna can do the same thing. Except unfortunately, North America separates the Pacific from the Atlantic. So unless they take the canal, there is no other route.

I forgot to mention that both bluefin tuna, southern and northern, have a very restricted spawning area. The southern bluefin tuna spawns only in an area above Australia.

Now to the surface fishery and the geographical distribution of the two species. There is a little overlapping around Australia of the southern bluefin and northern bluefin.

As I understood, I am open for questions. Anyway, if there are any questions, I will gladly answer them.

Question: Are the species endangered?

Answer: Well, there are many species in this group which are definitely endangered. We are talking not as much as being endangered, but perhaps a bigger term should be applied, vulnerable to fishing. The most vulnerable species would be the southern and northern bluefin tuna. And the next one would be the yellowfin tuna in the Eastern Pacific.

Question: In your fishing statistics, I didn't see any mentioning of Russia. Is their fishing effort large or small?

Answer: The Soviet Union fishing effort, as far as the tuna goes, is very small. They started years ago with a little fishing in the Indian Ocean and in the Black Sea. They caught a lot of bluefin tuna and consequently, that's one area where the bluefin tuna is definitely endangered. In the Black Sea, the bluefin tuna is very rare fish now. Then they purchased a number of purse-seiners and they were fishing off Africa and they had lots of problems. They do have a tuna fishery, but it's still insignificant.

Question: In one of your slides, you showed that the amount of tuna being landed leveled off. Was it caused by less tuna out there or more fishermen trying to catch the tuna?

Answer: There are more fishermen trying to catch tuna on the global scale but the catch per unit of effort is down. It's just leveling off, the resource can support only so much

and that's it. Of course, there were effects of the El Nino current and demand for tuna.

Question: Here in Hilo, there is a serious concern about catch variability from year to year of yellowfin, bigeye and albacore, what is the cause? Is it local over-fishing or related to specific year-wide class variability? What's your opinion?

Answer: Depends on the species. We know that some of those fish, like the yellowfin tuna, is more or less a permanent population. If you come to Hawaii, we know that many fish, like aku, migrates and isn't here all the time. In the Eastern Pacific, there are some areas which are considered home grounds where the fish are there all the time. But many of the fish will move and we know very well from tagging experiments that they do that. So there are a combination of factors to answer your question. There has to be a combination of both. The fluctuation in the environment and also the migration pattern of the fish.

Question: I am concerned about the proposal for ocean mining off the coast of Hawaii and I am wondering from what I understand from the mining process that large effluent plumes will be released in the ocean. What effect will this have on the migratory patterns of fish that are important to Hawaii's commercial fishery and also has any studies been done anywhere in the world where ocean mining is conducted on its effects on the fish catch?

Answer: I cannot answer that question. I am sorry, I just don't know the answer. So it would be misleading to tell you.

Thank you very much.

TUNA BEHAVIOR AND PREY ODOR TESTS

Kim Holland, Ph.D.

Hawaii Institute of Marine Biology

Actually what I want to do this morning is talk about two completely different experiments that I've been involved in for the last couple of years. I'm at the transition point of winding down some experiments that I have been doing with the responses of yellowfin tuna to the smell of their food, and cranking up an experiment which is involved with tracking yellowfin tuna as they move around the fish buoys that have been put in the water. And so I would like to give you a very brief breakdown of the odor experiments which I am on the tail end of and a brief look at the trackings that I am starting to crank up.

And as Dick just paid his dues to the various funding agencies, that's very important for those of us in academic fields. I'd like to also do the same. And again, a lot of my support comes from both of these projects - from Sea Grants, from various State of Hawaii agencies, and from the Japanese Tuna Fishermens Coop Association, and from the University of Hawaii.

First, the odor experiment. We all know that the tuna are very visual predators. They use their eyesight very extensively in the final capture of their prey. But some experiments on the preliminary basis that I was involved in a few years ago with John Bardach, another fellow from the mainland, and Walter Kihara, who I see in the audience here. We had some preliminary evidence that tuna also use their sense of smell to find a prey. Many other fishes are very well known to do that, but that was not demonstrated in tuna, largely because nobody really suspected it because they are always thought of as being very visual predators. But the preliminary experiments that we did showed in captivity that yellowfin tuna can smell food. And so based on that very early experiment, I have for the last few years been going back and doing it more thoroughly and more extensively.

And the experiment involved is this. First of all, do tuna normally respond to foods? Our early experiment said yes, when you keep them in captivity and expose them to food odors, they will respond. But we didn't know if they do that naturally in the wild. Is smell important to tuna in the wild? If it is, do they have a preference for any particular kind of smell? And if they do have a preference, can you take a chemical analysis of that smell and find out whether or not there are particular chemicals in that fingerprint, in that whole 'soup' that are primarily responsible for response of a tuna?

The very important thing to do as far as I was concerned, was not to teach the tuna to do what I wanted to find out. And so two methods or two parts of the experiment were very, very important. One is that whenever I was doing the experiment, it was very important that the guy actually doing the experiment was one person and the person evaluating the response of the experiment was somebody else. So we don't know what we're looking at; when we evaluate it, we're not biasing it through what we expect to see. That was one criteria that we had to maintain. The other criteria was established or comes from the fact that it's well known that if you feed any animal something, will it be a cat or a horse or a cow or a tuna, whatever you feed it, if you feed it a monotonous diet over time, it will come to prefer that diet. It may not be true for us, but for more primitive animals that's true. So I had to make sure that if I was going to ask a tuna what it preferred to smell, that I hadn't already taught it what it should prefer.

And so in order not to do that, I made sure that the fish that we had in captivity were fed a diet very similar to that we know they feed on in the wild. So we went to considerable expense and after it, to provide our captive fish with a good diet. In fact, they ate probably a lot better than I do. They had fresh opelu, fresh akule, fresh frozen squid, nehu off the aku boats - the aku skippers were very cooperative, and frozen krill - shrimp. So we were trying to give them a representative diet so that they did respond and if they showed preferences, it wasn't because they had already only been fed one thing and it wasn't because we told them what to do. (first slide)

Most of this research in captivity was done at Kewalo Basin at the National Marine Fisheries Service lab at Kewalo Basin. This is the apparatus that I used. On the top of the observation tower in that box, there is a video camera. Halfway down that tower there is a oneway mirror so the fish can't see me but I can see them. And in the tank are the fish. Running from inside the tower, into a pipe, which I could control from inside the tower is a continuous stream of water which, when I throw a switch, will shoot a slug of whatever the compound is that I am testing into the tank. The responses of the fish if there is one, get recorded on the camera and then somebody else who didn't do the experiment can look at the tape and say, yes, this fish did respond and it responded on a scale of one to ten - say, a five, or a three, or a two, or didn't respond at all or it got so excited that it bit the tube. And that has happened. And so then you can rank, you can judge the effectiveness of different kinds of stimulus. (next slide)

This is what they look like from up on top of the tower. In the extreme top right-hand corner around 2 o'clock, and you can see a dark support for the odor tube. The odor goes in the water and the flow of the tank is going clockwise so that

odor will drift around the tank. And I know from doing dye experiments, where it is at any given time so I can judge when the fish first encounters it and if it responds. (next slide)

This is what the fish looks like. I know most of you know what a small yellowfin tuna looks like. One of the things that I wanted to show on this was the stripes on the side which Dr. Klawe referred to and the function of which is still unknown. It's thought that maybe the stripes or feeding bars the tuna throw up when they are feeding might be a way for the school to communicate across the school from one side to the other. If one guy on one side of the school picks up bait, changes color, that signal gets rippled across the school and all the fish can join in on the hunt. That is only an hypothesis. (next slide)

This is what the monitor looks like when we are evaluating the tests. (next slide) We test freeze-dried stimulus. That is half a gram of freeze-dried opelu rinse.

Now tuna are not sharks. Sharks make their living from preying on dead or injured or decaying animals. That's not the way tuna feed. Tuna feed on whole, live, healthy bait. So it can affect their sense of smell that had developed to detect prey, it wouldn't be to detect something that was dead and dying. It would be to detect a school of fish that had left a trail of smell behind it in the water. The mucus off the eye sides, the urine, the feces, and the school of bait will leave a trace behind as it goes through the water. So we don't test chopped up fish or macerated fish, we test just the rinse taken from the outside of the animal. We take that rinse, say opelu, make a thick soup, take the whole animals out, don't get our fingers in the rinse, then freeze-dry it. And you end up with a powder. That way, each time you do a test, you always put the same amount in. So if for one test or another, you get a stronger or weaker response, it's not because you put in more or less that time, you always put in the same amount. So that's what half a gram of opelu rinse freeze-dried looks like. If any of you want to test your nose on it, there's some freeze-dried opelu and some freeze-dried nehu rinse here. Even the human nose can detect it. Don't snort it, just sniff it. Okay, so we put in half a gram of freeze-dried rinse into the tank and observe responses of fish. (next slide)

And if you take a school of tuna in the tank, you've not taught them what to do (we tried very hard not to shape their responses), the answer is 'yes.' Yellowfin tuna do respond to odors without being taught to do it. And they do so quite strongly. If you do a repeated number of tests, you can come up with a list of which kind of odors they respond to most strongly. So naive yellowfin tuna in captivity, respond on a scale of zero to nine like this. Now crude and opelu, crude stands for just crude opelu rinse from the icehouse.

We'll get to that later on. Crude is not freeze-dried. The brine is opelu brine from the icehouse. Freeze-dried is freeze-dried as I have explained about. And the 'AA' stands for the amino acids. That's the portion of that smell is made up of amino acids. Amino acids as you may know are the building blocks that muscle is made up of. And amino acids are one of the major components that get leached into the water and which in other species of fish, have shown to be effective feeding stimulus. So we analyzed the amino acids in these rinses and tested them. You can see that compared to the whole freeze-dried rinse, the amino acids were not very effective. Just looking at the 'FD' part, we see certain things. We see that opelu is better than 6.9, is better than squid, is better than nehu, is better than akule, which is about the same as krill. This is the naive fish that was tested first time. Now you can't, I have to buy my live fish from an aku boat. You can't just use them and throw them away, you have to get as much use out of the fish as possible. So after the first initial test with the naive fish, then trying very carefully not to shape what they did, we repeatedly test them through a preference series. (next slide)

If you do a preference series, you see that these are four schools of yellowfin that were tested. That generally speaking, their preference is for the smell of opelu. The second most effective was the squid. Then akule, then krill, then nehu. Fortunately for us scientists, they have blanked control water, which didn't do very well at all, which is very reassuring. (next slide)

If you take that which I just showed you and actually put some numbers to it, we see that opelu, squid, akule, krill is better than nehu, which is better than control. Even though I had a preference hierarchy, statistically, I couldn't tease out the difference between opelu, squid, akule, and krill. But there is a difference between the smell of those four and the smell of nehu. Which is of interest I guess to the bait fishing because that's preferred pole-and-line live bait as you know.

But they fondly make up for what they don't have as far as smell for a fish; they probably make up for it in being very good visual stimulation. They flash; they are easy to catch. They are not easy to keep, but you can get a lot of them in a bait well.

So we showed that fish do respond to odors. They do respond to some better than others, in captivity. We tried to take this experiment and for some, to make it really sink in, to do some testing in the wild and in the ocean. We did this in Kona two summers ago around 'f' buoy. And in that instance, we put some of the best odors - opelu rinse and squid rinse into the water at the buoy and observed the response of wild fish

as they swam through that odor plume that we were putting into the water about 70 feet down. (next slide)

This is a little drawing of how it looked. We got our security blanket, the dark cage, like about 30 feet and at 70 or 80 feet, we had the effect of the odor came out in a stream, in a curtain. We looked at the responses of the fish as they went through the odor plume. (next slide)

This is the boat that we used. Some of you who may have been there last year may recognize it. It's the National Marine Fisheries Service boat. That's the old 'f' buoy there. (next slide)

This is looking up from the cage up to what's the bottom of the boat. On the extreme left-hand side, you can barely see the bottom of the buoy. (next slide)

Looking down after these tests were over, we put dye in the tubes so that we could see where the current had actually carried the odor over the preceeding tests. (next slide)

This was courtesy of Jerry Kinney of Volcano Isle Fish, Inc. One of our best trials in captivity. And one of the ones we used in the field was the brine from opelu brine in the icehouse. This stuff is good arouser for yellowfin tuna. There's no doubt about it. One of the projects we're currently working on is a way to dry this stuff and concentrate it for the average man on the water. (next slide)

Around the buoy, you got into a large school of opelu, a large school of skipjack. One of the ways that we could see the fish respond to the odors is when the pick the amount of turning. And the amount of turning would result in them flashing more in the sunlight. (next slide)

This is what a school of aku looks like when it's flashing. One of the ways we have of knowing that the fish responds is when the frequency of flashing from the school becomes more frequent. (next slide)

This is a mixed school of small shibi and opelu that was drawn into the hose when we were letting the odors out.

Okay, I'd be happy to entertain any questions about the odor stuff a little later on. I want to change spheres now and during the course of the next couple of days, I'll be real interested in shooting the breeze on that subject of what I am going to approach now.

On the side of the boat, we have planted a hydrophone, which is a key element in the project which I am now involved in collaboration with Rich Brill from the National Marine Fisheries Service and some other people. And that is tracking

the movements of the tuna around the F.A.D.s. I am not convinced that the F.A.D.s are detrimental. I am getting ahead of myself. I don't believe that it's been demonstrated that more fish get taken off the buoys than they would get taken any place else if there was as much effort spent fishing for them in other places. In order to get a handle on what influence of buoys or other natural floating objects is on the behavior of fish, there's no more direct way of doing it than actually catching a fish, putting a transmitter on it, throwing it back in the water, and following it around. And what that enables us to do is to get a feel for how far away the influence of the given buoy is. Also how much time a given fish spends there. Does he spend a couple minutes there and take off? If he takes off, how far away does he go? Does he come back? Does he just keep going? Did he spend hours there? And if he is there, how deep is he? The transmitters that we can put on these fish are pressure sensors. So when we go back to that lab and print the stuff out, we not only know if he went that way, but how deep he was when he went that way, and how many times he comes up close to the surface, if he turns around and so on.

We feel that we've developed through this little 'boat' which is entirely unobtrusive around the buoy because I can't see going fishing 'f' buoy on Sunday in the Townsend Cromwell fishing research vessel. You know, you'd only get in the way. But a small boat like this, we can be unobtrusive. We can operate at very low cost, and we can keep going back and chipping away at this problem. And the techniques that we developed over the last year or so we think are very instructive and we're just trying to crank the whole projects up onto a larger scale now. That hydrophone that sits in the water on this side of the boat looks like this in drawing underneath the water.

One of the things that we did after we bought the hydrophone is we made a little fiber glass bearing or shield that goes over the front. That one little innovation that we installed after we bought it from the factory has made all the difference to our ability to track fish. The reason is that it reduces the noise of water going over the hydrophone when we are tracking. So now we can still track at seven or eight knots which is about trolling speed for those of you who didn't know, and still, the noise coming across from the rush of the water is not loud enough to drown out the signal coming from the tag. So even if the fish decides to make a run on us, we can stay with it. And the more we do this, the easier we find it is to stay within reach of the fish. (next slide)

This is what a very small yellowfin tuna looks like with a transmitter on its back. This is about half the size of the smallest fish that we tracked so far. The transmitters put on an ultrasonic ping, which comes in through the direction of

the hydrophone, which goes into a tape recorder, which we then record all the information on it as to how deep he is and where he is and take that tape recording back to the lab and we can get the data off the tape recorder. Fish of really small size like this with a transmitter sewed on its back like that, swims perfectly well for weeks in our tanks. So we don't think that if a fish doesn't keel over right when we throw it in our water, and that's only happened once, that the transmitter doesn't really affect their behavior too traumatically. (next slide)

This is the track that we've started when we realized we had something to work with. This is the track of a fish that we caught at 'f' buoy at the same period of time that we were doing an odor study that we talked about. And this fish we caught right next to 'f' buoy at sunset, hand-lining - grabbed up on the boat, cover its eyes, keep it nice and still, put the transmitter on to its back. Over a 24 hour period, that fish traveled about 13 miles. That's about 10 or 12 times a yellowfin tuna, bigeye, this is the bigeye tuna. The remarkable thing was that having gone about 13 miles, the longest leg which was about 6½ miles, at sunset the next day, almost exactly 24 hours later, it was right back on the buoy. So we thought now we've got something we can really look at buoys and the way they affect the fish. And it was this track which spawned the project that we are having renewed again. So this remarkable piece of navigation was the beginning of what we are now doing.

We've moved our operation from Kona, where we didn't have a lot of access and support so we were kind of out on a limb, back to Oahu, where we have the University and the National Fisheries has a space of operations where we can go out on a regular basis. So the tracks that we are doing now are centered on the leeward buoys, on the Waianae coast of Oahu - 's' buoy, 'r' buoy, and 'b' buoy at Kaena Point. (next slide)

When we go to the buoy, and we fish it for two or three hours either trolling or handlining, and there's nothing going on, then we go and we fish the 50 fathom ledge where we can find fish of the same size that we find associated with the buoys. And by tracking the movement of the fish on the ledge, we have something to compare with tracks of the fish which we get from the buoys and see if there is any difference between the behaviors.

And this is a tracking by a 12 pound yellowfin that we picked up on this point on Oahu. We picked up on the 50 fathom ledge right here and at sunset, it was offshore just arrived overnight, this is midnight, just like it was going to 's' buoy which is about here, and turned inshore and by the next morning, sunrise, it was right back up on the ledge again. And that's where I had it for the rest of the day. We lost it

up by Kaena Point at the end of 25 hours by mistake. We went back the next two days, (next slide) and, no kidding, we find it again right on the 50 fathom ledge. Right where we had lost it two days before. That day it worked the 50 fathom ledge. I wonder where 'b' buoy is. At sunset again, offshore all night long, it came back. Sunrise, by the 50 fathom ledge again. We went to Waianae, had a shower, took out some sodas and went back out again. Next day, we were back again. Sometimes that's the way you feel out there. (Excuse me, which way is the current going?) The current on that track was running to Waianae. I want you to notice that this thing made a big circle around 'b' buoy. It looks to us that we do not have any evidence that the buoys affect the behavior of all of the fish. This is the third day's track. Again, it left the ledge at sunset, this time went offshore and came to 'b' buoy right over here and came back again. The time that our bottom finder hit the 100 fathom ledge on this day's track compared to the one 24 hours previously was one minute. So it seems that this fish knew knowingly where he wanted to be, at exactly what time of day he wanted to be there, how long it was going to take him to get to where he was offshore to that ledge. These fish are showing us remarkable navigational abilities. We also would never have had the depth that this fish is traveling. (next slide)

This is one of the ones of tracks that's of most interest to us at the moment. This is the fish that we caught at 's' buoy, threw it back in the water at five minutes after seven in the morning and over the next five hours, made an almost direct course so that nine miles and five hours later, it was right on 'b' buoy.

See, one of the things we wanted to get out of this research is how close together you have to put the buoys or how far apart you have to put them before they start sharing the same fish. The State of Hawaii as everybody knows, only has so much money. It would be nice to come up with an effective strategy for how many buoys to use and where to put them. This kind of information can give us exactly that kind of strategy. But we have to do it for all the species that are involved and for different sizes of the same species. The kind that we are focusing on right now are just the 10, 12, 14 pound size bigeye and yellowfin. But from this one track, it becomes obvious that nine miles is not much for fish of this size. And the amazing ability to go in almost a straight line from one buoy to another.

There is a couple of other interesting things about this track. Sunset, that even though he was on the buoy, same as the ledge fish, right offshore. And then overnight, he came back in, didn't make it to the ledge, looked like he was going back to the buoy and the tag went to the bottom. We were very upset about that that somebody's tag fell off. But it's

getting us a real good idea of the movements of these fish. We've caught very small sample size at the moment, but we hope to increase.

The other thing that answers the question about the current, the current on this day was running to Kaena Point. The fish we have small scale movement, not just large scale movements for this fish as well. This fish spent 85 to 90% of the time that he was in the vicinity of the buoy, on the up current side of the buoy. (I'm just wondering if these depths are fathoms or feet.) These are fathoms. This is 50 to 100 fathoms. Fathoms start about here some place. (next slide)

We also have depth data. And this I think is going to be particularly pertinent to the handline and the longline fishery people in Hawaii. This is the track of a bigeye tuna that we caught in Kona. You can see his traveling depth here is about 200 meters. This is 600 feet, which is at day time. One of the amazing things about this fish and the bigeye tuna that we brought since this one, is that every hour, on the average, almost every hour, it makes a big excursion up close to the surface and back down again. And in an hour later, they do exactly the same thing. An hour later, the same thing. Twelve times in twelve hours of daylight. The bigeye fish that we caught next to 's' buoy a couple of months ago did exactly the same thing. But the information that we are getting is that these fish spend a lot of the time at one depth. So if you're targeting your scent, you want to intercept the fish where he's most likely to be. This kind of information is going to be very important. The yellowfin tunas are closer up and both of them, whether it be a bigeye or yellowfin, change the depth at daytime, which this is, shallower at nighttime. And we also know where they are at that way, at night.

We've only just started this project, but these kinds of very precise movement data between buoys, around buoys, how far a buoy can reach its influence, and how deep are the fish when they get there. I think this is going to allow us to get a real good idea of how to work the buoy system. And what we want to do is expand the project to not just look at yellowfin and bigeye, but to aku when they are on the buoys and the mahimahi that are on the buoy. So we can come up with a multi-species picture of the way these different members of the pelagic community use the floating object. And I think also that this kind of information can tell us just how important the buoys are to these species. Are there really more there or are there just more people there? By asking and following the fish around, you think though, we can find that out. (next slide)

This is bigeye tuna that in the space of one minute, dove, for reasons we don't understand yet, from 150 meters to 380 meters in a minute. That's about 700 feet in a minute. And this fish is about this long. So that guy was hauling. And

he was going down. He was either chasing, I can't tell what he was doing, but he was either chasing something or something was chasing him.

This kind of quality data, nobody else in the world has this kind of stuff and we are hoping to apply that to practical problems that our fishermen in Hawaii are facing.

I'll be happy to take any questions.

Question: (re: fish aggregating buoys)

Answer: Well, we don't really know. There are buoys where people can handline for bigger fish. It's to protect the more patient and put their lines back. One of the things that we want to do is to go looking at bigger animals. And it very well be that these buoys are working for the bigger fish the same way they are doing for the 10 pint size, but the effect is going on down below. And there is only one way to find that out and that's to attract one or two or more and see if their behavior is similar or different. There's no doubt that there's a lot of smaller size yellowfin taken on the buoys. There's no doubt about that. What I'm saying is that we have fish that occur, ledge fish which occurs right in the area of the two or three buoys and over six days, he never went to one of them. On the other hand, we've got fish which we do catch on the buoys, and keep going back. I'm not sure that if you didn't take all those people fishing 'f' buoy or fishing 's' buoy and put them on 50 fathom ledge that they wouldn't catch as many fish. I'm not saying that that's true. I'm just saying that it's still open for debate.

Question: (re: fish behavior at buoys)

Answer: I think that what these fish at the buoys are doing is using it as part of a home range. They patrol and part of their daily patrol is next to the buoy. I think some of the fish habitats in Kona may be places where the fishermen have found that happens to be on a regular circuit that the fish run and they know that if they stay over that place long enough, the fish would come through there. We'd like to do that. If we had our druther, we'd get this tracking cranked up and it could go for years. And there's all kinds of problems that we've addressed. Like, where do the fish go, when they don't stay in Hilo, you know, or is a fishing site just an intersection of a bunch of different laps that a bunch of different fish are moving every once in a while and they intersect? And right there if you fish, your chances of catching one may be much better than if you catch in anyplace in general. There's all kind of questions that we can address.

Thank you.

TUNA PHYSIOLOGY

Richard Brill, Ph.D.

National Marine Fisheries Service

The first thing you want to know about tuna is that they are very active, very high energy demand animals. And that's reflected up there where it says metabolic rate. The standard metabolic rate is the metabolic rate of the tuna just sitting there. It's an artificial condition but we have measured metabolic rate in that area and under those conditions and the active metabolic rate. We don't measure metabolic rate in terms of the energy the animals use. We measure how much oxygen they consume - the idea of fire and light. It takes oxygen to burn up energy. So by measuring the amount of oxygen an animal consumes, you measure its metabolic rate. You can't see it in this column, it says tuna in this column and other fish. Sort of with other active fish like trout. First thing that you notice is that tuna's metabolic rate, its energy demanded is several times higher than other fish. Many times higher than a trout or salmon or fish of equivalent size. So it has a high energy demand that's reflected in the rest of this physiology as this slide shows.

So if an animal has a high metabolic rate, it has got to deliver a lot of oxygen to supply and meet that metabolic rate. So tunas have very large gill surface areas so they can take a lot of oxygen very quickly out of the water. The other thing is post utilization and transfer factor - just shows that tuna gills are very efficient in transferring oxygen. They have a high cardiac output. It's not enough to take the oxygen out of the water. You have got to deliver that oxygen and substrates, glucose to the muscles where it's being metabolized.

So you have to have a very high energy, high efficiency cardiovascular system. That's shown here that tunas pump a lot of blood because they have to deliver a lot of oxygen to their tissues. If you're going to deliver a lot of oxygen, you've got to carry that oxygen. The oxygen is carried within the red blood cells on the hemoglobin. Tuna have to move a lot of oxygen to their tissues. They have a high cardiac output. They also have a lot of red blood cells so they can pick up a lot of oxygen and they can deliver it to the tissues. Large blood volume, large O_2 carrying capacity of the blood.

So if you're going to burn up a lot of energy, you've got to eat a lot of energy. You've got to eat a lot. Tunas can eat up to 15% of their body weight per day. Other fish

can generally only eat 3 to 7% of their body weight per day. In order to do this, you've got to be able to digest your food very quickly. When a tuna eats a meal, it can digest about half of it in five hours. With other fish, it may take 5 to 20 hours to digest half of it. So tunas, as I said, are high energy animals.

Here's something that I think you'll be interested in because it relates to the burnt tuna problem. This is maximum white muscle lactate. When you exercise or sprint or run the 100 yard dash, you get out of breath. What you've done is you created a lot of what they call lactate or lactic acid in the muscle. That's because you can't supply enough oxygen to meet your energy demand when you're working at a maximum. That shows up as lactate.

Tuna live in an environment that we call, an environment where you can run but you can't hide. Their only escape from predators is to just swim flat out. Anyway, they catch prey not by stealth, they do not sneak around or crawl away like reef fish, they just blast up and grab it. So these fish are designed to be able to sprint. Not only can they go long distances using up a lot of oxygen, they are also very good sprinters. And that shows up because they can build high rates of lactic acid. I'll talk about this; it'll make more sense later on. The main thing is since they live in an environment where you can't hide, when reef fish is chased or flatfish or a bottom fish, it will go into a hole or bury in the sand and do whatever it has to do to rest and be quiet for several hours to repay what we call the oxygen debt. In other words, to metabolize, to get rid of this muscle lactate. Tuna don't have that option. They've got to be ready to go at all times. So they generally have a lot of lactate, but they get rid of it very quickly. They can metabolize it to take it out of the muscle and get rid of it in about one or two hours, where other fish take eight to twelve hours. So this is pretty remarkable. They generate a lot of lactate and they get rid of it very quickly. (next slide)

The other thing that's obvious about tunas is they are very, very streamline. They are both elongate and oval in shape. Sort of like a stretched out egg. That's a very hydrodynamically efficient shape.

The other thing that's unusual about tuna is that their fins fold flat. There's a series of what we call pelvic fins here, you don't even see them, they are folded flat right up against the body. There is a dorsal fin here. It's the first dorsal fin. You don't even see it. It's folded completely down into a groove. If you look closely, you see that there's a groove right here. This is the animal's pectoral fin. It folds flat right into the body. When they want to move out, they can fold those fins and make themselves very hydrodynamically efficient.

The other thing that's sort of interesting in these guys, the little yellowfin tuna, these are called finlets. They are not like other fins. They are like flags on a post. They flip back and forth as the animal swims. They are not passive structures. The animal actually controls the movement of each one of these fins. The next time you get an ahi on board, he's still in pretty good shape, watch his fins. You'll see him flip back and forth.

They swim through a bigger angle down here than they do up there. And what we think they do and we're not really sure of this, is act as float fence. In other words, as this animal swims through the water, swinging its tail, these animals direct water flow very efficiently over the animal's tail by swinging it back and forth. That reduces the drag and enables these animals to move at high rates of speed but still use the minimum amount of energy. So these animals are very, very well adapted for their environment. It also makes it very interesting physiologically.

This happens to be mahimahi. The reason that I put this slide in is to illustrate that tuna don't swim like other fish. Look at mahimahi. They control their body to a complete "C" shape. They also sort of snake through the water. They make a lot of sinusoidal movements as they swim. Their whole body participates in this swimming motion. (next slide)

This is a yellowfin tuna in one of our tanks. It's a little difficult to see because it's not dark enough in here. I want you to look at the yellowfin. I want you to look at its shadow. I don't know if you can see this. This is the shadow made by this animal swimming. Unlike the mahi that you just saw, this fish is perfectly straight from his nose to the second dorsal fin. A perfect straight line. It's narrow in back and he make a big angle. So these animals do not flex their whole body. This mass of muscle that makes up the tuna is held rigid, and its tail swings back and forth. That's supposed to be a very efficient way of swimming. Very efficient hydrodynamically. (next slide)

Okay, this is the most unusual thing about tuna. And it's very characteristic of this group. And it has very practical importance because it may be one of the bases for what we call burnt tuna. I really came up with that name, but it's really spa.

The circulatory system in fish acts like a car's radiator with reference to heat loss. So when the blood passes through the gills, it picks up oxygen and it cools off. So the blood becomes the same temperature as the water in which the fish is swimming. This now cool oxygen - laden blood goes back to the muscle. It loses its oxygen which allows the muscle to metabolize, to produce heat and produce motion, lets

the animal swim. It loses that oxygen, picks up carbon dioxide but also picks up heat. The blood comes back, now warm, goes through the heart, goes back to the gills. It loses its carbon dioxide, picks up oxygen and loses its heat. So now it's cool again. So what this shows in fish other than tuna, heat production in the muscle and heat loss at the gills are latent processes. It doesn't matter how much blood he pumps around or how hard he works his muscle, he is going to produce heat here in the muscle and he is going to lose it at the gills. That means fish other than tuna on a sustained basis cannot be warmer than the water in which they're swimming. I can show you the mathematics of how it works, but it's not all that interesting. It's absolutely true but there's no way it can be different.

Tuna on the other hand, have developed some very unusual circulatory system anatomy. What they have is what we call a countercurrent heat exchanger and I'll show you where that exists in tuna in a little while. You have the cool blood coming back from the gills, flowing through a little set of tiny blood vessels that are closely opposed to a set of blood vessels that are carrying the warm blood coming back from the muscle. So that means that the warm blood here coming back from the muscle flows through these set of vessels, exchanges its heat to the blood that's flowing back to the muscle. So this acts as a thermal barrier. So the heat carried in the blood produced here goes over what we call the veinous side to the arterial side, back to the muscle. So these fish have uncoupled this heat production-heat loss relationship. These tuna can be up to 20° warmer than the water in which they swim in. That's especially a problem for an animal that's struggling on the end of a line. They can get very, very warm. (next slide)

This just recently is a cross section of a tuna as you're looking at it end on. And I'll show you where these systems, these countercurrent heat exchangers actually exist. This is yellowfin tuna, kawakawa, aku, and bluefin tuna. The heat exhangers are right here. This is the vertebral column, the spinal column. This post portal vein is the vessel carrying blood coming back from the muscle. The dorsal aorta is carrying the blood coming back from the gills. So the cool blood comes back from the gills, goes through this heat exchanger, picks up the heat that's being produced by these muscles. So the blood in these two vessels are about the same temperature. And what they keep warm mostly is this red muscle here. That is the one of the anatomical positions of the heat exchanger. The other position is right here, we call the lateral heat exchangers.

The other thing you have noticed, I'm sure, is that fish have dark and light muscle, or as we call white and red muscle. Red muscle is used for sustained swimming. White

muscle is used for high speed swimming. This is the muscle that's served by the countercurrent heat exchangers mostly. This is red muscle. That's the muscle that gives the most warmth. White muscle doesn't give very much. I'll talk about that a little more later. (next slide)

This is an actual anatomical descript. I don't have to label the points. This structure is right under the spinal column. So the dorsal aorta carrying the cool blood coming back from the gills. This little tiny net of vessels, so that blood goes back up and then goes to the muscle. It picks up the heat that's being carried by the blood as it's draining out of the muscle. So the heat goes from the arterial side to veinous side and that's how the fish keep themselves warm. (next slide)

These are little lateral heat exchanges. I just put this in to show that these vessels are very, very tiny. These are about the thickness of a dime in diameter of a large fish. So these are very, very small. You can't even see it with the naked eye. The reason of that is it gives them a large surface to volume ratio which makes them very efficient in exchanging heat. (next slide)

What are the advantages of this? Why did the tuna evolve this fancy countercurrent heat exchangers? What does it do for them? That's a very good question. Unfortunately, I don't have a very good answer. One of the things we think it does for them is to give them what they call a thermo inertia. If you saw in Kim's slide that the fish spend a lot of time going up and down the water column. Besides keeping themselves warm, this specialized circulatory system when a fish dives down in cool water, it makes it cool more slowly than a fish that doesn't have this specialized circulatory system. This happens to be a bluefin tuna. And this kind of transmitter that was measuring water temperature and the fish's muscle temperature. So the fish at this point went from a water of about 20° to 5°, dove down into cool water. But his muscle temperature didn't change very much. This is because one, it is a very large fish, and two, this countercurrent heat exchanger gives the fish a good thermo inertia. In yellowfin tuna, it operates just about the same. (next slide)

Some of the things we're doing at Kewalo Basin to study this and how exercise and activity affects muscle temperature in tuna is to take a tuna, put a little transmitter on it and it puts out a series of beeps. The warmer this point of the transmitter is, the faster it beeps. So we take the fish, stick it and put this little temperature sensing device right next to the spinal column, right in the red muscle, right in the warmest part of the fish, shove it back in the tank and chase them around till exhaustion. That means

either till the fish is exhausted or they guy who was chasing them is exhausted. Whoever is exhausted first. (next slide) I was just going to say that the transmitter, the temperature sensing device is right here, right in the red muscle. (next slide)

This represents the change in temperature with time. This is in seconds. And this is temperature. Fish that are being chased, there are nine different fishes being represented here. Nine different yellowfin tuna. Some of the temperature measuring devices was in the red muscle, the warm part of the animal and some in the white muscle. What you can see is as soon as you begin to chase this animal and it begins to exercise, water temperature is about 24°. His red muscle temperature jumps up dramatically. It only takes two or three minutes before it gets up to 20°. This is in Centigrade. In Fahrenheit, it would be about double. That's about 15° warmer than they would be when the animal started. This may be the basis for the burnt tuna problem. Maybe. Maybe one of the problems. It's something we've been looking at. (next slide)

What are the unusual things about tuna? I will get my notes so I can get these right. Okay, so that's one of the things how tuna's physiology can affect product quality. I'll talk a little bit about this tuna's physiology and how it reflects distribution in gear vulnerability. This is a cross-section of the Pacific Ocean, from about the equator to about 20° north, which is about the latitude of Hawaii. And it is an area off Baja, California. This shows the different oceanographic conditions.

Tuna as I said, are very high energy demand animals. They have a very high oxygen requirement. They cannot live in water that contains less than 3.5 ml per liter oxygen. In other words, as you go deeper, most of the water tends to get cooler and there also tends to be less oxygen in it. And at this point, tuna cannot live below this oxygen level. That forms the floor of their habitat. They cannot live any deeper because the water is too low on oxygen. You can see that 3.5 level changes as you go.

The other thing about tuna and this happens to be for skipjack, they cannot live in water any colder than 18° Centigrade, which is about 64° Fahrenheit. So the low oxygen level and the cool water forms a floor. No skipjack in this area can live below this level. So what this means is that in this area, the skipjack were forced up very shallow. In this area, skipjack tuna have to live in the water that are no more than about 60 feet deep. That means in this area, this is where tuna are vulnerable to purse-seining. So if purse-seining hangs down below what we call the "stomach line" in the deep water where it's cool or not

enough oxygen, that forms a floor on a purse-seine and that's why purse-seining is successful. Areas up around 20°, you see how deep it is. It's down around 300 feet deep. Once you've got a deep purse-seine, nothing will catch tuna in this area on purse-seines. It'll simply go out to the bottom. That's what's kept the purse-seiners out of Hawaii; our thermocline is too deep here.

This is a more complicated point now. The tuna tend to overheat when they exercise. That problem gets worse as they grow. So as skipjack tuna grow, they have to live in cooler and cooloer waters. So for an eight pound skipjack, they have to live in waters that are 26° or cooler. Twenty-six degrees is about 79° Fahrenheit. So in this area, an eight pound skipjack has access to the surface here or here, but not here. Because the water up here is too warm for the animal to live. That means in this area, these fish are not vulnerable to any sort of surface gear. Because they have to live down here where it's cool. Now when the fish reach about 18 pounds, they have to live in waters that are 22° Centigrade or less. That's about 72° Fahrenheit. That means if you're looking for larger skipjack, you're not going to catch them on the surface here at all because the water is too warm. But you will catch them here where the cool water reaches the surface.

The other thing that happens and that we find very interesting is that the floor of the habitat where large skipjack tuna has met the ceiling for an animal that's about 18 pounds. In other words, in this area, there is no water in which that fish can live. If it goes too deep, there's not enough oxygen. If it comes up, it's too warm. So the skipjack of a larger size have access to the surface only in this area, and cannot live in this area at all. So the physiology determines distribution and that determines gear vulnerability. (next slide)

If you take this concept and put it on a Pacific-wide basis, this is for skipjack tuna about 13 pounds in size. No skipjack tuna can live out here. It can live outside here. It's simply too cold. The 18° water comes all the way up to the surface. No skipjack can live there. In this area, this largest fish has access to the surface. It's cool enough up towards the surface. In this hatched area, a 13 pound fish can live, but cannot be caught by surface gear. Because the surface water is too warm. So that's close to the Pacific.

When you get to areas off Baja, you get to the problem of large areas where the ceiling has met the floor and there is no place where this fish can live. These are absolute barriers to skipjack of that size. They simply have grown out of their habitat. Skipjack of that size cannot live in

this area at all. They can live in this area, but do not have access to the surface. And therefore, not vulnerable to surface type gear. Here they can live and have access to the surface. Although they are more vulnerable to surface type gear here. This explains a lot of skipjack movement that we have seen in that skipjacks can spawn here, migrate this way, and grow and once they get a certain size, leave and come back. What we think that's happening is the animals reach a certain size, they have simply grown out of their habitat. The fish that do not have this fancy countercurrent heat exchanger do not maintain warm muscles, do not have this problem. The tuna are unique and their distribution is unique for this reason. (next slide)

This is a little bit more complicated. This is the problem we're working on now. It's relevant to the burnt tuna problem. Remember I said that tuna generates high lactate levels? This is basically what happens to the muscle. when you metabolize glucose, that's the substrate, the energy that you burn up. If there's sufficient oxygen around, you know you are exercising slowly, you've got enough oxygen, your cardiovascular system can deliver enough oxygen to your tissue. It metabolizes this glucose all the way down and produce carbon dioxide and water which you exhale. No problem. Exercise like crazy like running the 100 yard dash, whatever, you now bring up so much glucose that you cannot supply sufficient amount of oxygen. But you still need to produce energy in your muscles. So what happens then is that the glucose is shoved off into this pathway. This is what we call lactic acid. And it's exactly what it is, it's an acid. Lactic acid breaks down into lactate plus proton. Proton is what an acid is. The hydrochloric acid you put in your car generates chloride ions and a proton. So this is how acid is defined. That is what we mean when we say acid. It's a chemical that breaks down and produces a proton.

This may be the other problem. The other causes of burnt tuna. The muscle becomes warmer when the fish exercise. It becomes warm and warm becomes acidic. Now tuna produce very high levels of this, which means they produce very high levels of that. That's a problem we're beginning to look at now to see how the tuna produce it and after they exercise, what do they do with it. We have several investigators from Japan and Canada that are studying the effect of this, the proton and where that goes, where that goes in the blood, how the animal takes care of it. And the fate of this product. Because eventually, it's reconverted back into glucose or metabolized back to the CO_2. So burnt tuna may be related to that.

A side problem from this is something called honeycombing tuna which is referred mostly to canned tuna. We think that's related to a product called histamine. Now tuna have

a lot of products and a very similar chemical called histadine in the muscle. The reason why we think they have a lot of histadine is because it absorbs this product. We think that's what histadine does. We have high levels of histadine that we can breakdown if the animal is not handled right into histamine, which causes honeycombing in the tuna.

To get back to my original point, you have to understand the physiology of animals if you're going to talk about product quality, you're going to talk about distribution, you're going to talk about management. You really have to understand the animal. I think that's the last slide.

This is one of the lactate experiments we're doing; the animal has got several of its blood vessels, (it's anaesthetized) with these tubes. So we can exercise it, put it on the table, stick these tubes into its blood vessels, and take successive samples. It's the kind of work you can do on tuna when you have them in captivity. Which is the reason for having the Kewalo research facility because it gives us access to animals so we can do research and experiments on them. I think that's it.

Thank you very much.

F.A.D.S AND TUNA MOVEMENTS

Richard Brock, Ph.D.
Sea Grant Fisheries Specialist

My project really began when the State (of Hawaii) put out the first Fish Aggregating Devices (F.A.D.s), that was in the spring of 1980. My objectives were to define how and why the Fish Aggregation Devices work. I guess in short, you could say that the goal is to gain an understanding of how the system works. So perhaps we can improve upon and maybe manage the system a little bit better.

Well, how do I accomplish my work? I spend a lot of time in the water out there around the Fish Aggregation Devices or at least I try to.

One of the things I do is I've been following the recruitment of fish to buoys (F.A.D.s). This tell us how fast the populations build up, how big these populations can get and how long an individual fish may stay around a buoy.

Another thing that I do is I attempt to design experiments to understand what makes the fish aggregate. I hope to be able to understand this someday.

An offshoot of this work is that perhaps we may be able to get information that will be needed to make the buoys more attractive to fish. Maybe we don't want that, but in the past, that's something we've wanted.

Another thing that I do is that I look at what fish feed on, around and away from the buoys. This gives me an insight as to where a particular species is in the total food web and it allows me to see any changes that may occur in food habits.

My information then comes from the Division of Aquatic Resources' catch reports. This has been very helpful. But most of it as I said, comes from field work, by fishing, by diving around the buoys and by setting up experiments.

I think this is a good place to simply say that by doing work around those buoys is logistically very difficult. For those of you that fish are probably well aware of this. It's frequently pretty rough. The fish move over very, very large distances and they can move very fast. There is also problems with diving, it could be rather hazardous at times.

Well, what have I found out? What I'll do is I'll quickly just discuss some of the things that may be of interest to

fishermen. To begin with, this is not my own information. This comes from the Division of Aquatic Resources. They estimate that the 25 buoy systems that we now have, help fishermen land an estimated 655 metric tons a year. Now, according to the members that we just saw a little while ago up on the screen that Dr. Klawe showed us, 655 metric tons isn't very much. But it's substantial when you look at our total reported State landings here for Hawaii. Our recent reported State totals are under 4,000 metric tons, if I'm not mistaken. So 655 metric tons is a fairly significant amount.

Another thing is that our buoy catches that we make here are very similar in composition and in amounts, if you will, to those that are made around buoys in other South Pacific localities using the kinds of techniques that we use here. So what we see here around our buoys are essentially the same thing you see around buoys elsewhere in the Pacific.

In my monitoring around the buoys, I found a large number of fish species that will usually occur. This list is by no means complete. I want to point out here that if you go down the list and start to look, there are a number of inshore species showing up. These are coral reef fishes that show up. I think there is nenue, mamo and weke. These are all forms that usually occur inshore. But when they are in the buoy community or the buoy fish community as I call it, they're just newly transformed juveniles.

The fish recruit to these buoys very, very quickly. The first species may arrive in about 15 minutes. Recruitment usually begins with what I call the small prey species. The biomass or the total fish weight usually goes up very rapidly, usually within three or four weeks and reaches some sort of carrying capacity, if you will. The top of that peak, the asymptote, can be anything from a couple of hundred kilograms, depending on the buoys and the season, to many, many metric tons of fish. Beyond that point, it tends to fluctuate, primarily due to the presence or absense of tuna schools.

Some of the species in the buoy community will stay there as what I call residents, these are fish that usually remain for a week or more in the vicinity of the buoy. Some of the residents include the yellowfin tuna, particularly the small ones, the shibi-ko, and mahimahi. Other species just pass right through and as far as I know, include such things as the billfishes.

One of the other things that we've managed to find out is that if you look at the total annual catches from a particular buoy site, and these are total annual reported catches now, we find that the buoys that are further offshore have greater catches. The bottom axis is the distance in miles from the buoy to the 1,000 fathom isobath, the 1,000 fathom line. In

other words, the data points that are on the left hand side of this graph, represents those buoys that are close to the 1,000 fathom isobath that are further offshore. As you approach shore, the catches drop way off. Why is this? It may be possibly due to greater food resources around the deeper set buoys or perhaps those buoys by being further offshore may be in closer proximity to the normal migration paths of the fish as they move by the Islands. This we don't know yet.

Why do fish aggregate around floating objects? I have a lot of people ask me this question and I've spent a lot of time floundering it. I can just say, to begin with, there is no one single simple answer. There has been numerous hypotheses put forward as to why these fish aggregate. In general, I can make a few comments. In general, small juvenile fish and what I call bait species, these are real small things, recruit to the floating object. This can either be a buoy or a log. They recruit to the object very quickly. They use it as shelter to escape predation. This is what it appears for the small ones, if there are predators about. If there are no predators, they may use it as a point of orientation, feeding out away from it and coming back to it. So without predators then, it's more of a point of orientation.

With time, the large predacious fish, these larger predators or big carnivores if you will, will arrive and they take over residence around this floating object for a variable period of time. The large fish initially feed on the small fish keeping their population level low.

Irrespective of whether there's big predators there or not, there is a continual recruitment of these prey fishes seeking the shelter offered by the object. So, for a predator it's advantageous to hang around where the food is coming in. It makes it sort of easy to catch your food. But once the floating objects have been in the water for a while, you get a very, very large standing crop or biomass, if you will, of predators. Then there isn't enough food to support them right at the buoy so they use the buoy or the floating object, I'm using these interchangeably now. These predators will roam in and away from the floating material usually to return. In this case, the floating object then is again serving as a reference point. And this reference point, if it's a log, will be carried in one direction in a current system. So it's a unidirectional movement. Therefore, predators, I'm surmizing now, that's associated with a log or floating object that's moving in one direction is much more efficient in his food search because he is moving on one direction rather than randomly through the water column. Otherwise if he was not associated, he would be moving randomly and run a greater chance of circling through the same water that has been previously searched for food. So this may be one of the reasons why these fish associate with floating objects.

In summary, if asked why fish associate with a floating object, you might say that or I would say that, the presence of potential food or prey species, as well as having a unidirectionally moving solid object are probably two major reasons why these larger fish will aggregate around a floating object. Now in the case of a buoy, it's the same thing but it's anchored and the current moves by. So it's advantageous to stay somewhat in the vicinity of the buoy and use it as a reference point because the current just moves by replacing the food materials, if you will.

Well, in the usual situation, the prey fish around the buoy or around the floating object are not abundant enough to support the predators, such as the mahimahi and the tunas. And this is probably why when a fisherman finds a log, the fish bite real well. A logical next question that you might ask the biologist is what is supporting all of these predators if we know that they are residents, if they are indeed hanging around this particular object.

Most of the biomass that will occur around the floating object is made up of tunas. They are the most important part of it. And when I say tunas, I am speaking primarily of the aku, the ahi, and the bigeye. Aku evidently, feed on just about everything. This is from stomach content work. Either or both are from around buoys and away from buoys. They seem to take whatever is there. It appears that the individual aku schools do not stay for too long of a period around the single buoy or floating object. With the yellowfin or the ahi, it appears that they may stay around for weeks. When they do, they seem to switch their feeding habits frequently to take in deep sea caridean shrimps. These are red shrimps. Some of you may have seen them if you fish the buoys. These are of the genus Ophlophoras. It seems to be a very common occurrence with buoy associated yellowfin. It's same thing with the bigeye that are associated with buoys or logs. Well, what they apparently do is stay around the buoy, probably using it as a reference point, as I suggested earlier, and they move out many miles away feeding and then returning. I think Dr. Holland will be describing some of these movement patterns, how they go out and come back. So that would tend to support some of this hypothesis.

Okay, the ancestors of our fish aggregation devices were first built in the Philippines and they still are. This is a rendition of what they call a payao. It's made of bamboo and coconut palm fronds, as you can see. According to the fishermen, they say a very important part of this are the palm fronds. Now this sort of fish aggregation device would not hold up here in Hawaiian waters and would break apart very rapidly. But it's interesting to note that the palm fronds seem to be a very important component. One of the thoughts is that these palm fronds may serve for shelter for

small fish and presumably, if there's more shelter for small fish, they can dodge away from the predators. In other words, avoid the predator. If there is more of them, that may be more of a visual stimulus for the predators to stay in the vicinity. I guess that this system seems to work but I don't know because we don't have anything quite like it here. In Hawaii, there's been very little research on the role of shelter beneath buoys, its effect and its role.

I've begun some initial preliminary tests looking at commercially available shelter types hung beneath our buoys. What this is, it is called a parasol. The top or the apex there, is what is attached to the buoy. Usually it's put on the anchor chain and coming down from the apex are four fiber glass rods with nylon net stretched over it. This thing then, when it's in the water, close up horizontally with a mouth of it, if you will, sort of floating up horizontally. For scale, it is only 5 to 5½ feet high if you want an idea of the size of it. So anyway, I've begun some tests looking at the effect of shelter, presumably the effects of shelter beneath this aggregation devices.

Now, I have some very preliminary data. I just want to make the point that this is extremely preliminary. What I've got here and I know this is kind of hard to follow, is the catch per unit of effort shown on the left hand side. Now I'm using catch per unit of effort as a measure of fish abundance. That may not be totally true, but presumably if there are more fish there, they are easier to catch, you can catch more fish. If there are fewer fish, you catch fewer fish. Anyway, I've got catch per unit of effort on the left hand side and then on the bottom axis, I've got time and days. And this particular graph starts back about early fall, this last fall, goes through winter and ends in about March. And what I want to point out is that the solid line on there represents the catch per unit of effort around one of our fish aggregation devices. This is taken on one boat now. That solid line represents 'w' buoy which is located off Laie point. And then the big dotted line or dash line represents the catch per unit of effort at 'u' buoy which is about 10 miles to the south of Kaneohe Bay, over the same period of time. And then that little dotted line at the bottom is the catch per unit of effort in what I call control areas, 4 or 5 miles away from any buoy. I placed two of these parasols, if you will, on 'w' buoy on point A. You can see a point right there and that was on the 26th of December and you know for you fishermen, you know what tuna catches are like at that time of year. They are generally pretty low. The catch per unit of effort went right up just immediately after that, within a couple of days. It stayed up there for a short time then it came back down, it crashed back down sometime after the high point. And the reason why it crashed is that my parasols broke up.

They were designed for use in calm Carribean waters, not rough Hawaiian waters. So they broke up and I took them off at point B. That's where I actually removed them. Well anyway, I want to just stress that this is very preliminary data.

This is an example of a slightly larger model underwater with a couple of divers on. This picture was taken in the Carribean. Well, why do they work? I mentioned this business of shelter. The Filipino fishermen seem to think that in the Philippines, the sheltering effect allows the small fish population to build up. I didn't see any change in the resident population of small fish in the short period of time when I had these parasols up. However, one thing I did see is that under a strong current situation, these parasols would resonate and vibrate and make a fair amount of low frequency noise. There has been a fair amount of work done at the National Marine Fishery Service, a number of years ago in Honolulu to show that yellowfin tuna respond very nicely to low frequency sound. So there may be something there. Perhaps it's low frequency vibration, I'm not sure. Anyway, this is an area that I hope to be able to pursue over the next couple of years and this role of shelter as a whole range of different types of shelter that I'd like to look at.

Well, what is the future of F.A.D.s here in Hawaii and elsewhere and yellowfin in the Central Pacific in general? This is a question that's been frequently asked. I guess since the last State Legislature there was a bill proposed. There's been a lot of flack fly about, a lot of questions and very few answers. I can't possibly give you all the answers, there is no way. I don't think there's anybody who could. But I have some interesting little tidbits of information I kind of like to share with you. And I'll just sort of leave it at that if you will.

This slide here shows the expansion of the Japanese longline fishery. These are all taken from other publications, none of my own work. Okay, those dark lines indicate the year. So this started in 1948, the Japanese longline fishery was fishing in that area and it moved on through into the 70's, to the mid 70's. The longline fishery, as you probably all know, fishes for adult yellowfin and bigeye. We're concentrating now more on the yellowfin, or at least I am at this point. All I wanted to say in this particular slide is look how the fishery expanded. So it's fishing for the adults that live in the deeper water layers of the water column. The small juveniles tend to be off in the surface or closer to the surface and are taken in the surface fishery.

This next slide is catch per unit of effort information from that longline fishery. This is based on Japanese data. Now, what we've got on the left hand side is the catch, and down along the bottom there is the fishing intensity or the

effort, if you will. There are two major groups of data points. There was an early group of data points and a later group. The early group is on the left. What I'd like to just point out here is that if you interpret this graph the way I do, in that first set of data points, with a little bit of increase in effort, you got a much bigger increase in catch in those early years. But as time went on in the second area here, it took a large increase in effort and very little change in catch. This sort of suggests that something is going on in the longline fishery, well at least with the adult yellowfin. According to some of the literature I've read, it's been suggested there by the mid 1970's, the fishery was probably something close to or maybe over maximum sustainable yield. That was mid 1970's.

Fish aggregating devices attract mostly small yellowfin in terms of the yellowfin tuna. Not too often do they attract the large fish. These small fish are apparently in the surface water and as I said the adults tend to be deeper. It's been estimated in one recent publication that there are more than 1,000 fish aggregation devices in use in the Pacific and Indian Ocean today.

Many of these fish aggregation devices are fish with purse-seines that are catching large numbers of juvenile aku and ahi. In this slide here on the left, that is what I want to key in on. This is just sort of a schematic of what a purse-seiner looks like. This is simply a large net that is used around floating objects or an open school of fish. And the bottoms close up, it's pursed up and thereby entrapping the school. Anyway, this fishery has expanded quite a bit in the last few years. And I've heard, I don't have any proof of this, but I've been told that the Philippine payao fishery has essentially collapsed. This is what I've been told. They use purse-seines extensively, very extensively in that fishery. It's my understanding that they were taking yellowfin that were just 6 or 7 inches in length which are pretty small yellowfin.

There was some mention a little while ago, I guess Dr. Klawe mentioned the South Pacific Commission or somebody did. The South Pacific Commission is a non-political entity. It has 23 member countries and it covers most of the Western and Southern Pacific. If you think of the Pacific Ocean, the South Pacific Commission area encompasses just about everything except for Hawaii, Australia and New Zealand. One of the things that they are in charge of doing is improving the economic opportunities of the member countries and consequently, they've put quite a bit of effort into the fisheries and fisheries development. Over the years, they've had a large program looking at both skipjack and yellowfin resources in the South Pacific Commission area. To do this, they have tagged a large number of fish primarily skipjack,

but let's concentrate on the yellowfin. They tagged roughly 10,000 yellowfin. And they recovered 390 of these fish. From this mark and recapture program, they estimate the resource to be between 150,000 to 1,000,000 metric tons. Now that's the total weight of the yellowfin resource.

Now some other little interesting bits of information. In the South Pacific Commission area, there has been a purse-seine fishery developed. In 1978, there were 12 boats. Now these boats, primarily in the early years, fished on logs, just open floating logs or debris and ran their purse-seines under the logs and caught the fish. The 12 boats in the fishery caught 30,000 metric tons in 1978. Now remember our old fishery here in Hawaii is reported to be less than 4,000 metric tons. By 1982, they've gone to 62 boats and they caught approximately 200,000 metric tons. They are really getting up there. In 1983, they estimated 300,000 metric tons. The percentage of yellowfin in these catches range from 30 to 50%.

The one thing that I'd like to leave you with is from the words of Dr. Kearney, who's in charge of this program. He said that longline catches have gone down in the areas where the surface purse-seining fisheries have been operating. This is kind of interesting. So I personally feel that it doesn't look too good for yellowfin in some of these areas if they continue with the high fishing pressures they have.

EL NINO AND TUNA

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Ladies and gentlemen, after you have your tuna sandwich and company talk, I want to take you away from the tuna and bring you into another area of research. And, that is, I want to tell you something about the changes that are going on in our climate system.

In fact, the ocean and the atmosphere are the two largest components in a large heat engine and the vacillations of these heat engines determine the changes of our climate. And one of the biggest signals in these up and down climatic changes is El Nino. And this is what I want to report to you today.

I'd like to tell you what El Nino is. I want to tell you what the ocean responses during El Nino are and I want to outline them on the example of the 1982 El Nino event. I want to show you then what the atmospheric responses and I'd like to discuss somewhat the causes of El Nino. There are many possible causes and we don't really know what the main causes are. I want to tell you then something about the consequences of El Nino. And, last not least, I want to make a few comments on how they might affect our local situation and the tuna situation in the Pacific.

Now, El Nino is a short form of Hispanic for El Nino de Jesus. And this is a small name that the local fishermen on the coast of Peru and Ecuador have given to a coastal current that runs south along the coast every year around Christmastime. (first slide)

As you see here along the coast of Northern Peru and Ecuador, every year at Christmastime, warm water transgresses southward along the coast of Peru. And the local fishermen have noticed (the phenomenon) a short time ago, over 200 years or so, as long as statistics have been taken. Soon the scientists recognized that El Nino was not occurring at the same intensity every year. But there have been times when El Nino was much more strong, when it was more long and people called it catastrophic El Nino events. During that time, fishery changed drastically. You have terrestrial rainfalls in the coastal areas of Peru and Ecuador and flooding in the low lying country. Now it was not until about the 1950's or 1960's that people realized that El Nino was not a local phenomenon in the waters of Peru, but that it was related to

much larger events in the ocean atmosphere system. (next slide)

And it was a Norwegian meteorologist at UCLA, who showed that whenever El Nino occurs, there are large changes in the entire system. The trade winds here and the northeast trades that are blowing over Hawaii and the southeast trades that are blowing from the coast of Peru into the Western Pacific. They are changing, and these changing patterns of ocean center of atmospheric circulation cause in turn, changing patterns of ocean circulation underneath. And it was this meteorologist who found these relationships and made the reference that the large oscillations in the ocean atmosphere system are related to the local event of El Nino.

He showed (next slide) that whenever in the Pacific Ocean, there is a large shelf of circulation with the trade winds blowing from the coast of America, Indonesia, there's a rising air and large amounts of air follow to Indonesia, and there is a return flow in the upper atmosphere and the sinking over the Eastern Pacific. This circulation has been called the water circulation. And it's one of the largest circulations systems that we have on the globe.

Now whenever this circulation system changes in intensity, then it has an effect on the underlying ocean. And that's what the UCLA meteorologist hoped to claim and could demonstrate on the basis of observations from various islands in the Pacific.

Now, my involvement with El Nino didn't really start until about 1970. But I was the only physical oceanographer in a group of population dynamicists who met in Lima in Peru to discuss the fate of the anchovy fishery.

The next slide will show you the dramatic effect that El Nino had on this fishery. In the 1950's and early 1960's, the anchovy fisheries started to develop in the waters off Peru. And it rose from almost nothing over one decade, to 1970, to the largest fishery on a single species, catching in the order of 10 million tons of anchovy each year.

Now we met there in Lima in 1970, because there were discussions going on under the sponsorship of FAO whether or not to limit the fishery. The government wanted to allow a limit of 12 million tons. The experts from their fields suggested 10 million tons. And they of course agreed to an average of 11 million tons. And that solution didn't have to be implemented. In fact, in 1972, came El Nino and El Nino wiped out the fishery. The following year, only two or three million tons of anchovy had been caught. And ever since that time, the Peruvian anchovy fishery has not recovered.

Now El Nino doesn't affect only the anchovy fishery. It affects also the birds that are feeding under normal conditions on the anchovy. And you see that before the anchovy fishery even started, there were about 28 million birds in the area of Peru. And there was another El Nino event in 1957-58, when the bird population dropped down to about six million birds. It slowly recovered until in 1965, the next largest El Nino occurred and then it dropped down to about four million birds. It recovered very little in the following year when fishing intensity was very high. And then in 1972, it dropped down to less than four million birds. And that is where it is still now. So you see that an event in the physical environment of our earth has such dramatic consequenses to the ecosystem, to the fishery, and to the bird life.

Now at about that time in the years after that, we started to accumulate data on the 1972-73 El Nino, in order to try to explain. And in the next slide, you will see a few of these data that we could accumulate. Here you see sea level, on both sides of the Pacific, in the Galapagos Islands, in the east and far in the west in the Solomon Island during the period from 1970-1973. And what you see here is that in the years preceeding El Nino, sea level is somewhat higher, only about 10 centimeters. That's so much in the Western Pacific Ocean because the trade winds are blowing stronger and sea level is being built up. And sea level is slightly below, about five centimeters below in the Galapagos Islands. So the Pacific is filled with output. That's a normal tilt of 40 centimeters from east to west across the Pacific.

Now when El Nino comes, the southeast trade winds collapse, very strongly reduce in intensity. And then suddenly sea level rises in the east by about 20 centimeters in the Galapagos Islands and it drops in the west over the duration of one year by about 30 centimeters. That means the flow, the eastwest flow at sea level becomes much less.

The next slide will show you in the schematic rate, this situation. In the other diagram, you see the normal situation. Normally, this normal rinse will have a slope of about 40 centimeters on the surface. And then at the same time the thermocline sinks down to the west. The trade winds that are blowing from the east to the west are accumulating warm water in the Western Pacific Ocean. They are thickening the surface layer who underneath keeps the warm layer. In the east, it's only about 50 meters.

Now when you have a very strong trade wind, this situation is intensified. You are getting more warm water in the Western Pacific and in the Eastern Pacific, the thermocline rises closer to the surface. At the same time, sea level

drops here and sea level increases here. Now when the wind system relaxes or collapses, then the water from the west, the warm water that has accumulated in the Western Pacific Ocean sloshes back like a surge from the Western to the Eastern Pacific. It deepens the thermocline, it raises sea level in the east, and over the course of events, the warmer water becomes less thick in the west and sea level in the west drops. And large masses of water float from west to east across the Pacific Ocean. And that is what we observe as El Nino on the eastern side of the ocean.

Now this situation has actually, in the next slide, been modeled by theoretical models and hydrodynamic models that can simulate the behavior of the ocean when the wind collapses. Here you see one of these computer models by the theory, and what is being done. You are modeling the winds from the ocean, the depression of the thermocline, then you relax the wind, and the ocean is free to behave. Water from the west is moving eastward, transgressing the thermocline, and the wave takes about two months to travel from the Western Pacific to the Eastern Pacific. After two months, it has reached the coast of Ecuador and then it starts to spread north and south along that coast. The thermocline after three months is depressed by about 50 meters along the coast of Ecuador. And at the same time, in the Western Pacific, the thermocline rises. And after almost a year, the eastern side of the ocean, the thermocline is deep and the water is warm, and then in the western side, the thermocline has risen. So we know that this actually happens, as the physics of that mechanism are quite well known.

And now I want to show you in a sequence of observations from the present 1982 El Nino event, how sea level behaved. What you see here are sea level observations, daily means at four stations. Ponape shows you the behavior of the Western Pacific, north of the equator. Christmas Island shows you the behavior of sea level at the equator. Santa Cruz in the Galapagos Islands shows you what happens on the eastern side of the ocean and Funafuti in the Southwest Pacific, a little bit north of Fiji, shows you the western behavior.

And now let us go through the sequence of tide. In 1981, the first third of that slide, very little happened at sea level at all these stations. And then in about June-July, 1982, the wind fields started to collapse in the Western Pacific ocean, in the Philippine Sea, and the area north of New Guinea. And this started to set up a wave. Sea level started to drop in the Western Pacific and Ponape. A couple of months later, in August, you see the sea level suddenly rising at Christmas Island. And you see here a period of about six months, when sea level is very high at Christmas Island. Sea level in Santa Cruz in the Galapagos Islands doesn't rise until about October-November. And it reaches

a first peak in December of 1982, when the surge of water from the Western to the Eastern Pacific reaches the eastern side of the ocean. Then by about the turn of the year, '82-'83, the wind field westerly winds actually shifted into the South Pacific Ocean. And there between the equator and about 10^{o} south, you have a period when there are not trade winds blowing. They are actually from the west. And that triggered another wave that came from the South Pacific Ocean from the area between the Solomon Islands and Funafuti and it left to a drop of sea level of 40 centimeters. That's over a foot of mean sea level at Funafuti and to a second peak of sea level in Santa Cruz of the eastern side. Now I will show you that this situation is not only limited to the area near the equator, but is actually a very widespread signal that we are observing.

The next slide shows you the sea level deviation from normal, and the numbers are millimeters. And it shows you at the beginning of the El Nino when we suddenly got westerly winds over what is north of New Guinea and to the Philippine Sea, that sea level decreases here by about 15-20 centimeters in this area. The same time, a heap of water forms near the equator, blown by these westerly winds and this heap of water, also about 15 centimeters in height, starts to migrate eastward along the equator.

The next slide will show you the situation in September, '82. Now the area of a negative anomally, that means of a drop in sea level, there's a maximum of 20 centimeters here is being much larger. We have a heap of water of about 20 centimeters near Christmas Island. You see, little entries so far on the eastern side, but there is already a signal here in San Diego and off the coast of Chile.

But if you come to the next slide, during that time, we have a very lucky coincidence. A colleague of mine from the Department of Oceanography, has embarked on a series of measurements, measuring ocean currents to the south of Christmas Island on the equator.

And this is a slide that shows the measurements of these currents. Normally, under normal conditions we have near the surface, the south equatorial current, the water flows from east to west under the influence of the trade winds. Anomalies at the depths of about 100 meters, you find a current, the under-current that flows at the equator from west to east. This normal situation is observed in the first half of 1982. And then suddenly in August of 1982, you'll find easterly flow in Christmas Island, totally unusual experience that they make. Easterly flow as high as 120 centimeter per seconds, that is four feet per second that water flows there for a period of about three months. And if you calculate out how far that water got, an individual water particle would have traveled

5,000 kilometers or 15° of the longitude along the equator. So here is direct measured evidence of the fact that water is actually moving from the Western Pacific to part of the Eastern Pacific in this big surge. You see it goes down to over 100 meter depths and it lasts for about three months with a mean speed of about 70 centimeters per second. Now let us go on with looking at the sea level. (next slide)

What is the response in December, 1982, after that wave has passed Christmas Island? Sea level is now over 300 centimeters. That is more than a foot higher. In the Galapagos Islands and along the coast of South America here, it is now negative over vast area of the Western Pacific. But largely north of the equator, 20 centimeters below normal. And this is all the water that has moved across.

Now we go on in time to the next slide, and you will see here in May, 1982, between about December and generally February, the wind field has moved from the northern to the southern hemisphere. And we have large area of westerly winds here. At that time, we have the formation of hurricanes that swept down into Tahiti and the Marqueses Islands over there, connected with that flow of westerly winds south of the equator. And now the sea level is dropping in this part of the world around Funafuti, the Solomon Islands and over to Tahiti. And all that water is now traveling east, giving us a sea level that is 40 centimeters above normal in the Galapagos forming the second peak of sea level. Now by July, 1983, the wind system has come back to normal, but the ocean has not yet recovered that fast. The recovery of the ocean takes a much longer time, you see that even in August, we have a depression of 30 centimeters in sea level in the Western Pacific. So you see that these responses of the ocean to the wind field are really large.

During the time when these very low values of sea level appeared there, we got many letters from the islands in the Western Pacific asking us what is happening. Is the island rising? We are finding that temperatures are becoming too shallow that fish cannot move in and out of the lagoons anymore. That the large amounts of reefs are dying off because it's exposed during low water everyday and otherwise it's covered with water. And they've been asking why is all that happening. These are depressions of sea level that we have never seen before as long as sea level measurements have been made on some of these islands.

Now let me show you the response of the surface temperature in the ocean during this event. Under normal conditions, we have the warmest water in the ocean in the Western Pacific. And it is in March, at the end of the southern summer, usually in the southern hemisphere more than 29° Celsius and in September, it is largest in the northern hemisphere. This is the normal expanse of 29° Celsius water.

But during the 1982-83 El Nino event, it was quite different. And I will show you a sequence of maps showing only the area to the east of the date line. You will note that in a normal year, the 29° water, the very warm water, is basically limited to the west of the date line, and in the area of Costa Rica and Southern Mexico.

Now when we come to the next slide, to that year 1982, there's a much larger area of warm water already in existence before the 1982 El Nino event. And then as the wind goes on, the area increases. You may see a progression of warm water from both sides of the equator and then at the equator to the Eastern Pacific Ocean by October.

In the next slide, you will see the progression from November-December, when all the water to the Galapagos Islands is potentially covered with water warmer than 29° C. So this is a tremendous change and since it's actually the warm water that has been surging from the Western Pacific toward the east.

Now I want to tell you something about the atmospheric response, which will explain to you in a certain way why this event that is centered in the Central Pacific Ocean has repercussions worldwide.

Now what you see here is in the middle of the Pacific and it's an idealized picture, an area of very stong cloud formation. That means an area where we have vertical movements in the atmosphere, a rise of warm air, moist air that leads to very strong rainfall. This area is normally over Indonesia. But when it comes to be situated in the Central Pacific Ocean, then we are getting an enormous development of atmospheric circulation. Theoreticians have calculated the response of the atmosphere to such a heat source.

It shows you here in this picture, how the circulation and about 10 kilometers altitude wil change. That is the altitude where the jets fly and where the jet stream is in existence. The jet stream is a flow of air that goes from west to east all around the world, both in the northern and southern hemispheres. But that shows you the deviation when you have a heat source, and equatorial heat source situated in the Pacific Ocean, you will get an enormous flow from the east at that high level. You will get an enormous flow from the west in the mid-latitude. That means the mid-latitude jet stream will be intensified in both hemispheres.

In contrast, the water circulation which has a wind blowing from west to east above the equator, will be weakened. Now this pattern extends over the entire globe. And for that reason, we have changing weather patterns almost everywhere.

The rainfall that no longer occurs over Indonesia. Most of the rainfall occurs over the Central and Western Pacific Ocean. So you get a drought in Indonesia. You get also a drought in Australia because the pattern there has been changed. You get an intensification of the jet stream in mid-latitude. That means in that winter, we got a large intensification of outer tropical storms and these were the storms that were causing all the swells that destroyed the beaches in the Southern California and along the West Coast of the United States or the heavy surf you have heard about. These are the storms that have been traveling along here.

You have another development of an anti-cyclonic system there that is called the airflow changes over North America. The airflow changes over North America will either bring you a very cold or very mild winter. And these are the global repercussions. You have of course, at the same time, this terrestrial rainfalls that are usually connected to El Nino over the coast of Ecuador.

Now how does this come about? And now the next slide will show you something about the causes. Today, we can measure with satellites, many things in the atmosphere. First of all, we can measure the outgoing radiation. That means we know where the heat is being reflected from the atmosphere. And that tells us where all the very high cloud covers are. And where the high cloud covers are, that's where all the rain falls. And this is where the atmosphere gains all its energy, where the thick heat engine is located that is driving atmospheric circulation. But you see here that during December, 1982-February, 1983, this heat source, and the "w" stands for wet and the "d" stands for dry at that level. That means we have here many, many highly reflected clouds that show the location of the rainfall pattern and of the heat source. Whenever you have a heat source over that area, you have low level winds. That means the trade winds, the winds near the surface that are converging towards that heat source. And these winds at the same time, are causing surface water to converge towards that heat source or underneath the rain area. And when water in the tropics converges, then the area is warmer.

Now as you see here, that there is an association between events in the atmosphere and events in the ocean. This was the claim of people in the past. We have warm water in the equatorial Pacific and therefore we have a convergence of the wind and therefore we have rainfall and rising air and the divergence in the higher layers. And the ocean is driving this system.

Today, most people believe in particular meteorology that the atmosphere is causing a heat release. The atmosphere is gaining the heat. It is raining and the surface winds are the consequence. And the surface winds are pushing the

water together and makes the ocean warmer. And so you have here a coexistence between circulation states in the atmosphere and in the ocean. And this, most likely, is the situation that most things are necessary, that we have a positive effect between ocean and atmosphere that allows that situation to exist and it maintains the situation over long periods of time.

This pattern of heat release in the atmosphere is a big heat source. This, during the 1982-1983 El Nino migrate from Indonesia where it's usually situated to the Western Pacific between June and August to the Central Pacific in December and February and even further east into the Eastern Pacific between March and May, 1983. This was a time when you had all the severe hurricanes in the southern hemisphere. And earlier, you will recall we had Hurricane Iwa here in the Hawaiian waters which was a very rare situation.

Now in the next slide, I will show you a little bit on the effect of that pattern on global circulation. I mentioned already before in the color slide that I showed you, that an equatorial heat source is changing the pattern of global circulation at high levels and this has an effect on the lower levels. This is what people call tailing connections. That means if something changes in the atmospheric system in one location, it will have consequences in other locations, because the atmosphere is a global situation. In contrast to the ocean, we have ocean basins and they are somewhat separated from each other.

Now in this case, you may notice here that on this diagram, if this is the Western Pacific Ocean here, here is California, that we in the Hawaiian Islands are given by the fact that we have weaker trade winds, less clouds, less rain in larger parts of the Hawaiian Islands, that will show up as drought conditions. And this happens in the winter of the year 1982-83 for instance, when we had those kind of conditions. We are getting less rain through Kona storms and therefore have drought conditions.

Now in the next slide, you will see the largest scale patterns of winds that we are observing. Really, the area over Indonesia is the largest heat release area on the globe.

And that brings me to the question of explaining El Nino. And this is a very tricky one because there are many possible effects. Today, most of us believe that we have a large heat engine, ocean and atmosphere, which is a real turbulent system. And this turbulent system is subject to fluctuations.

Now in Indonesia, we have a low pressure system that is there most of the year. But this low pressure system

migrates north and south. In January-February, it is in the southern hemisphere over New Guinea and north of Australia. As you can see, the wind system as it converges toward that area of the world and that is where all the rain falls. In July-August, the system that converges is situated in the northern hemisphere over the China Sea partly and over the Pacific. And you see that the southeast trade system and the monsoon system over the Indian Ocean are converging towards that area. Now this is a process that happens every year. The swing of that convergence or rainfall between the southern and northern hemisphere. But in a certain year, this system will also make fluctuations east and west. And when this system happens to move over the Western Pacific Ocean, somewhat more to the east, then it apparently gets into that feedback system that I explained before. That means where the winds are causing anomalies in the warmer ocean, this warmer ocean feeds back on the atmosphere. And it's a self-reinforcing process. And once that process is being sent up by these random fluctuations of the Indonesian low, then we are getting the start of an El Nino.

Now an explanation that is being based on the randomness of such a system is of course very unappealing for many scientists. People want to have explanations that you can show a cross effect relationship and where you can say "b" follows from "a." It doesn't seem to be so. I think that the Indonesian system is just undergoing random fluctuations and this is what we have to expect. But some people still like to say that, "No, there's some warm anomaly before it happens in the Western Pacific Ocean that will actually trigger that system."

Now warm anomalies, warm temperature anomalies in the Western Pacific besides the effect of the Western Pacific which is always warm, are occurring all the time. They have very little magnitude and amplitude, and therefore, we can't really say which of these anomalies will eventually develop into an El Nino.

And I show you how this convergence of the wind system actually looks during the 1982-83 El Nino. (next slide) Here you see a case during the '71-'72 El Nino where data have been processed. You see here in the case of 1971, when the wind here was actually abnormal in terms of having a thick divergence near the equator. Winds were going away from the equator. And that means we have a very cold equator.

In contrast, in September-October of 1972, we have those very strong convergence of winds in the Western Pacific and that is the situation that reinforces the El Nino situation in ocean and atmosphere.

Now there are other possible explanations. (next slide) I'll show you something about the randomness of this process.

Here you see what people call the Southern Oscillation. The Southern Oscillation is a shifting between air masses, between the Indonesian area and stemming over to India and the area of Easter Island. And between these two areas, we have changes of atmospheric pressure. When atmospheric pressure is low here, it is high there and we have very strong trade winds flowing. The southeast trade winds over the Pacific, from over the Pacific Ocean and they accumulate all that warm water in the west.

On the other hand, when atmospheric pressure is relatively high here, and not so high over there, then the difference is small and the trade winds are weak. Now this is what people call the Southern Oscillation.

And the next slide will show you the time setting of that Southern Oscillation. And it shows over the period of 1950-1978, the fluctuations of the Southern Oscillation and how they are related to changes in the wind at the equator. Now these changes in the wind on the ocean can change by 50% between periods of a high intensity in the Southern Oscillation and periods of a low intensity. And you see that these come in instances of about several years high to eight years. And they are quite randomly distributed. People have not yet found any regularity and I think we don't really expect any regularity in the occurrence of El Nino.

Now there are other possibilities and other ideas in which El Nino might be affected. First of all, the next slide will show you something about the CO_2. You know that here, not far from you and Mauna Loa, you have an observatory that measures the CO_2 content of the high atmosphere. And we know that since people started to burn fossil fuels, the CO_2 content has been nothing but going up.

So we may have here an indication that the world is becoming warmer. But so far, we do not really know. Our information on both the ocean and the atmosphere over the last 50 or so years are not adequate at this time to tell us whether or not the global atmosphere or the global ocean has deviated significantly from a trend which is in the order of about one or two degrees in 50 years. This has not yet been established with certainty.

Nonetheless, there are indications that at least certain parts of the world have increased in temperature. Now this is ascribed to the increase of CO_2, and that may give us oceanographers, the idea that probably El Nino events have been becoming more frequent in the last few decades. We gain our information, our statistics are not really precise enough to test such ideas.

There is another possibility that is being mentioned by many people. And that is a connection between El Ninos

and volcanic activity. (next slide) Here you see the major eruptions of volcanoes. And you may have read that just in time for the 1982 El Nino, El Pilon erupted in South Mexico. And it blew tremendous amounts of dust into the atmosphere. There are some people who want to say that many of these eruptions preceeded El Nino events in the past.

Now this in turn is a nice hypothesis. But the evidence for that is rather shaky. We do not know how the dust accumulation in the atmosphere actually affects atmospheric circulation. And unless people can make computer models that will tell us the difference between an atmosphere or the difference in atmospheric circulation between a period in which dust was injected and in which dust was not injected, we really don't have the proof for it. It's a nice hypothesis, but that is all that it is at that time. In any case, it is one that one cannot outright reject. But the energies that are being released during an El Nino cycle are really so large that they can only come from ocean atmosphere.

Now I have already mentioned the number of the consequences that come out of the fluctuations that's associated with El Nino. I told you about the droughts that we have in Indonesia, in Australia, and also in South Africa. But how? From the Southern Oscillation, you see the influences going well over into the Indian Ocean area. There are relationships to the Indian monsoon. But these relationships are not as clear cut as, for instance, the appearance of rain at Christmas Island and the appearance of rain in the waters off Ecuador. Also the association of North American winters is not so clear. There have been El Nino, yes, with which we have very severe winters over North America. There have been El Ninos in years when this was not the case. So the daily connections of which I spoke earlier are very much dependent on the location of the heat source in the atmosphere.

Now there are other events that I already mentioned. That means the storm activities and hurricane activities that were changed in the equatorial ocean.

But now let me say a few words to the impact on the fishery and the possible impact. We know that the warm water that is moving eastward across the Pacific Ocean is also spreading north and south up along the coast of California, as far north as British Columbia, and down south as far south as Chile. And there we had displacements of the fishery. And I think it's proper to call them displacements. We know that the tropical fish from the Eastern Tropical Pacific have been caught further north. We know that every fishery off Southern California is displaced further north. We have heard that the salmon captures along the coast of Oregon and Washington were much lower. And that the Canadian

catches were way up. The catches of king crabs were way down. And similar effects were spreading southward along the coast of South America.

Now what are the reasons for that? First of all, most of the fisheries are very strongly temperature dependent. And therefore, when water masses are moving, the different locations and displacements along the coast can be as high as 1,000 kilometers. And in the open ocean, displacements can also be quite substantial. And when that happens, the fish stop and their migration moves may change. At the same time, the large scale ocean circulation like gyres, the North Pacific gyres, the north equatorial current that is sweeping near the Hawaiian Islands is changing the location. And consequently, their migration patterns of the tuna will change.

Now of course, when people are always trying to tie the changes of the fisheries of the abundance of fish that is locally caught to local events. But you see that we have to keep in mind the effect that outer changes in the ocean atmosphere system, the changes in the circulation changes of the ocean are really very large scale events that affect the migration of the various species in a large scale and not only in a local situation. So local changes will not be the causes, but they are the large scale patterns that have shifted. Now what do we need for the understanding?

I'd like to mention one more point. And that is, I watched this morning when Dr. Klawe talked and showed us one slide on the world catch of fish. I was really surprised how small the year to year fluctuations in that world catch really were.

In contrast, you have seen from some of the slides that I showed that fluctuations in atmospheric and oceanographic parameters are so much larger from year to year. And you just have to allow the fact that our natural systems are undergoing very large year to year fluctuations.

And I think in order to drive a better understanding of these things, we need better statistics and better observations. And this is the way I think a lot of fishermen in the local industry can help scientists to improve their knowledge by providing information. Occasionally I hear from people, "Oh, we know so many things about the local currents in our waters." But when I asked them what are these changes, "Oh, we just know it," but it is no where documented. And I think people could contribute to the understanding of the local situation and of local effects by making detailed studies and report their observations.

Thank you very much.

Question: Where are we in respect to El Nino right now? Are we in a decline of that, is it continuing or what?

Answer: Well, El Nino in the atmosphere, stopped in about August, 1983. And ocean effects were over by December of 1983. Right now we have rather intensified trades again. I would say that the situation is completely back to normal.

Question: The question I wanted to ask you, you see, when we had the drought year, right? There was also a drought in Fiji, Tonga, Samoa. A very bad one. But we've never had the least amount of rainfall that we had here. Yet on the other hand, just down here, beginning of the equator in the Line Islands, we had a tremendous increase of rain - in Fanning a Christmas. Now you say that we're back to normal, but we find our currents are still not right in the ocean. Our fish have not come back for three years. We don't see the bait that we normally have. I think we're still in a lot of trouble.

Answer: I have the feeling from your statement that if you say that your catches have been less than desirable for at least three years, that this situation has already started before El Nino. That means in the winter, '81-'82. ('81 was good, '82-'83 was bad) So El Nino didn't start until July, 1982. And so effects of El Nino, you could only expect that after that time. Now there are of course ocean effects that are lingering on. Waters off the coast of British Columbia are still above normal in temperature. And because these rates in ocean circulation are spreading very slowly. Now if you say that ocean circulation near the Hawaiian Islands is not back to normal, on what, you may experience probably here locally in the waters around Hilo. What has actually changed? (Well, our currents aren't running in the right direction. They don't change normally with the moon phases. Their currents are not nearly as strong now as they were two years ago.) Well, this is what I have in mind, if you could give us some documentation on, we could probably analyze that and learn something from it.

Question: You have observed, I think you mentioned in the beginning that the anchovy fishery off South America just did return after 1972-'73 El Nino. Have you made any observations in the permanent changes in the fishery, that obviously I'm talking about, our fishermen here, that's what I want to extrapolate. Is it common that these changes once begun by El Nino will not recover? Or is that estimates? You can generalize the question.

Answer: Well, once shouldn't blame El Nino for everything. I would say we have definite changes in parts of the world that are not El Nino related. There have been changes in the fishery around Iceland, and in the fishery in the Baltic or fisheries elsewhere in the world. And such changes are not

El Nino related. It is very difficult to say for a large area of the Pacific. And for our statistics, for information that goes back only about some 30 years, and in these 30 years, we have had perhaps five El Nino events. This is all what we have to build any statistical evidence. Now superimposed on these events of El Nino are of course, the influence of man. That means the fishing activities of man or any pollution problems or CO_2 increase. And such thinking is most difficult to separate on such a time scale, the recurring from the nonrecurring events. You see, El Nino is a recurring event. It happens sometimes five, sometimes ten years. And they are superimposed on that, they are trends in the development. And some of these trends are not reversable. And that is the reason why one can't easily separate what one does to the other.

Question: I have two questions. You mentioned about the randomness of the currents. What about the intensity of the phenomenon? Is it equilibrium or do you have, I've heard that this is one of the extreme events that we've been through now. What are some patterns with respect to that?

Answer: This El Nino event of 1982-'83, was the event of the century. The last event that had a similar magnitude was I think in 1878. Almost a hundred years ago. And all the events that are in our recorded history, that means where we have reasonably good oceanographic and meteorological informations have been weakened.

Question: My second question, because of this intensity in this past year, I remember seeing the slide that Dr. Brill put up there, in terms of the termal barriers for aku or skipjack. In terms of where a certain isotherm reached the surface, and also the mention of the lands in terms of that range of optimal water condition, when you have an El Nino phenomenon, and we have massive displacement of warm surface water heading towards the Pacific, towards the Eastern Pacific at the same time, deepening of that layer. It would seem like those little pockets of isolation in normal periods would just spill over and would lose some of those effects. So something like this on a large scale I think, might be very pronounced; it might stay with us in terms of age classes for skipjack for years to come. Or I suspect it in that regard. Has the volume of water actually increased for a certain temperature or has it newly been displaced and the fish can follow it in the water current?

Answer: That means, usually you get an increase of temperature and a thickening of the upper layer. These two events usually go hand in hand.

Question: Are the cold water upwellings back to normal now?

Answer: Yes, the cold water, the tongue of cold water that stretches from the Galapagos Islands to the date line over Christmas Island, this is back to normal. It's actually occurring of the last couple of months, it has been cooler than normal.

AHI BURN RESEARCH UPDATE

Robert Nakamura, Ph.D.

Department of Animal Sciences
University of Hawaii at Manoa

I certainly enjoyed Dr. Wyrtki's presentation.

The problem of ahi burn goes beyond the borders of Hawaii. The Japanese are also dealing with this problem.

Before I go on, I'd like to acknowledge the assistants in this study - my co-workers: Bob Burke, who is in the audience; back in the Honolulu laboratory working very hard this afternoon is Dave Coleman, Susan Takashima, Jayson Akamine, and Elaine Chan.

In the late 1970's, the National Marine Fisheries Service gave us a modest amount of money to start the studies on burnt tuna. Some of you remember Dr. Jean Cramer, who worked on this project at the time. About two years ago, the County of Hawaii gave us start-up money to begin studies on burnt tuna. Last year, they gave us substantial money to keep the project going. At the present time, we are working with grants from the State Department of Land and Natural Resources and from the National Marine Fisheries Service. We do have funds to continue the study next year.

My talk on burnt tuna will be directed mainly toward the ika-shibi industry and to those of you who are directly involved in the industry. So those of you who are not that familiar with that industry, it started in the early part of this century, by people who were fishing for ika (squid). They soon found that they could catch ahi with the squid. The industry languished for a while, then in the mid 1970's, there was an increase in the intensity for that fishing industry. For those of you who aren't familiar with burnt tuna, it appears on fresh cut flesh as a whitish-pale, or pale-soft watery tissue that, I understand, is slightly sour tasting. The main effect of this condition is that it substantially reduces the value of the tuna because it is less desirable for sashimi. It can be fried without tasting the effects of this condition, unless the burn is very severe.

The burnt condition is not a new one. As I said, the Japanese described it as 'yake-niku.' I remember it over 30 years ago when I was working at my uncle's fish operation, which was my first experience with burnt tuna. And now I have become a lot more familiar with it.

As I said, our burn study began about two years ago and I would like to present some of the data that we've obtained.

The first thing we had to do was to establish a uniform system of classification of burnt tuna. Burnt tuna was burnt tuna before, and we tried to make sure that our results in Hilo would be the same as those in Honolulu. And therefore, we set up a uniform system of classification which is of more particular merit to us than anybody else in the sense that we are familiar with our system and perhaps most of you have your own systems for classifying burnt tuna.

Essentially, in working with burnt tuna, we started out with a system from 0 to 5; 0 meaning no burn, and 5, extremely burnt tuna. But in the process, we have found it useful to separate it into, instead of five or six different categories, to separate it into three categories. The categories at the present time are zero burn or no burn, normal appearance in ahi; class one burn, slight burn or moderate burn (which is the second category); and the third category is what we classify as badly burnt tuna. And there are some compelling reasons for separating it out into these three categories.

Our studies were intentionally divided into three parts - the auction floor studies, boat studies, and diagnostic tests. These three studies are interrelated and cannot be easily separated, but it may be useful to separate them out so that it ties in with what I am going to say.

I'll start talking about auction floor studies. Auction floor studies are divided into several categories. The first studies we conducted in the last two years were between the Honolulu and the Hilo auctions where quite regularly we took data. The data that we obtained was primarily on the classification of burn of individual tuna; we classified individual tuna as to size, weight of the fish, the sex of the fish when we can, and the boat of origin - the boat that caught the fish. We started to compile the data and found it very useful. (next slide)

This is a summary chart of our auction floor studies. We examined a total of over 4,000 fish. We found, in a very short time, that over half of these were long-line fish and therefore these were young or uncut fish. The long-line fish do not burn to the extent that ika-shibi burn, and therefore they feel it is not necessary to cut these fish. Therefore, these can be put into one category.

Incidentally, we are talking about fish that are all over 80 pounds. Burnt tuna rarely occur under that size.

The second large group, then, are cut or filleted fish, and the bulk of the data is obtained from the Honolulu market,

where many of the fish are shipped into Honolulu and cut open at the auction. And the reason for that is, in all probability, that they are concerned about the occurrence of burnt tuna, and they cannot predict the appearance of burnt tuna in uncut fish and therefore all of the fish are cut open on the auction floor.

Of the cut fish, there are two large categories. One is the ika-shibi fish out of the Hilo fishery. The second is from all the Islands, apparently, but mainly from Kona side and Honolulu and Poipu. These are then the cut fish which are a vast majority of the auction floor. Obviously, we do not have data on the uncut fish. Of over 1,000 fish, 28% were found to be burned. This 28% is divided into 18% mild or number one burn, and 9.6% or 2-5 of the severely burned fish. And a total of these make up the 28%.

Here are the ika-shibi fish under these two categories of cut fish - 7.3% - therefore, it is lower than the severe burn in the total cut fish; and as I say, non-ika-shibi is sport fish and perhaps burned to a greater extent. Here we have 43% of the fish burning in the sport fish and only 23% are burning in the ika-shibi. Another interesting fact that we found here was that the price of fish dropped approximately 50¢/lb. immediately even with a slight burn. The price on really burned fish dropped nearly a dollar.

You can see, then, dealing with the number of fish that we are, we are talking about given a mildly burned fish and a 150 lb. fish, we are talking about a $75.00 loss per individual fish. I think that we can see the economic consequences of such a problem that the fishery has been taking a licking from El Nino and also from the burnt tuna. Just to finish up here, in sport fishing, you can see that the severely burned tuna is almost 19%. (next slide)

We recorded much of the data between May and September of last year. Out toward this end here there are very few fish represented in this data. Most of the fish are in this area here. We can see the percentage of burnt tuna fluctuates in intensity between 20 and 40 or about 28% overall. (next slide)

This is another example of the economic effect of it. One of the things that we found quite interesting is that even very good ika-shibi fish receive a lower price than long-line fish, perhaps, because of the burn condition and these fish that are cut open are less desirable to the buyers. You can see again on a long-term basis over these several months that the price of the long-line fish is always better.

We thought that it sounded logical that if 80 lb. fish do not burn, then perhaps the severity of the burn is directly related to the weight of the fish and the size of the fish.

We find that, sure enough, the long-line fish tends to be lighter than the ika-shibi fish. This looks interesting, in spite of the fact that the long-line fish were lighter, they are still commanding a higher price than the ika-shibi fish. However, when we looked at the weight, sometimes it holds that the bigger fish does not demonstrate the weight relationship to the degree and severity of burn of ahi in the market. (next slide)

One of the things that fishermen have been telling us for a long time is that female ahi burn during the spawning season. I'll concede to them that females burn more than males. As you can see in our data in all weight classes, females always burn more than males. This is in spite of the fact that we find that the males are heavier than the females. And yet, the males are burning in all of our samples, less than the females. So we find that the fishermen are right that the females are burning to a greater extent than the males. (next slide)

One of the things that we do find exceptionally high here, in most months of the year, even in the early part of the season when they are not supposed to be spawning, we find that the females are still burning more than the males. And this brings up an interesting point. These kinds of basic reasons for the burn in tuna has got to accommodate this information that there is something about the physiology or something unique about the female that makes the female more susceptible to burn than the male. I concede therefore, that there are some predisposing factors that contribute to burn. In other words, I reflect on former reports to some of the groups here, that burning does not occur prior to landing the fish on deck. The basis of this is that we have examined histological and pathological tissue samples microscopically, and we find that there is no evidence that the condition occurs prior to landing the fish on board. In other words, these are apparently some predisposing factors that contribute to burning more in some fish than others. (next slide)

This slide shows the weight of fish versus the number of fish, and illustrates that the average male is larger and heavier than the female, and yet this is probably the reason for the confusion in the data that shows that weight does not seem to be as important in burning in tuna. Apparently, the depth of the fish is probably more important than the weight of the fish in the presence of burn in tuna. (next slide)

We continued to gather other economic data including the type of fishing: long-line, sports fishing, and ika-shibi, and the number of fish that occur on the auction floor during the various months of the year. We are continuing these types of economic studies. Dr. Steven Miller has been contracted to review our data. Our data is entered and analyzed in a

a computer, which is taking that information and applying economic formulas to it to get a better understanding of economic aspects of burnt tuna to the industry. This work is continuing at the present time and we should come out with a report at a later date. (next slide)

As I said, these are economic studies based on auction floor data that we have gathered. These are the typical studies that we have completed that indicate some of the information that I have presented. There have been some laboratory studies that include bacteriology, histology, and core sample studies, which are not completed and are not conclusive right now. The bacteriological studies have been baffling. We, at the present time, cannot correlate the trends of numbers of bacteria with the appearance of burnt tuna. It is premature to say that bacterial enzymes are not involved in the degeneration of tissues of tuna. The histological studies are also continuing as we were at one time interested in it as a means in diagnosing burnt tuna. Obviously, the diagnostic test is involved in auction floor studies; studies on development of the diagnostic test have been based on tissues obtained at the auction floors. (next slide)

We have tested quite a few different kinds and methods for detecting burnt tuna in uncut fish as it is very important economically to develop a test that we can tell whether a fish is burnt or not without filleting the fish. And this is primarily for the purpose of export of tuna out of Hawaii. Therefore, we went through a lot of tests including equipment such as tory meters which detects freshness of fish, and we found that the results could not be correlated with the occurrence of burnt tuna.

PH surprisingly does not seem to be a reliable means of differentiating burnt tuna from non-burnt tuna. Dr. Brill's talk this morning was interesting in that regard because the Japanese did that and we did that and it seemed like the obvious method to determine whether a fish was burnt or not. The results were very confusing and it is not sensitive enough to differentiate the burnt tuna from non-burnt tuna. There is a possibility that there is a buffer that rapidly buffers that fish's pH, so that pH cannot be used in this manner.

This is one of the tests that we found to be more useful in diagnosis. (We thought that histologically microscopic examination using frozen sections on the auction floor could be used in the diagnostic tests.) It is a difficult means - you have to be very familiar with tissues. It is a very difficult test - it would take a lot of training and a lot of manipulation in order to develop a test of this nature. We would not have been very pleased with it, with the use of histologic methods; however, we thought at one point, maybe this

may be the needs that we have to resort to.

However, there was a colorimeter test that we found to be useful in the detection of burnt tuna. In the development of the diagnostic test, we have to develop a simple test, a rapid test, preferable one that could be used on the auction floor and could give you immediate results on the condition of the fish. We wanted a test that was efficient, a test that was cheap. The colorimeter seems to fulfill almost all of the criteria very adequately. It is a simple method, and very rapid - it takes only a few seconds, it takes just a small sample of flesh; there is a digital readout - you don't have to make any calculations, it is a simple test - it takes a technician only a few minutes to put in on and read a test. It could be reasonably inexpensive, and could be very effective, and we think that it probably the test that may be the one that can be utilized. There are many parts to this. It can get very complicated, but it doesn't have to. In one part of the test, there is a digital reading from 16 to 26 plus. And in this test, we find that anything under 16 (remembering that they are less sensitive at both extremes). However, we found that when the machine reads 16 or less, we never found a false reading there. They were all good fish there. So if the machine reads 26 or more, it was called a bad fish. The cutoff point we think is about here, 23. If I were using this test and I had a reading of 23, I would hesitate to export that fish. However, at 22 or less, we're dealing with a very small percentage of severely burnt tuna - this dark area is severely burnt tuna. The striped is the area of the slightly burnt tuna. Therefore, if the fish has a reading of 23 or less, then at worst, you are dealing with a very slightly burnt tuna. And there are some slight false positives there.

We feel that we can increase the sensitivity of this test. One of the ways in increasing the sensitivity of this test is to make a reading of a sample that was taken from the superficial part of the fish and comparing that with a sample from the deep part of the fish, which would give you a difference. Because I think that these false positives, some of the false negatives are due to the fact that some fish are lighter than others or some fish are darker than others. Remembering that this is a test of color. Therefore, we feel that perhaps, if we got two samples, a deep one and a shallow one of these samples that were in this area, where we were getting false negatives, that we may have been able to detect these positives here on the basis of the difference between the superficial and the deep specimen.

All of this work was done on specimens that were obtained on fish that were filleted. They were cut open, and we could see the area from which we were getting our specimen. And therefore, the tests up till now are not useful in the fact that unless a fish is cut open, we cannot get the samples.

Therefore, the next step in the development of the test, obviously, is that we have to take core samples; samples from the uncut fish using perhaps a corer that can obtain a sample of fish from the superficial and deep portion, sampling it and testing it through core sampling. We have to develop a method of coring and we have to test out the accuracy and efficiency of this test compared to tests of the fish that was cut open later. We plan to do this. We have to get here, the cooperation of the processers, the fishermen, the buyers, in order to get permission to do this. (next slide)

The third part of this study then is on the boat studies. What we call boat studies. Some of you will remember the Holoholo, the ship that was lost at sea and it has made the University very sensitive to the lawsuits by University employees for accidents that occur at sea. Therefore, we encountered considerable difficulties in getting my co-workers on board these ships to observe. Because we feel this is an important part of the study of burnt tuna. We have to know what is going on, on the ships and being able to correlate the factors and the fish handling and the conditions on board ships that can be related to what is going on, on the auction floor, on whether the fish is burnt or not. We thought this through for months. And finally, they allowed us to go aboard ship, but by that time, it was towards the end of the season and we did not obtain the fishing data to analyze, to give us any kinds of answers. However, the techniques that we will use have been developed and we are very anxiously awaiting the expansion of fishing in this season that our observers can go aboard the ship and start to do the work that we have to.

Even the work aboard the ship can be classified in two areas. One would be the observation of fish handling and fish catching practices such as the length of time they fight the fish, the time that they catch the fish, the handling of the fish subsequent to catching the fish, whether they gilled and bled them, or whether they gutted the fish, whether the fish got into a tank and into the ice chest immediately or was delayed prior to getting in, the time from catching to the auction floor when we can examine the fish. These are data that we would like to have so that we can determine which fish handling method is effective in preventing the occurence of burnt tuna. (next slide)

This may be very important in that we have reason to believe that there may be different factors that are responsible for the occurence of the mildly burnt tuna versus those factors which are present in the severely burnt tuna.

One of the reasons is that there is not great correlation between the severely burnt with the mildly burnt tuna. Sometimes we have for instance, here when we have a high

incidences of burn or severely burnt tuna, but not so high in this area. Whereas in here, we can see a lot of mildly burnt tuna, and proportionately less of the severely burnt tuna.

We have other reasons to believe this, other data that I would rather not discuss at this time. To believe that these two mildly burnt tuna and severely burnt tuna may be affected by different factors. One of the things that we believe may be occurring is that the severely burnt tuna may be less amenable to management practices, fish handling practices, where mildly burnt tuna may be amenable to various fish handling techniques. (next slide)

The other kind of data that we expect to get aboard the ship is, for instance, we would like to get samples of flesh at various times after catching. I said that we have a few samples of fish flesh that were obtained immediately after catching and at that time, we find a mild edema in these fish we have not seen in the few samples that we have seen. As expected, we do not see any burnt tuna. However, we feel that the events that result in burnt tuna are occurring sometimes between the time they land the fish and the auction floor. We have to have specimens of fish to check the pH, the lactate, the temperature of the fish, and many factors of that nature, histologic following the occurrence of burnt tuna - histology to better understand it.

And one of the other things that we have to do is measure internal temperatures of the fish from the time of catch until the time that they get off the floor. This information we feel is necessary, and as Dr. Brill said, we have to understand the conditions if we are going to adequately deal with the occurrence of burnt tuna to help the industry.

I thank you for your attention. If I have time, I would answer questions.

Question: Do you think that the Hawaii incidents of burnt females might be related to spawning and perhaps the females utilizing more of their fat reserves into the production of eggs in which the males would not be doing?

Answer: The question was could the higher incidence of burning in the female be related to spawning. I think very well that it can be. I would be interested in whether females maintain a higher temperature than males do - as related to fat mobilization. We are going to get into glycogen studies - glycogen in the liver and muscle studies in order to try to see if we can ascertain these kinds of things, fat reserves to things of that nature. So yes, I think for the moment, we may be involved. How, we are not quite sure yet. What I am saying is that burning is not only occurring right there at spawning, they are occurring at other times. (Well, my

thought is that females are, egg production goes over quite a long period of time.)

Question: Was this strictly yellowfin or was this bigeye? And if so, was there any difference?

Answer: The vast majority were yellowfin, but there are some bigeye in the data. But some of it is including the bigeye; most of the data is made up of yellowfins.

Question: (re: the time when burn occurs)

Answer: I have had fishermen tell me that fish that are burnt, sometimes when they refrigerate it overnight or something like that, the next day it would be unburnt. Histologically, this is not possible. The damage that I see in the tissues that I examined under the microscope is so severe that this solution does not seem possible. And I don't think that tissues can reconstruct in that manner. However, the color patterns may change sufficiently that lightly burnt tuna - pale colored - may mask the burnt condition. I have no reason to doubt what the fishermen tell you, but that's the only kind of explanation that I have. I know that the muscle tissue has been destroyed in such a degree that it will not reconstruct.

Question: I have several questions. With regard to the implication that is very similar to the porcine stress syndrome in that there might be some sympathetic nervous component to the burn. Have you had any evidence that suggests that using an ice pick to pith the ahi actually stops the burn?

Answer: I think that your observation that this condition looks very similar in appearance to that of porcine stress syndrome is very astute. We have thought that it looks like the porcine stress syndrome - looks like another condition called catch myopathy in other animals. It looks like hypothermia in dogs and chickens under anaesthetic. It looks like a lot of different conditons. We have thought about that question that you have asked specifically in that I think that this Taniguchi tool is effectively that. It's like pithing an animal in that my understanding of the Taniguchi tool is that it enters the spinal cord and effectively destroys the nervous tissue of the fish soon after landing. It should be effective as a method to prevent burnt tuna. I know that a lot of fishermen have tested it here and my impression is that they were not favorably correct. But some fishermen have told me that I'm wrong.

Question: I have quite a few number of questions. Has anyone talked about using nondestructive methods for looking for burnt tissue by using ultrasound or electrical conductivity? Second one, was in the case of catch myopathy, has anyone

talked about using injections of sodium bicarbonate to the heart when it is still beating?

Answer: I like your question because we thought of it. Electrical conductivity essentially is not effective. On the ultrasound, we did try it. It is only, we can detect it only when it's very severe. When we have very severely burnt tuna and it will not penetrate skin. The ultrasound is not very effective - it has to go through the thick skin of the fish. The other one about injecting sodium bicarbonate or something of that nature. We have kind of looked at blood. We don't have enough data of fish where we obtain blood at the time of catching in order to adequately evaluate that. We did think of that. I think that you have trouble convincing some fishermen with the fish flopping on deck and you want to go inject sodium bicarbonate. But it is a good suggestion. We have it in the back of our minds. When the time comes when we can get a high percentage of fish, in other words, if we can reproduce the disease. In other words, if we knew this and we left the fish on deck, let the fish flop on deck or whatever, in order to produce this, then we can start doing that kind of study. But right now, if we do inject sodium bicarbonate, we're only going to get 23% of the fish burnt anyway. And therefore, it would be very slow type of research in the fact that we would have to do a very large number of fish in order to adequately assess such a method to prevent it.

Question: (re: when burning occurs)

Answer: The information that that is based on has to do with pathology. When I examine fish microscopically that are burned, there is so much damage to the muscle that I know that body will react to that. And therefore, you would expect to start to see the kind of quality that results very rapidly after. You have for instance, an infection and the body is reacting to that. If I take a section of that, I would see an invasion of a lot of cells there. It takes just a matter of hours, the cells will invade the area and start to deal with the condition. What I don't see, I don't see cellular invasion of the tissue. And therefore, I conclude that this event occurs postmortem. In other words, the cells don't move around for very long after the animal dies.

Question: (re: fighting time and burn)

Answer: That is a very good question because we have asked that very question. In fact, some handline fish are brought up within 10 minutes. And there is not much fighting of the fish. In sport fishing, it may take an hour or two hours to bring a fish up and we are baffled by the fact that if a fish fights for that long, I would think that the temperature of the fish would rise sufficiently and most of

the fish would be burnt. The fact is that what we find right now or what we think right now, is that about 50% of the sport fish are burnt. And therefore, it is a little baffling to me and I would really like to talk more about this very issue. It's very interesting. And yes, you're right in that if temperature is involved, then Dr. Brill's countercurrent system of the ahi is very involved because that will raise the temperature considerably over.

BIG ISLAND FISHING INDUSTRY CONCERNS

Small Group Discussion Results

GROUP I:

I. Fishing Industry Problems (prioritized)

A. Lack of organization by commercial fishermen

1. Formation of a co-op

2. Special licensing for full-time commercial fishermen

3. Voluntary

B. Improvement of launching areas

1. Pohoiki

2. South Point

3. Wailoa

4. Support facilities around launching areas

5. Security

6. Lack of water to wash boats

C. Formation of co-op to purchase bait (i.e. squid, opelu)

1. U.S. Government - USDA Coop Service

2. Locate and organize bait fishermen

D. Lack of enforcement of existing fishing laws (i.e. non-licensed fishermen selling fish wholesale)

1. Enforce existing laws (Tax Department) (DLNR - Division of Aquatic Resources)

a. Not paying taxes

b. Write letter siting incident

2. Have fish dealers inc., supermarkets show license number of fishermen prior to purchase

E. Marketing and exportation of fish

F. U.S. Government fisheries program aids - not available (i.e. satellite, ocean information)

G. Coordination of medical and dental group programs that is feasible for the fishermen

H. Consumption by porpoise of fish and bait

I. Availability of fish (where did all the ahi go?)

J. Constant supply of quality fish

K. Training program for commercial crews

L. Lack of baitfish

M. Lack of support facilities for fishermen (i.e. boats, reels, etc, engines)

N. Ciguatera fish poisoning (i.e. kahala)

O. Whale sanctuary (concern by commercial fishermen)

P. Have government agencies organized to help fishermen

Q. Non-biased observer to oversee auction block

R. Ability to separate fact from fiction

GROUP II:

I. Tuna Industry Problems (prioritized)

A. Location of ahi schools

B. Porpoise

C. Launching facilities

D. Lack of navigational aid (Loran-C) on Hilo side (also Kona)

E. High expenses

F. Funding for new boats and information (research)

G. Catch reports

H. Sharks

I. Relationship between purse-seiners and local fishermen

J. Baitfish problem

K. Relationship between long-liners and local fishers

II. Solutions

A. Location of ahi schools

1. Where are ahi biting?

a. Statistics feedback

2. Send printouts

3. Where were fish last month?

a. Need current information

4. Continue funding for research for tracking

B. Porpoise problem (stealing bait)

1. Overpopulation, overprotection (Federal responsible)

2. Research for repellent (sonar) effective fishing method to exclude porpoise

C. Launching facilities

1. Money, freshwater/washdown (Pohoiki, South Point)

2. Improvements for existing facilities

3. New sites for ramps (Ka'u, Honoka'a)

4. Get Department of Transportation attention, show economics

D. Navigational Aids

1. Need aid system (1990 next improvement)

a. Steve of Oceantronics has information

2. Need secondary station for LORAN-C (emphasize safety to Federal)

GROUP III:

I. Fishermen Problems

A. Too many fishermen in small area for all fisheries

B. How to establish multinational fishing controls

C. Need to define migration of fish stocks

D. Need to improve Fish Aggregating Device program

E. Why large fluctuations in prices of fish to fishermen ($ here, ¢ mainland)

II. Wholesalers Problems

A. How to stabilize price

B. How to reduce burn

C. How to develop export markets for large seasonal supply

III. Retailers Problems

A. How to maintain consistent high quality control

B. Should there be better grading and labeling standards

IV. Common Problems

A. Availability of produce/stable supply

B. Alternative fisheries for off season/seasonality of resources/marketing

C. How to get government help for the industry

D. How to develop ongoing cooperation of all units within fishing industry (fishermen, wholesalers)

V. Solutions to Common Problems

A. Find out why tuna aren't here (where are they) during the off season

B. Determine factors influencing abundance

C. Determine effects of taking large amounts of small ahi

D. Establish system of communication between fishermen, wholesalers, and retailers

E. Establish lobbying effort

F. Stablize the number of fishermen

G. Overall management of resources

H. Develop storage capacity

I. Define commercial fishermen (license, etc)

1984 LEGISLATION AFFECTING HAWAII'S TUNA FISHERY

Virginia Isbell
House of Representative
State of Hawaii

Thank you for allowing me to be here with you this morning. I look forward to perhaps stimulating your minds and giving you a few new ideas, thoughts that maybe you had in the back and need to bring out.

It might be interesting to note that I got caught in the rain this morning. I walked over to Suisan to get some excercise and ended up getting wet in the process coming back. But I do thank the person who stopped and gave me a ride so I wouldn't be totally soaked in this air conditioned room. Also, in a hotel this small, it's good to excercise a little bit too, after meals and before you get going in the morning. So you'll notice I hardly use any elevators. I go up and down the steps. And you ought to try it. It's very good and that's what they're for, you know.

I have about eight or nine items that I would like to bring out. I'm going to go very fast and I hope that you can absorb some of this. Please feel free to write down anything that you want more information on and after I'm through, if you want that information, I'll be happy to get it to you if I have your name and address and what it is that you want.

The first thing that I would like to mention is that I did introduce a resolution this year on port authorities. Unless you feel that your ports are all run very beautifully and perfectly, you probably wouldn't be interested in this. But I feel that they aren't and that the State needs to get out of the business of running their harbors. So I introduced a resolution to ask that this be looked at. And unfortunately, we ran out of time. But we did have some excellent testimony on it. One of the things that we learned is that the State isn't in the business of really promoting harbors. Their job is by statutes, simply to run them. So this explains why they are run the way they are. So I would like to suggest that that be one of your goals, if you're interested in it next year for legislation.

The second is the whale sanctuary. I presented my testimony at the whale sanctuary meetings in Honolulu. And I am in opposition to that. And I signed the resolution, and in fact, introduced one which Representative Matsuura had hearings on, there were two actually. And we went on record as being opposed of the whale sanctuary because we do not feel that it will produce anything beneficial to the whales that they can't

do right now. The only thing that might happen is that it would bring money in for perhaps in science, research and education. But I think that the sanctuary, if it's going to be anywhere, should be where the whales migrate, their whole trail across the ocean. They are only here for a few months and the whale sanctuary just didn't seem to make sense to me.

The third thing I'd like to mention is something that very few people know much about. It's the greenhouse effect and how it might affect the water. Now this may affect your fishing industry as well. The greenhouse effect is the carbon dioxide that builds up around the world from the burning of fossil fuels. Everytime you get into your car or in an airplane, the leftover from what's burned is carbon dioxide. It allows the heat from the sun to come in, but it cannot escape. And it is irreversable. The problem is that we don't know how bad it is right now or how long it will take to get worse or to the point where we start having a melting of the icecaps.

We have the Arctic which is already ice in the water. As it melts, it's not a hazard problem; a hazardous problem as it is in the Antarctic, which is on land. If the Antarctic should start to melt, we now have a rise in the water level because that's water or ice melting off of land into the ocean. If there is a rise in the ocean, then you can expect this eventually. We don't know when or really if (it will occur), but it seems to be a very strong bit of information on many people's parts, enough so that there are doctor's theses being written about the greenhouse effect. There is the possibility that by the year 1990, we may see a beginning in the rise of the oceans. If so, what effect does that have on currents? What happens when you have a lot of cold water entering into the oceans of the world? I believe the television program NOVA, is doing a special on the greenhouse effect.

The fourth item I have is on ocean mining. There are so many interesting conflicts in this. The ocean mining leases go out next year, 1985, and they are for the Northwestern Islands of Hawaii. Now it's interesting that the United States Fish and Wildlife Service administered the wildlife refuge in the Northwestern Hawaiian Islands, for 1,200 miles beyond Niihau. And it is also the only undeveloped fishery resources of the State. Now if the Department of Interior gives out leases for ocean mining, for cobalt with the manganese crust, what effect does this have on the undeveloped fishery for ahi, tuna, other species in Hawaii? How does it affect you? How do you feel about that?

We haven't even discussed what happens when you put a Caterpillar tractor under the water and manipulate it on the top by controls. It crawls along the ocean and crushes the crust. And then makes a slurry out of it, sucks it up through a tube, puts it on a barge, and puts 90% of that

(which is seawater which brought the heavy metals up), back into the ocean. According to the United States Department of Interior's environmental impact statements, that would be nine metric tons of waste water per day in that sea mining area. We don't know what happens when you dump the water back in. And we don't know what happens to the fish. Do they need clear water to feed? Does that chase them away? Does it destroy their habitat? Does it affect their food chain?

We also have a conflict between N.O.A.A. and the Department of Interior. One is saying that the other doesn't have the authority to offer the leases. As far as the environment goes, in the ocean and the land, those things will be coming about with the environmental assessments that are hopefully going to be done. But I think that you need to be aware that the leases are going out next year and how does that affect your fishing industry?

This past February, I sent out a questionnaire to all over the world - Department of Land and Natural Resources here, I sent it to Thailand, Australia, Italy, and I asked them very basic questions. Ahi populations, I said, are local populations shared with other fishery area. In other words, do our fish migrate? Are any or many of the local tuna relatively localized in range or their life cycles? Do the small ahi tend to be more localized in range? How many populations pass through and stay in Hawaii's near shore waters? Is there much or any exchange between the populations? Are any populations of tuna, ahi being seriously overfished? And how do you determine this? What proportion of Hawaii's ahi catch is the fish less than 5, 10, 20 or 30 pounds? Would an increase in proportion of small ahi in the local catch be the result of serious overfishing? If local fishery methodology changed to take an increase in proportion of smaller fish, what effect does this have on the local ahi fishery? Could small fish be selected for/against by hook, size, fishing and location? Did juvenile ahi tend to be concentrated near the shore or are they restricted to near shore habitats? Would the heavy take a small ahi near F.A.D.s (Fish Aggregating Devices) have any effect on the local fishery? Does a combination of F.A.D.s plus purse-seining have the capability to deplete a local fishery of ahi? Can the purse-seining be done in local Hawaiian waters or is the water too clear? What size fish are taken in purse-seining? Can the size of fish be selected by the sinking net method? Is purse-seining sometimes combined with the use of logs, buoys or F.A.D.s? Will purse-seining deplete the industry? Is purse-seining detrimental to other types of fish? This was my questionnaire.

And I have found out that nobody knows anything. The answers that I got back were that basically there's very little if any knowledge, but some of you may be pleased to know that the one department that knew the most about nothing is the Department of Land and Natural Resources, Aquatic Divison.

Now, here's some of their answers. I won't read them all. If you want this, remember, it's available to you. They're original documents that I have highlighted.

Are the local population shared with other fisheries? 'These stocks are not well defined and not much is known about their separation. We do not know if they mix with the other stocks.'

Are any of the local tuna relatively localized in range for part or all of their life cycles? 'If no catch reports are turned in, then we are not sure if the fish are there or not. We are not certain about the distribution of juvenile ahi.'

Do small ahi tend to be more localized in range? 'We don't know if small ahi are more localized.'

How many populations passed through and stayed in Hawaii? 'Well probably,' is their answer, probably this and probably that. There is no sure answers on anything.

Are any populations being seriously overfished? 'We have no information on the status of the ahi population around Hawaii. However, the Eastern Tropical Pacific population of yellowfin tuna has been extensively studied and scientists monitoring the catches of fishing boats for many years and that population is fully exploited. Now that is along California coast. And they have instituted tough regulations in other words. However, we don't know what the maximum sustainable yeild is for the Pacific yellowfin tuna.'

What proportion of Hawaii's ahi catches less than five pounds? 'We currently don't have figures for these.'

So anyway, those are the answers, that is, 'We don't know, we might, well, probably,' and that's why I said at least they made an effort to answer every one of my questions. But they know a little bit about practically nothing. So I put that up for you if you want it. It's there. But I really give them credit with what information they have, they've at least tried to answer my questionnaire. By they way, I sent that out before I was asked to be here. I did it simply because I wanted to know more about what was going on in the tuna industry and the ahi industry.

I had a question about Thailand referred to Sri Lanka and they passed the buck. They suggest that Sri Lanka might have the information. Well, some of you know that the two Americans who were just released from Sri Lanka, they are not necessarily the most friendly people right now, so I doubt if I'll get an answer from them.

At Scripps Institute, they said that they never conducted research on the Central Pacific population. N.O.A.A. has no real information. They suggest that fast sinking nets as used in the Philippines might work. But in another letter, I found that Philippines have completely exploited their tuna and the industry has collapsed from using some of the payaos. So we've got to look, as maybe we're doing the same thing.

And I have a question for you. Are we farming our fishery or are we mining it? Think about it.

Tuna fishing data appears so steep in politics that is is difficult to get objective answers.

I'd like to know how much thought has been given to the morphology of the fish. That is, to the size of fins, the length and the contour. Do they have anything to do telling us how much they migrate? We seem to feel that there are three migratory areas. The Western, the Central, and the Eastern Pacific. What we don't know whether they stay within those circles for sure. There are so many unanswered questions that it makes you wonder how long we can continue to go along without having some of those answers. Could this not aid in determining the migration population in the interchange?

This year, we introduced legislation to limit the size of the ahi that are being caught. And it was because there is a great concern: if we don't let them grow up, how do we have some more that spawn? And if you have small lures, you'll catch the small ahi. If you have the bigger lures, you'll catch the bigger ahi. So some people who are catching the very small ahi, it would appear are going after them specifically. So we need to look at this problem. Is it going to affect the future of the tuna industry or the ahi?

If we are going to do anything about it, perhaps we need to look at how it's going to be enforced and either think that the law enforcement people who are also in DLNR, with the Aquatics Divison (although they're separate), would be hosted and stationed down at the fish buyers. If the fish buyers can't buy a small ahi, then people aren't going to catch them - if there were a law against it.

One thing you might be interested to know, (and we're talking about different things that are happening here in Hawaii) and this is not the tuna industry, but the entire Monterey abalone industry is moving to Kona. And this is a multi-million dollar industry that would be developed on land there. They found that because of the deep water association that they have with OTEC or NELH in Kona, they are able to use the water more effectively and it doesn't need straining because it's so pure from our deep water sources. They are also able to raise the seaweed necessary, the kelp, to feed the abalone. I did go

through their facility in Kona. The abalone have little 'apartment houses,' like cubicles. They figured out how to put them in little 'apartment houses' in little plastic grating, and then as they get older, they get into larger 'apartment houses.' Pretty soon they're this big around and they're just brought out, and there they are, all ready to eat. So they found out it works.

There seems to be a conflict between the DPED and the DLNR. Department of Planning and Economic Development is meant to get economic development. And of course, they're the one pushing for the manganese crust mining. On the other hand, the DLNR is supposed to be promoting the fishing industry. And so I wonder if those two have gotten together lately because they seem to be in direct conflict over here.

I also had information on a person who did a doctorate on decision making. And what she found out was that people in high places don't like to make decisions. I have her whole thesis here. I've gone through it and it says that organizational behavior is the inability of decision makers to process information or the lack of sufficient information or a combination of the two. It may sound very complicated, but it's very very interesting. I have highlighted a lot of it. But what I discovered was she did a study on 214 people who are decision makers in this State. Representative Matsuura was one of them, he may not know that, but he was sent a questionnaire along with others. These included top administrators - Federal, State and County, county councilmen, legislators, fishing officers, fishermen, all kinds of people. They were from this whole State as well as the Western Pacific Island Government. The least returns came from the two Regional Fishery Management Councils.

The legislators were able to cope with new concepts but within set boundaries. Members of Regional Fishery Management Councils would not be inclined to change traditional methods of decision making because of their inflexibility in internalizing new ideas.

At the extreme closed end, is a profile of fishermen and the fishing interest and State level decision makers who have strongly held this set of beliefs and inability to accept new information which requires behavioral changes. I realize I'm saying this very fast, but what it's saying is that they are stuck on their ideas and they don't change very quickly nor do they like to make decisions.

When decision makers are categorized, the truism that where an individual stands is basically where he sits. I'm sure if we ask Representative Matsuura how he stands on the subject, it is in his position of where he sits as a Representa-

tive and Chairman of the Ocean Marine Committee. If I ask some of you about where you stand, it's going to be basically where you sit. Are you sitting on a boat? Are you a fisherman? Or are you in a decision making capacity? We often have a rejection of externally generated information because of suspicion of any information which is not generated in the House. Does that strike a bell?

The fisherman's legal definition in the State of Hawaii is that anyone who pays $10 fee for a license, is a fisherman. It requires a filing of a catch report.

But I have a question for you. If there are only 525 full-time commercial fishermen, (although the State estimates 800) who are supposed to put in a report, and many of them do not, then how do we account for 150,000 recreational fishermen who go out and fish, who do not have to file a report and who harvest the coastal fisheries and contribute to the underground supply to their outlet, friends and relatives? They are not required to report any landings and/or are thus not statistics. But if there are 150,000 recreational fishermen and they only went out one or two days of a year, think about it. That's 150,000 fishing expeditions that are unreported, multiply that by only two days and it is staggering. I think we've got a problem.

Most commercial fisheries, they've discovered in this questionnaire and another, is done 20 miles from shore. The average age is 42 of the fisherman. By the way, there are 1,575 part-time commercial fishermen. There seems to be a problem with wise management of our natural resources and actually I'm beginning to think it's wise management of our human exploiters of the resources.

Many of you have worked in this Conference, have been here and absorbed a lot of information, I hope that you will not just leave this Conference and think well, that was stimulating or well, I knew that already, nothing new or you know, there is a problem there. What are you going to do about it? I would hope that you give some thought into forming what I would call well coordinated public/private partnerships. It's a project to jointly address shared problems and evolve innovative solutions which have mutual benefits. Now if you all leave, go your separate ways, and don't even discuss what you've learned here today except maybe with a couple of people, then what is the Conference all about? I think it's to leave here with some real definitive chores for you. Get together in partnership groups with public/private organizations, set your goals, determine what your problem is going to be and try to come up with some innovative ideas on how to improve it. I have been to many conferences and I know that's what happens. You get up and leave and you don't even give it another thought. The next year, you come to a conference and we discuss the very

same things that we discussed 10 or 20 years ago. Because I've gotten reports from 1971, I've got reports from 1963, and they are exactly the same as what you're talking about today. Nothing has really changed. When are we going to address the problems? Are we going to wait for the other guy to do it?

I'm willing to help you and I know Representative Matsuura is. I've left a lot of things for him to talk about which come about through legislations. Midst in, I want you to know that he's one of the hardest working individuals that is at that Capitol. He's in his office still reading when I'm leaving which is pretty late anyway. He's in his office still when you call him. I don't think he sleeps much. But he reads all the documentation he can get and he tries to make good decisions based on that. We have departed many times in what he felt was good and I was totally opposed to. Like the unagi and a few things like that. That's because as individuals, we have separate ideas on what we feel are important to the State. If you can disagree and still come together on the bigger issues, and be friends outside of that room where testimony hearing is being held, then that's what it's all about. That's the kind of maturity you have to have. You don't hold grudges. You get out there and work and you work a little harder. But it's working together that brings us all about. Nothing he does is done alone. In fact, if he doesn't have the consensus of his committee, he doesn't pass anything. So he's got to prove that what he's doing is acceptable and this is the way it should be with you.

You should all feel that it is your responsibility. It's not the State's, it's not the Federal Government's, and it's not the County. The fishermen, the people who are out there fishing, need to take a good look at what is happening in the industry. And if these answers are not coming forth, then figures some way out to make them happen.

I'd like to thank you very much again for allowing me to be with you. And I do want you to know that I'm available anytime you'd like me to talk. I enjoy that. I just always hope that I don't talk too much, but that I give you something that's stimulating and brings to you new ideas. And of course, I give you the challenge. Join some partnerships with each other, get to work. This is a coalition, join it and figure out the answers to our perplexing problems.

Thank you very much.

1984 LEGISLATION AFFECTING HAWAII'S TUNA FISHERY

Richard Matsuura
House of Representative
State of Hawaii

Thank you very much. After Representative Isbell said such nice things about me, I'm going to have to remember her when I go to the Senate and pass all her bills.

Well, before I start here, I just want to introduce Representative Mike Crozier. I know he was introduced yesterday, but I want you people to meet him. He's one of the real strong supporters of fisheries because he has been in the fishing business. I think his uncle is 'Mr. Aku' on Oahu. But when it comes to fish, he is the front point man. I mean he is really somebody who is very interested in the development of fisheries.

Okay, now first, I'm supposed to talk about legislation and all that. First, I'm going to give you my failures. I might as well tell you about my failures first and then we'll go on to some things that have passed.

Two failures that I have which I take full responsibility. One is that we tried to eliminate the 4% tax on the boat repairs. I felt that in introducing this bill, I felt that this was a good bill because it's unfair for the local fishermen to have to pay the 4% excise tax when people coming from California don't pay it. People coming from Japan don't pay it. We're the only ones in Hawaii who pay and that I think, is very unfair. Unfortunately, it didn't pass. But next year, God willing, it is going to pass. Is that right, Representative Mike and Virginia? Okay. They're two of my members over here, right in the Committee.

The other one that didn't pass is in terms of the ahi, you know, Representative Isbell mentioned. We tried to pass a bill whereby you could not sell, you know, in the open market, ahi that was less than three pounds. And we used that three pounds primarily because even in the cannery, they were getting about one cent a pound. Here again, there was strong opposition from some of these fishing groups too, that this was something that they felt was detrimental to the aku industry, primarily, they felt they got their bread and butter from the small ahi. So these things still have to be resolved. But those are two bills which I thought would have some impact on the fishing industry that didn't pass.

Okay, now let's go on to some of the bigger issues. You know, I have here all the bills that passed and all the resolutions that passed, but I figured if I go through all of

them, I would bore you. So I thought today, instead of talking about just legislation, I thought maybe I'd better cover some areas in which to give you some idea of how the Legislature works. And you know, how you can help us.

I think one of the biggest bottlenecks or the biggest problem that we have as legislators (I got elected the first year as a freshman, went over there, and became Chairman of the Ocean Marine Resource. Besides catching small fish with the hand pole, I didn't know anything about fisheries.), is all of a sudden, you're chairing a committee that is going to set policies, directions for the whole State. And this is where I felt very uncomfortable, because I didn't know the fishing industry or the aquaculture industry enough to really set the tone.

And this is one thing that I have been trying to formulate within my own self, a grand picture. Because once the grand picture is instilled in an individual, such as myself or Virginia or Mike, it's very easy to write bills. Duck soup, I'm telling you. And it is easy to pass because each bill would be like a piece in a puzzle forming a grand picture. Maybe you know the old fishing industry and then you can run a legislator to fit a piece in the puzzle. And then the pieces will all fit together and all of a sudden, you've got yourself the total ball of wax, totally developed.

Now I cite these things because this helps us. So when we come to bills, we don't have one grand picture. The aku fishermen, for example, is against a bill when the ahi fishermen is for the bill. You have the processors for it and the fishermen against. You have to come out with the priorities. What is important? What is the thing that you really, you know, need to develop the industry?

Now as I was sitting here, I was trying to think in terms of what are some of the issues are. I'm an agriculturist, so I know approximately what I need to do. In Sri Lanka, they called me one time because a hurricane had knocked down all the coconuts there. So they called the Rockefeller Foundation. And the Rockefeller Foundation called and said, 'There's a guy, Dick Matsuura in Hilo. Call him, he's the guy, you know.' So they called me, and I went to Sri Lanka. And thus, I helped them. You make decisions, because at least I had some picture. They were using coconut milk in their cooking. I just substituted coconut milk with soybean milk. And all the problems were solved. I showed them how to grow the soybeans and process the soybeans and I came home.

Now the same kind of thing is easy for me because I have some background. In the fishery industry, if we have some background, it's very easy for us to do something. And I'm just going to cite an example.

You look at today, what do you think is most important, you know, I'm talking about the total tuna industry now. What is really the most important issue that is standing today? Are you interested in catching the tuna? Are you getting the good price at the market? Is the quality maintained? Hey, that's what you're interested in and that's it. Many of you don't get involved in national legislation. You don't get involved in the State legislation. Because you are like the agriculturist. You just are independent entrepreneurs.

Now look at the tuna industry today. Bumble Bee closed down in San Diego. Van Camp is going to close down July 1st of this year. Starkist is going to close down October 1st of this year. In other words, there isn't going to be any cannery except for one small little bitty one on the west coast, in the San Diego area. The question is why? What's happening? What's happening to the whole tuna industry? Why are the big guys closing down?

I'll give you another example. You know, about a year ago, I guess it was, I went to the tuna businessmen to brainstorm. I stopped over at Bumble Bee and I was talking to one of the top managers. I said, 'Look, what can we do in the State of Hawaii that can help you, and help the tuna industry?' So this guy told me, 'You do me two things, and I will guarantee you I will have another ship at the tuna factory. Five hundred more jobs.' When he said that to me, lights all lit up because as you know, Puna Sugar lost 500 jobs. If I can get another 500 jobs in Honolulu, that's going to help the economy.

The two main things he asked for were first, the land behind the tuna packers, so they could put a bigger freezer facility back there. Second, they asked that the channel to Kewalo Basin be deepened and dredged to make it to at least about 20 feet. So I said, 'Okay, I'll do my job and you keep your promise.' Okay. Well, we got him the land and the channel is scheduled for the dredging and it will be done by December. So I kept my word. What did they do? They don't want to put the freezer on now. They have limited the catch that they're going to buy from the long-liners to 500 pounds or something like that. And for the other additional 500 pounds, they put a time limit to June 15th. And that's what I balked at. I said that by June 15th, the fishermen will not have even caught their fish. So that's as good as nothing. Because they'll be getting their fish from Singapore.

Now what does this tell you? It tells me that in the industry, something is happening. So where do we attack? There is one amendment that's going to be placed in Congress. And that's one of the reasons why I have been pushing for this, counting on our Congressional leaders to make sure that they support it. Get everybody's support. Use some of your chips, because one little thing can have a big effect on the total industry.

Right now, when the tuna cans come to the United States, if they're oil packed, they pay 30% import tax duty on that can of tuna - 30%, if they're oil packed. If they're water packed, it is 6%. One-fifth of the thing. The American public likes the water pack. Do you think those foreigners, do you think they are going to pack them in oil? Everything that's coming to the United States is water packed, 6%. Six percent is nothing. By the time you start looking at what they pay their people and all those guys, and the subsidy that they have, it is nothing. That's why we're sick. The whole industry is sick. So we got to move the 6% of water pack up to the same as the oil pack which is 30%. I think we can survive. Then Van Camp won't close down. And maybe Starkist won't close down. Maybe Van Camp might go back into production. I don't know. Maybe Bumble Bee, maybe we'll get the other freezer. And maybe we can get the Midway operation all going again. But right now, I foresee some problems.

You know, as you look at the total industry, I always felt as when I was in foreign countries. I helped Iran with their tomatoes; you know, that's something that I've done. If you go to Africa, it's soybeans. India, soybeans. You know, I have some calling me the soybean king of India. So I've done all these kinds of things in terms of the movement of the industry.

Now the thing that a lot of people don't realize is that one should look at foreign policy, the State Department. I always tell the State Department to look at what the missionaries did. Because the State Department is repeating the same mistakes as the missionaries. I said that the fishery guys are making the same kinds of mistakes as the agriculturists. Because there's no way you are going to compete.

For the sugar industry, they've given an example in India. They don't pay income tax on any agricultural production, income from agriculture. You don't pay any income tax now. Now when it come to sugar, the government then subsidizes. They pay them what, I can't remember now, double what the world price is. They pay their farmers double what the world prices are. Of course, they pay them in rupees, which is worthless paper anyway. The U.S. owns half of the monies in rupees in India. So they pay them that and then what do they do? They take the sugar and dump it in the world market. Why do they do that? Losing 50% of their money. Because the worthless rupee now becomes valuable currency in U.S. dollars. That's what they compete in. That's why the sugar industry is having problems. Why do you think Bumble Bee is going to buy tuna from Singapore? They say it's bigger fish and all that, and cheaper. Because Singapore I'm sure, if you look into their fisheries and you know, the things they have highly subsidized, are their industries.

And that's why I'm saying we can pass legislation. I'm out talking about some of the legislation but what I want you

to know, to be aware of today, that there are many issues that you can yourself help. If you know Senator Matsunaga, call him up. If you know Senator Inouye, call him up. If you know the Congressmen, call them. Because this is your livelihood. Because you can say, oh, eh, that's nothing to us. You know those guys, the California guys, those are the big guys. They are guys who have 100 foot boats. But if the tuna industry goes down the tube, these guys that have to make mortgage payments on their ships are going to look for someplace where they can fish and survive. And if two or five ships should come to Hilo, I'm telling you, the guys who are over here and the Hilo fishermen, those guys with the big ship are going to start dumping all their fish over here. And you're going to be in trouble. These things are indirect and the kinds of things that you must become aware.

Now let's go back. I'm coming up with the big picture. I think that because we are all interested in the fresh fish and all these kinds of things we feel we never looked into the bigger picture. Now I give you an example. And to some of you who are listening (to the radio), I'm on the program this week on 'Insight.' So you know some of the questions.

I will illustrate an example of what we've got to do. And Mike, and of course, Virginia know, the pineapple industry. From the very first year I've been on the Agriculture Committee, the pineapple people always come for promotional monies to promote pineapple on the mainland to make sure they eat pineapples, know how to cut pineapple or make all these kinds of dishes.

So in my first year and being naive, I'm for agriculture, and so I passed everything. I gave them all the money they asked.

During the second year, they came back. This time, they came back with nice brochures, Ladies Home Journal, and all the beautiful pictures. I mean nice looking pineapple pictures.

So at that time, I said to them, 'Every year you guys come up with the same stuff.' They used to come with the double breasted suit and looked like real expensive guys, the advertising kind. So finally I said to them, I would vote for the money but do me one favor, consider doing five things for me and report back to me. You can use some of the money and do these five things and report back. Because I wanted to see what the impact would be. Because I have some experience with soybeans, with the development of guava, so I wasn't just talking you know, out of my hat.

Then this year they came. And as they were making again the nice presentation again, all the magazines they put in, the t.v. and all of that. I was trying to figure out, what the five things I told them to do last year were, and I forgot.

So this year, I asked them, did you remember the five things? They said that they couldn't remember either. And I couldn't remember.

This year, I said to them, I'm going to ask you to do only one thing for me. I told them this year I want you to go see the script writer on Magnum PI and instead of taking Tom Selleck and putting him into some old Pearl Harbor set (usually they catch the guy, you know, pound 'em, beat 'em up, starve 'em, he's almost near death from treatment like that). I said, instead of doing that, take him to Kunia pineapple camp. Take one of those old plantation house, put a big man with a bolo knife watching him, starve him till he's almost near death, you know, and the script calls for Tom Selleck to somehow knock the guy out. And then take a hold of the knife and go over to the pineapple field and take a pineapple, slice the pineapple like the locals do, cut and eat it. I tell you all the mainland people watching that are going to be hungry for pineapples. Because now they know how to cut that pineapple. And it's free. So I told them that.

Last week, I was in Honolulu and I called Universal Studios. I asked, 'Did the pineapple guys call you about the scenario?' He said, no, nobody called about the pineapple industry ad. So I explained to them the same story I gave you. She said to me, hey, that's a terrific idea, you know. I think we should do something like it to help the industry. She asked do you have some other ideas. I said, yeah, I do.

You know, I said I also want to help the juices, the guava juice guys. She asked what do you have in mind? I depicted a scene, Kahala Hilton, a beautiful dining room, and a dining table with the centerpiece of dendrobiums, beautiful dendrobium flowers and here comes a Princess of Tonga. You know, one of those real high cut dresses, slick. Tom Selleck is waiting over there in the bar, watching her walk in, so he tells the bartender, give her a Hawaiian Delight. So this guy makes the drinks, sends it to the gal, compliments of the gentleman at the bar. And we'll make two scenes like that.

Later on I'm going to twist my wife's arm and have her write to Ann Landers. Dear Ann Landers: You know I saw Magnum PI and Tom Selleck gave this beautiful gal the Hawaiian Delight. What is it?

So you see, that's why I went on the radio this morning. I had three bartenders prepare me the Hawaiian Delight. And I asked the public this morning, to help me invent the drink because I don't drink. This has to be a lady's drink. Maybe guavas with some vodka. But it has to be something that I like too.

So if we have a good drink that is a lady's drink, I'm telling you, do you know how many ladies read Ann Landers? And

you know how many people watch Magnum PI? All the ladies going to drink, there isn't going to be enough guavas! So this is why I am saying, it's these kind of innovative things that we must take. Because these all are free. We've got to do something to help us to move.

And to a lady who called during the radio program, I answered that it is all possible - because I did it.

I was the first to make soybean ice cream. And do you know where I made it? In India, 20 years ago. I had a contest among all the professors' wives on campus. I gave them all soybeans and they were to come up with a product. I had hundreds of products. Three ladies made ice cream. I had my professional staff improve the ice cream. I gave some to the meat companies and they helped me with the flavors. And we came out with beautiful ice cream. And so, on the radio program this morning, I told them about the ice cream. My wife, listening to the program, told me that with the soybean milk that they feed babies, you can make ice cream. So, for tomorrow's program, all you ladies who are making ice cream, use the baby's soybean milk if your baby is allergic. I cite these kinds of things because it is important for us to work on the market.

We passed some bills on using the geothermal heat to process fish. Besides ahi, I am looking at tilapia. Tilapia, I think, is going to be one of the answers to Hawaii's future in fisheries, and although some people may disagree, I am looking at unagi someday. But right now, unagi is shot dead. But since we do have this geothermal resource, I am looking at its development into some kind of pupu kind of food. Even when we look at all the sushi bars that are developing in the U.S. today, no one has eaten chikuwa, the tempura type food. We have not even developed any fish products that are worth it except cat and dog foods. But, I tell you, there are things that we can develop that will be delicious. It's just that we have not made it a priority. We have to sell these products. If transportation is going to be a problem, we must go to processing.

These are the kinds of things that I want to talk about - the big picture. These are the kinds of things that you have to tell us; what is it that you really want; what kind of product line can we move forth. After that, it becomes easy.

We also introduced legislation to make the Hilo Iron Works into a marine center. Isbell, Carpenter and I combined our resources to purchase and take over the place. And I guess I am looking at the University to get into the food technology product development area. We must get into the product development area. The University of Minnesota will not get into fish product development because they do not have the fish. But

we do have fish. Look at our growth areas. Tremendous! When you talk to the University of Illinois about product lines of soybeans, (they'd say), do you know this cake is made out of soybeans, this plastic rim, all your paint is made out of soybeans, your baked good, you name it. There are so many products, you'll never believe how many products are made out of soybeans. I can list you thousands of product lines. How did that develop? Through research.

So these are the kinds of things that we must innovate ourselves to place our priorities here.

I've talked about marketing and transportation. And the reason why I stress this is because when you are putting together the big picture, many of you will say, no, the first priority is to catch the fish - help us to catch fish. The production. That's why when I first was elected, everyone said get the baitfish, we need the baitfish. So we put a lot of money into bait fish. Some people said top minnows don't work, so we went to mullet - they made a breakthrough now in mullet.

In terms of technology, as Representative Isbell mentioned, do you know how far behind we are? Many of you know the pointsettias. They are not blooming today. They all bloom at Christmas time, right? Why is it? Chrysanthemums also. Chrysanthemums grown in the yard will bloom in the fall. Why? Because the mechanism that triggers the flowering in plants is the length of the night. Because as the days get shorter and the nights get longer. When that happens, the plants will start the hormones and the plant will flower. Well, we knew that as plant scientists back in 1930. We knew about this photoperiod effect on plants - 1930!

And in 1980 is when we got the first glimpse that this photoperiod has an effect on the reproduction of fish. And that is why, if you would like to see a mullet spawn on July 4th, at 10:00 a.m., I can take you to the laboratory at 9:00 a.m. and between 9:00 and 11:00 a.m., you will see the mullet spawn. The technology has made a breakthrough, and we can reproduce these fish.

These are the kind of things that can develop and these are the feats we can do, because if the mullet can be used as baitfish, then at least some of our baitfish problems can be resolved.

One thing that I must stress on you is that you are not fishermen. You are food producers. When I look at these kinds of things (i.e., I am a fisherman and I want to catch ahi, etc.) you are living in an ancient age. Because you will be making the same mistake that the railroad companies made. A long time ago, the railroad companies said their business is railroads.

And even the sugar companies said the same thing - their business is growing sugar. That's it. But if the railroad companies said that their business is transportation, (Do you know the king of power the railroad companies had at that time - they owned everything.) they would today, own all the airlines, all the trucks, Matson, they would own everything. But because they said their business was railroads, today, they want government subsidies.

This is why I am saying right now, you are not fishermen, you are food producers. Whether you are going to produce the food on the land with aquaculture, and if the ocean leasing bill passes, or by ocean ranching, which is a thing of the future. These are the things that we must look ahead into, and like Mike here, who says he is a 'Panasonic' man. He will tell you that I am a 'Star Wars' man, because I look way, way ahead. And that is how I look at things. Someday, you may be going into the ranching of fish.

There are many other kinds of things that I think need to be addressed. Boat harbors. What I would like to see is a boat ramp between the lighthouse in Kapoho and Kapoho Bay. That is where the fishing ground is, in addition to South Point. If we can look at the resources and move, when we come to setting up their priorities, there is so much we can do. On the production side, even in terms of going to the U.S. Navy for help, or to N.O.A.A. We have to get involved in these things because this information will help us. Look at the Japanese Navy. Look at Taiwan, China, and Russia. They give all of their fishermen a tremendous amount of data that they collect, such as thermocline. Do you know how long it took us to get the thermocline infomation from the U.S. Navy? They said it is secret information and yet, all of these other countries give their fishermen daily reports. So finally, the Navy said that they would give us the information once a month. Once a month? Maybe it changes more frequently. So finally, once a week. Now they are doing it once a day. So that's all right.

Now the U.S. Navy can spot submarines in the ocean. And if they can spot submarines, they can spot fish. Japan and Russia do not have the satellites that we do. We do have satellites up there. And the one they will be putting up early next year can help us spot those fish. And these are the kind of help we need.

We don't want to deplete the ocean resources. That's why we need conservation. When we invite the Japanese over to talk about conservation, do you know what they tell us? Hey, forget it! For you guys? You only account for a small percentage of the fish. Why should we sit down at the table with you? But, you see, once we get the U.S. Navy behind of us, and all of the satellites behind of us, we can start moving

into their fishing grounds in a whole big fleet, and we pass laws to subsidize fishing; (i.e., no more income tax for fishermen) tax credit, etc., everyone will be building boats to go to their fishing waters; and pretty soon they (the Japanese) will want to come to conference, because we will be catching all of their fish.

These are the kinds of things that we have to look at in terms of work and strategies, and what are our priorities; what do we do first? And these are the things that you yourself have to understand first, and then tell us. I am an agriculturist and my knowledge of fishing is limited. They tried to put me on an aku boat and make me a fisherman, but I get seasick. But really, we are still ignorant as to what the fishermen really need to push the fishing industry.

Priority number one should be marketing and transportation for you, which means product development also. We can develop the market with all the sashimi bars that are coming up, and go into the production. Ciguatera research, too, is important. Because if anyone in Hawaii gets sick from eating poisonous fish, no one will buy fish in Hawaii. These are the kinds of things that are important. Baitfish is important too. We need to give you the leverage.

FEDERAL FISHING BOAT LOANS

Bob Iversen

National Marine Fisheries Service

I see that we are running a little late as far as our time is concerned. And I'm going to make my comments rather brief and describe three programs that the National Marine Fisheries Service has. And I would suggest that if anybody wants to get the real nitty gritty details, there are a lot of them, you can see me privately during lunch or after lunch.

The National Marine Fisheries Service with one exception, and I'll get to that at the end of my little talk, does not loan money.

We have three programs. One of them is called the Obligation Guarantee Program, which basically is a loan guarantee. You borrow money from a bank and we guarantee the bank's portion of the loan 100%, which makes it a risk-free loan as far as the bank is concerned. We ask that you put up 25% of the cost of the vessel. The bank puts up 75% of the cost of the vessel or reconstruction of an existing vessel. And the bank's portion is covered 100%.

We do all the closing, all the paperwork, so it's a minimum strain on the bank and on the fishermen, as far as paperwork is concerned. But there is paperwork and I won't go through a check list of things you got to produce for us, but basically it's the same sort of documentation that the State of Hawaii would require for one of their boat loans.

Our Obligation Guarantee Program or Loan Guarantee Program covers vessels five net tons or above. As a rule of thumb, a vessel five net tons is about 28 to 30 feet long, depending on how the Coast guard had measured it. We are trying internally through adaptation of our own rules and regulations to bring this down for local residents to two net ton boats. At the present time, we have not succeeded in doing this. So the Federal Loan Guarantee Program only covers vessels that are five net tons or above.

However, the Loan Guarantee Program, due to some rules and regulations and I have a copy of the Federal Register if anybody wants to get into the nitty gritty, now covers shoreside processing facilities. This occurred in 1982. And if any of you were contemplating expanding your fish processing facilities and would like to know more about that, please see me promptly after my talk.

Our program does not cover the purchase of a used vessel. However, if you own a vessel that is five net tons or above, you can reconstruct that vessel providing it costs at least $40,000 or 20% of the replacement value of the vessel, depending on which is less.

And normally our Loan Guarantees are made not to exceed 20 years. Sometimes on a reconstruction and a rehabilitation of a vessel, it can be 10 years.

As far as the fisherman is concerned, we like to see a fisherman with a track record of about three years. A lot of fishermen in Hawaii, I have learned over the years, are pretty successful fishermen. But when you ask them to prove it, they can't do it because they didn't keep adequate records. This is one of the big stumbling blocks that we have found. The fishermen cannot come up with the records. Hopefully, conferences like this will get out the word that it's very important for the fisherman to be as much of a businessman as he is a successful fisherman. So we would like to see a track record of about three years of successful fishing.

And as far as information that we require, it would be quite similar to the checklist that Mr. Kobashigawa went through in explaining the State's program. So that's our Obligation Guarantee Program.

We try to get you the best interest rate that we can when working with the lender. If you can't find a lender, we don't require denials. But we'll try and get you the very best interest rate that we can. So I can't tell you exactly today what the interest rate you would be paying is. It depends upon the money market at the time. So that briefly covers our Loan Guarantee Program.

We have another program that works very well in conjunction with the State Loan Program. It's called our Capital Construction Program. And I think that some of the fishermen in the room, I know at least one, that's taken advantage of this. And the Capital Construction Program is a way for a fisherman to accumulate funds, to either buy a new vessel or to reconstruct or rehabilitate an existing vessel. And you can go down to two net tons under this program.

It works like this. You enter into an agreement with the Secretary of Commerce. And you select a despoitory, that's usually your bank or an account. You put a certain amount of proceeds that you normally would declare on your Federal Income Tax into this Capital Construction Fund. You do not show this when you submit your Federal Income Tax in April or whenever you put in your Federal Income Tax. It doesn't show as earned income. Now while it's in the bank, it's drawing interest. Now when you take the money out to reach your goal, whether it's five years or ten years, to buy a new

boat or to reconstruct your existing boat, then you pay taxes on it. But you don't pay taxes on the interest that you receive while the money was in this special fiduciary account.

So it's sort of a forced savings program for the fishermen. And it works out very well because you could have a goal to get money through the State or through some other program and you're saving up your portion of the equity that's required to reach your new boat or your reconstructed boat through this Capital Construction Program. It's very popular.

I have been away for about three years and I have just returned from working elsewhere. But in our region, when I left about three years ago, we had on the order of 400 or 500 fishermen with accounts in the Capital Construction Fund.

So it's a very useful tool to accumulate funds. If you don't see the money, you don't spend it. It's like having an automatic payroll deduction. I found if my wife wants to get me to save money, we put it aside before we see it. We don't spend it and we save it. I think that's all I'll say about the Capital Construction Fund.

Now recently, you know that on a nationwide basis, a lot of the fishermen, fisherladies, fishers have been in tough shape because of the down turn or overcapitalization of the fishing industry. And some legislation was passed recently by the Congress which made several millions of dollars available in emergency loans. Now, this is a loan and it's not a loan guarantee for people who are about to default on their mortgages. And this covers vessels five net tons or above.

Three million dollars are available nationwide for emergency loan from the Fishery Loan Fund in fiscal year 1984. A million dollars are reserved for fishermen whose vessels are already financed under our Obligation Guarantee Program or under our Loan Program. And these fishermen should apply as soon as possible. According to the notes I have here, it says before June 1, 1984. That doesn't leave you much time.

If funds for this category exceed applications for this category in June 1, this excess of funds will be made available to applicants whose vessels are not financed under our Fishery Obligation Guarantee Program. So even if you don't have your vessel financed under our Loan Guarantee or Obligation Guarantee Program, you still could put in for some of this emergency help.

Two million dollars are reserved for fishermen whose vessels are not financed under the Fishery Obligation Program. And these fishermen may apply during the open season which was from January 15 through July 1, 1984. The interest rate is 3%. That's like a gift from on high. The maximum maturity is up to

10 years and the maximum loan amount is one year's worth of mortgage payments. The loan will only go to cover mortgage payments, not bills you've got due to your fuel supplier or your bait supplier or others. It's to get you through over the hump so that you don't go into bankruptcy. And so that we don't have to foreclose on your mortgage.

So we have these three programs. One is the Loan Guarantee Program, we guarantee 75% of the amount that it takes to purchase your new boat. You put up 25%. We guarantee the bank's 75%, a 100%.

We have the Capital Construction Fund, which is a neat method for the fishermen to accumulate funds for the purchase of the new vessel or the reconstruction of an existing vessel. For this program, you can go down to a two net ton vessel.

And three, we've got the Emergency Loan Program which is going to run out in another couple of months. But if anybody here is really having problems, please see me and I can give you the name of the person that handles this program in our office. I normally don't do this, I'm pitch hitting for Peter Malone, who couldn't make it today. And he's up to date on all the details, and can work with you. All it takes is a phone call. I've got some of his business cards. And if I can't answer your questions today and give you the nitty gritty of details, well, Peter Malone will do it tomorrow or the next day.

So thank you very much.

ANNUAL REPORT ON LOAN PROGRAMS

I. THE HAWAII CAPITAL LOAN PROGRAM (Chapter 210, HRS)

The Hawaii Capital Loan Program was established by the State Legislature in 1963 to assist small business enterprises unable to obtain needed financing through conventional sources. Loans may be made to such concerns to finance plant construction, conversion, and expansion; for land acquisition; for acquisition of equipment, machinery, supplies, or materials; and for working capital.

Loans in this program may be made in participation with other financial and governmental institutions. The Hawaii Capital Loan Program has the following restrictions and limitations:

--No loans shall be granted unless other financial assistance is not available to the applicant, and the applicant does not have sufficient resources of credit.

--No loans of State funds shall be made for a term exceeding 20 years or for an amount exceeding $100,000.

--Participating loans shall be no more than 90 percent of the total loan requested, and shall not exceed $100,000 in State funds.

--The loans shall bear a simple interest rate of 7½ percent per year.

To evaluate the impact of the program, the recipients of the Hawaii Capital Loan Program were surveyed in 1983. In the survey, 49 percent of the respondents reported that the program's financial assistance "helped our business to survive."

Here is a summary of the survey findings:

Date of Survey: November, 1983
220 Firms Surveyed
110 Firms Responded

Summary of Businesses Surveyed

Total employment	5,300
Current annual payroll	$ 60,000,000
Gross annual revenue	$340,000,000
Taxes: Gross Excise	$ 7,000,000
State Income	$ 650,000
Real Property	$ 500,000

Estimated Direct Impact of Hawaii Capital Loan Program

Employees added by loan effect	1,350
Current annual payroll	$ 15,000,000
Gross annual revenue	$ 85,000,000
Local taxes	$ 2,000,000

In the above table, "Estimated Direct Impact of HCLP," the number-of-workers figure (added employment) was derived from the survey responses. Since this added employment makes up about 25 percent of total employment, payroll, revenue and taxes were estimated using this ratio. Using multipliers from the State Input-Output model, the total employment impact of the HCLP was estimated to be about 2,530 jobs and the total income impact about $29.9 million.

The legislative intent in establishing the program was that DPED, as a lender of last resort, provide loans to businesses that are unable to obtain the necessary financing through conventional sources. This means that such borrowers cannot meet standard banking criteria, and are therefore "risky" by banking standards. It is the State's policy, however, to take these risks. This policy has resulted in considerable benefits. These loan programs are exceptionally successful and are among the few State programs which generate far more tax dollars than they cost to operate.

The last appropriation released to the Hawaii Capital Loan Program Revolving Fund was in 1980 and the fund is now self-renewing through interest and principal payments. Interest payments of $248,307 in 1983 were significantly more than the administrative costs of the program, which were about $145,000 ($95,000 for personnel; $15,000 for supplies, equipment rental, postage, etc.; and $35,000 in defaults). Considering both the $3.8 million revolving fund appropriation and the approximately $1.2 million in other expenses over the life of the program, it has aided in the creation of one job for each $2,000 spent.

This program is continuing to serve small business and the revolving funds are growing. The role and effectiveness could be expanded through several changes, some of which would require little or no increased expenditure. The following are four possible changes:

1. Increase loan limit to $250,000 - Potentially productive projects are now excluded from consideration by the existing $100,000 ceiling. This would probably eventually require increased State contributions to the revolving fund; but, as past experience has shown, this should eventually be more than compensated for by greater tax revenues.

2. Promotion - So far, no wide spread promotion effort has been undertaken to promote the program with the small business community. If additional money were made available for an expanded effort, a campaign aimed at businesses and financial institutions might well turn up many more productive projects.

3. Aid in packaging and business analysis - With the current staff size, only limitied help can be given to prospective clients to prepare the investment analysis and loan application. The quantity and unfamiliarity of the paper work undoubtedly discourages some prospects who deserve assistance.

4. Fewer restrictions - The loan program is available to firms which are (1) small, (2) local and (3) have been denied private financing. As Hawaii now competes with other locations to attract new business, a selective relaxation of these restrictions for chosen industries could be a valuable part of our incentive package to encourage the type of industries we want to relocate in Hawaii.

As of December 31, 1983, 42 loans (31 percent of the number of loans) or 29 percent (dollar volume) of the total loans outstanding were over 90 days delinquent. Since the inception of the program in 1963, the accumulated loss totalled $312,070 representing 26 loans. This represents 2.4 percent of the total State financing of approximately $13 million.

At December 31, 1983, a total of $1,444,769 was available for loans.

II. HAWAII LARGE FISHING VESSEL PURCHASE, CONSTRUCTION, RENOVATION, MAINTENANCE AND REPAIR LOAN PROGRAM (Part II, Chapter 189, HRS)

The Large Fishing Vessel Loan Program provides financial assistance for vessels over five net tons.

Loans under this program are available only to bona fide Hawaii residents or a partnership or corportation registered and authorized to do business in the State, and the vessel for which the loan is made must deliver its full catch to a port in the State. Loans for this program may be made in participation with other financial and governmental institutions, or may be direct loans from the State but have the following restrictions and limitations:

--No loans shall be granted unless other financial assistance is not available to the applicant, and does not have sufficient resources or credit.

--The applicant must derive or plan to derive at least 51 percent of his or her gross annual income from commercial fishing activities with the fishing vessel for which the loan is requested.

--No loan of State funds shall exceed 80 percent of the cost of purchase or construction of a large fishing vessel.

--No loan for the purchase or construction of a large fishing vessel shall be made for a term exceeding 20 years.

--No loan of State funds for the renovation, maintenance, repair, or equipping of a large fishing vessel shall exceed 80 percent of such costs or a maximum of $50,000, nor be made for a term exceeding 10 years.

--Each loan shall bear simple interest at the rate of 7½ percent a year.

During 1983, 12 loans were granted totalling $844,600. This amount represented approximately 80 percent of the total financing for loans in the revolving account. This amount is definitely inadequate and will require additional appropriations. The average cost for the construction of a new long range fishing vessel is estimated to be approximately $700,000. Currently, we have six pending loan requests totalling $742,000.

Due to poor fish catches, the December 1983 delinquency rate showed a substantial increase from 51 percent (dollar volume) in 1982 to 64 percent in the over 90 day category. This amount represents 50 percent of the total number of loans outstanding. The delinquent rate should decrease to an acceptable ratio when fish catches improve.

III. HAWAII SMALL FISHING VESSEL LOAN PROGRAM (Part IV, Chapter 189, HRS)

The Small Fishing Vessel Loan Program provides financial assitance for vessels under five net tons.

Loans under this program are available only to bona fide residents of the State or partnerships or corporations registered and authorized to do business in the State. The

vessel for which the loan is made must deliver its full catch to a port in the State. Loans may be in participation with other financial and governmental institutions or may be direct loans from the State.

The loans for the program have the following restrictions and limitations:

--No loans shall be granted unless other financial assistance is not available to the applicant, and the applicant does not have sufficient resources or credit.

--The applicant must derive or plan to derive at least 51 percent of his or her gross annual income from commercial fishing activities with the fishing vessel for which the loan is requested.

--No loan of State funds shall exceed $50,000.

--No loan shall be made for a term exceeding 10 years.

--Each loan shall bear a simple-interest rate of 7½ percent per year.

In September 1983, $125,000 was released to this program from a biennium appropriation under Act 1, SpSLH 1981. During 1983, 6 loans totalling $120,200 were granted representing 73 percent of the total financing of $164,982. As of December 31, 1983, the program had 40 loans outstanding totalling $709,259.

As of December 31, 1983, 17 loans (42 percent of the total number of loans outstanding) or 48 percent of the dollar volume were considered over 90 days delinquent. The high delinquency rate is attributed to poor fish catches especially on the Island of Hawaii. It is anticipated that delinquencies will decrease to an acceptable ratio when fish catches improve.

Two loans were written off totalling $14,727 during 1983. This represents 1.3 percent of the total State financing to date of $1,160,874.

IV. DISASTER COMMERCIAL AND PERSONAL LOAN PROGRAM (Part III, Chapter 209, HRS)

The Disaster Commercial Loan Program was established in 1961 by Act 189, SLH 1961, to provide financial assistance to business enterprises which suffer damages in a State disaster.

Before assistance can be provided under the Disaster Commercial and Personal Loan Program, Section 209-2, HRS, requires a determination and declaration by the Governor that a disaster has occurred.

Commercial loans of up to $25,000 may be made to business enterprises to rehabilitate their facilities as far as possible to pre-disaster level. Personal loans of up to $5,000 may also be made to meet necessary expenses or to satisfy the needs of individuals and families which arise as an immediate and direct result of the disaster.

Loans may be in participation with other financial institutions or may be direct loans. The loans under the program have the following restrictions and limitations:

--The applicants are required to present evidence that the requested financial assistance cannot be obtained wholly or in part from the SBA Disaster Loan Program and private lending istitutions, and they do not have sufficient financial resources to rehabilitate themselves.

--The loans shall not include any portion or item of loss covered by a contract of insurance, or for which the applicants receive assistance from any other Federal, State or local program of disaster relief.

--The loans shall have a maximum term of not more than 20 years.

--The loans shall bear a simple interest rate of 5 percent per year.

There were no disasters declared in 1983 requiring financial assistance from this program.

TUNA PROJECTS AND FUNDING

Janet Swift

Pacific Fisheries Development Foundation

We have supported a fish handling project in American Samoa. That has had some very good results. There have been lots of fish coming up to the Honolulu market. And Mr. Frank Goto speaks favorably of the Samoan Fishery handling. It's in very good shape when it gets here. We've had a tuna long-line project in Kosrae. Not one of our outstanding projects. Unfortunately, a lot of problems. There's a real need for the availability of fish in Kosrae. The people import a lot of fishes. But they don't get much fresh fish at all. We're trying to change that into a pole-and-line fishing project this year. There are lots of problems. Especially bad weather, boat too small for the hydrolic gear that was involved.

So we supported the engineering study of the Saipan commercial fishing project. That project is complete. I understand they're letting that to bid. It started out as a commerical fishing facility.

We've supported the static fishing project on aggregation devices in American Samoa. To give you an idea of the problem of F.A.D.s, the project had to be stopped for a while because the F.A.D.s all got lost and they had to finance and order some more F.A.D.s and install them. That lost them several months on the project, but hopefully it will get underway again soon.

We had a very successful project in Truk lagoon bait production. They're catching a lot of tuna, pole-and-line method in Truk lagoon. We've had the mention of a transshipping project recently completed in draft. We're doing a feasibility study for a Truk shipyard and testing topminnows here in Hawaii. We have the F.A.D.s project I mentioned and the Ponape Trochus project. Those are our past and some of our current projects. As you can see, they are not all with regard to tuna, but a lot of them are.

This year, our Board met in February and put together projects from the various areas. The projects that we're submitting for Saltonstall-Kennedy funds this year total about 5½ million dollars. That's Federal amount. There are matching amounts too. So it's quite a large program that we're asking for.

The Board has divided the project between top priority and medium priority projects. You may be interested in knowing what some of those top priority projects are.

Top priority projects for Hawaii. We have a Hawaii seafood promotion committee year two demonstration project. And we have Hawaii night hand line fishing study. We have the topminnow and baitfish study. So these three are the top priority that are going in for Hawaii.

Others we are interested in, include refurbishing a lot of the equipment that are in the various Pacific Islands that are broken down and need to be repaired to get under way for economic development or fisheries development. Cold storage repairs to get coops going again. We want to do a small scale seafood processing, small cannery for Palau. Some marketing for Truk. Some harbor developments for Yap. Airport chill box, a lot of areas need this kind of basic thing to keep the fish in while they are waiting for the airplane. As I mentioned, American Samoa had quite an expansion of its fleet and they want to put in some more mooring docks to accommodate the vessels. We want to reactivate the cold storage and cooperative in the Marshalls. Fish aggregation devices, we understand this year, the National Marine Fisheries Service does not want to entertain projects for fish aggregation devices, but some of the areas felt so strongly for the need of these devices that they asked for them anyway. And they decided to see what would happen. So the Commonwealth of the Northern Marianas has put in for aggregation devices also. Boat launching ramps are another need in many of these areas. Guam is asking for one. Pole-and-line fishing in Kosrae.

And I mentioned, the regional projects, we found a lot of areas needed fish quality enhancements. So we are trying to get a regional project where people throughout all the areas show how the fish will bring a better price if it's better handled.

The tuna industry this year is interested in continuing an on board tuna quality maintenance program. I mentioned the U.S. Tuna Foundation. They, on their own, support a lot of research and development projects. They've already put in several hundred thousand dollars in this project and they are asking for some more funds to continue this. Apparently, this quality is a problem for them too and for purse-seiners. So that's about what we're in to. That gives you the range of projects that we're doing and those we hope to do.

One of the documents that some of you may have gotten also shows the results of cooperative effort between the Pacific Fisheries Development Foundation and some other agencies also interested in development in these areas. Of course, Western Pacific Regional Fisheries Management Council and the Pacific Basin Development Council.

When we found that the funding for fishery development was just going down and down and down, we got together with these other agencies, cooperated with them, and put together

a plan and some priorities for development. And those of you who have that can see on page eight, our funding from fiscal year, 1980, has just gone really down. From $2.5 million Federal dollars in FY 1980, we went to 1.37 in FY 1981. Then down to $911,000 in FY 1982. Finally down to $317,000 in FY 1983.

And at that point, it became questionable whether our program would be worthwhile. We have basic overhead costs, administrative costs, so on. And so as a result, we did get together with these other agencies and put as much pressure as we could.

Of course, we could use everybody's help. We are talking about lobbying efforts. If you write in to your elected officials and so on, try and get their help.

We've had a great deal of help from Senator Inouye's office. And in fact, this year, as a result of this effort, we've got language in the Senate Finance Committee saying that there should be an adequate level of funding for fisheries development in the Western Pacific. So we hope that this will work for us in FY 1984 and that we will get more resources.

The future is still going to be difficult though, as long as Saltonstall-Kennedy Funds are scheduled to be zeroed out by the current administration, Federal administration. So it's an uphill battle to get this kind of funding.

Well, the last thing I want to leave you with is the funding cycle. Now, I mentioned that we have two Board meetings a year. One in September, when we find out about how many grants, what kind of funding we have. And we make up the contracts, subcontract, and it's usually an announcement to please get your projects ready for the next round.

At the January or February meeting, the fisheries officers come in and present their project. The Pacific Fisheries Development Foundation Board reviews the projects in great detail and chooses those that it will submit to the National Marine Fisheries Service for funding.

In the past couple of years, the deadline for National Marine Fisheries Service has been April 1st. This year it was May 7th.

Every year the National Marine Fisheries Service puts out in the Federal Register, the rules and regulations that will go in that year. So there may be changes from year to year which can be confusing and when you have to plan ahead, it is sometimes very difficult to know or predict what's going to be in the Federal Register. Those are just the things we have to live with.

So the announcement is generally made in late July or early August. So at this point, we have submitted our projects that we went over, the large number of projects. And we are hoping that we will get special consideration this year and in the future years. Because there is an awful lot left to do.

I mentioned we had a fisheries officers workshop, another thing that came out of that workshop was the appendix on the back of this book. You can see a kind of a wish list or shopping list of projects that the areas feel are important. And this is what we hope to be able to accomplish. If we get funding through the Central Western Pacific Fisheries Development Act, these are the projects that we hope to go for.

Okay, that's all I have to say. If anyone would like more information on any of the projects, or would like to be included on our mailing list, we do have quarterly reports that we send out. And from time to time, we have special reports on projects as they are completed.

Thank you.

FISHERY REGULATIONS AND POLICIES

Al Katekaru

Department of Land and Natural Resources

It is indeed a pleasure and a priveledge for me to be invited to this Tuna Conference and to talk to you. The Department of Land and Natural Resources is also called DLNR, and a number of times, DLNR was mentioned this morning. But as far as some of the Department of Land and Natural Resources' activities relate to local tuna fishery, I would like to briefly describe to you the responsibilities and functions of our Department and its Division of Aquatic Resources.

The DLNR, under the general direction of the Governor and policies promulgated by the Board of Land and Natural Resources, manages and administers State's public land, including its water resources, minerals, forests, aquatic life, and wild life resources. Included in its Department's responsibilities are the State's forest reserves, State parks, and historic sites.

Mr. Susumu Ono serves as Chairman of the Board of Land and Natural Resources. Board member representing the County of Hawaii is Mr. Roland Higashi.

Within the Department, we have the Division of Aquatic Resources. Some of you may not know this, but it's a new name for us. We were formerly called the Division of Fish and Game. Our Division carries out Department's programs in commercial fisheries, aquaculture, aquatic resources and environment protection, and aquatic recreation. Its activities include development and management of State fishery resources. Mr. Henry Sakuda is the Director of the Division of Aquatic Resources.

At this time, I would like to introduce to you, if you do not know him, our aquatic biologist for the Island of Hawaii, Dr. Robert Nishimoto, sitting back there. Dr. Nishimoto has broad responsibilities. He takes care of the fish buoys, he takes care of top minnows, prawns, I suppose he even is trying to stop the volcano too. But he has a lot of duties.

There is a Hawaii Fisheries Coordinating Council established by law in 1980, to advise the Board of Land and Natural Resources in fisheries development in the State. It has the responsibility of coordinating fisheries activities among Federal, State, County agencies and industry. The County of Hawaii is represented on the Council by Mr. Stuart Kearns, County Director of Research and Development and by Mr. Alika Cooper.

Surrounded by the Pacific Ocean, people of Hawaii look to the ocean as a source of food. Now this important role of the

ocean is reflected in our State Constitution. And the State Conservation Land Plan, one of several functions of plans recently approved by 1984 State Legislature. State agencies use the plans as guidelines in carrying out their responsibilities and activities. Guidelines called by establishing and managing our fresh water and marine fishing areas and expanding our fishing industry.

State's fisheries policies and directions can best be reflected in projects and activities of the Division of Aquatic Resources. Also, we are guided by in 1979 Fisheries Development Plan which we are currently updating.

At this time, I would like to describe to you a few of our projects that relate particularly to the Big Island tuna fishery. We have provided financial assistance to Dr. Robert Nakamura in his study of burnt tuna. And this financial assistance will probably be continued next year.

We have a joint project with the Pacific Fisheries Development Foundation, which Janet mentioned briefly, to conduct test fishing with cultured top minnows produced by the Maui bait fish facility. The objective of this project is to determine whether top minnows are effective around the fish buoys and if top minnows can be used by ika-shibi as well as power line fishermen. Already we have conducted preliminary sea trials by Hilo fishermen.

Our fish aggregating buoy program is probably the most familiar to the fishermen and of great interest to researchers. As you heard about yesterday, we first put the buoys around the Big Island in 1980. And it's estimated that the Big Island buoys have produced over two million pounds of fish.

Buoy losses continue to be a problem not only in Hawaii, but in the entire South Pacific. So we are constantly looking for new designs and materials to increase the life of the buoys as well as increase the fish attracting effectiveness. As far as the life of the buoys are concerned, this comes down to the mooring line and the anchoring systems. So basically, it is an engineering type of problem.

In tackling this problem, we are working with Dr. Richard Brock, Dr. Kim Holland, and Dr. Hans Krock, Director of the University of Hawaii Look Laboratory, also an Engineering Professor, in order to improve the buoy program. Now the Division intends to expand the buoy program this year. And we hope to add as many as eight buoys around the Big Island before the end of this year. So the total number of buoys around the Big Island would be as high as 16.

Another project. Last year, the Division began an ika-shibi fishery study involving tagging of ahi to determine their

local movement or movements. In order to do this though, we are looking at different kind of tags. Because we are aware that if you hook ahi deep and you bring it up, then the chances of tagging it and returning it and having it survive is not very great. So we are looking into the possibilities of break away hook tags. This is being developed by one of our biologists.

Now with the tag information and with available oceanographic data and very importantly, advice of the local fishermen, we intend to conduct exploratory fishing for new ika-shibi grounds. This study will focus on the Big Island's ika-shibi fishery as well as the developing of one on the Island of Kauai. As part of this study, also, we will be tagging small ahi caught around the fish buoys and get some better idea or knowledge about where the small ahi go.

We have other fisheries development projects. I'll just mention these briefly. Ciguatera, which we provide financial assistance to Dr. Hokama at the Univeristy of Hawaii. And I understand that he's very close to developing a dip stick test for the fishermen. This is something which you could poke into the fish and determine whether the fish has this toxin or not.

We recently completed a Midway Island feasibility study. We have been experimenting with a bait fish buoy placed in Kaneohe Bay, Oahu. We have been trying to encourage purse-seiners to off load in Honolulu. And this is a touchy subject, but we felt that since the cannery is an important part of our fishery, aku fishery, we wanted to be able to keep it going. And yet, by encouraging purse-seiners to off load in Honolulu, this would be a good strategy. Of course, the entire tuna industry is shifting gears. So it's very difficult to know what action we need to take next.

We also have a project calling for the establishment of a fishery support operation at French Frigate Shoals, in the Northwestern Hawaiian Islands. We also have conducted a Northwestern Hawaiian Islands commercial bottom fish survey. So these are some of the fisheries development projects that we are being involved with.

I noticed that the title of the topic that was assigned to our Department had something about regulations, but as far as tuna regulations are concerned, we have none. However, there are measures that affect the harvesting of tunas. These primarily are measures on the taking of bait fish by fishermen. There is a law that allows commercial licensed fishermen with a bait license to use nets, with meshes less than two inches and take bait fish that are specified by the Department. I'll mention what these bait fishes are later.

Also, commercial fishermen in going by light bait tuna boat and whose principal income is derived from fishing and sale of tuna may use small mesh nets longer than 50 feet to take

nehu for bait. All other persons, whether for recreational or commercial purposes taking nehu for bait, cannot use nets longer than 50 feet.

The law also prohibits netting in Honolulu Harbor and portions of Hilo Bay, with exceptions that commercial fishermen are allowed to net bait fish in both areas. Also, the law which prohibits the use of nets in certain areas of the State and also makes exception for fishermen with bait license to take nehu or iao for bait purposes only.

The DLNR recently held a public hearing to amend an administrative rule in order to add the gold-spot herring into the list of bait fishes that are designated as bait. The gold-spot herring has been mistakenly harvested as Marquesan sardines as used as bait. So we want to add the gold-spot herring to the official list of bait. The list of baits includes right now, iao, Marquesan sardines, nehu, piha, tabai, and thread-fin shad.

At this time, I'd like to briefly cover some of the major issues that we think should be focused on regarding the future of our tuna fishery. The first and foremost is knowing the size of the tuna resource or stock. I think a number of comments have been made earlier about the importance of information. Although much information has previously been gathered on tuna, much more is needed. The available information must be analyzed as soon as possible for application to tuna development and management decisions. We all know that our understanding of the tuna resource will only be as good as the quality and quantity of information received. And a very important source of information is the fishermen themselves.

Every commercial fishermen in the State presumably with a commercial marine license is required to submit a monthly catch report to the Department. The report requests information on day and area fish were caught, what were caught, weight of catch, amount sold and ex-vessel value (price). We need these types of information to obtain trends in catch rate and for predicting. Also for predicting where a fishery may be heading.

Now this sounds good and straight, but as you probably know, there are difficulties in getting information. The filling out of any report and submitting it to any government agency is a chore. And we understand that. There's a question of confidentiality of the information submitted.

So what can we do and what is being done? Regarding the individual fisherman's catch information, I want to inform and insure the fishermen that the information is treated as trade secrets and therefore proprietary.

According to State law, the commercial catch information submitted to the Department by an individual fisherman is

strictly confidential and only can be released through prior written consent of that individual or under court order or by subpoena issued by State Attorney General's office. Now summaries, totals, aggregated catch data are made public because they do not identify any individual fisherman.

We know that our fish catch reporting system needs improvements and we are evaluating the system. We just completed a system design study to give us a better idea of how to improve our statistic system.

Last year, we began providing addressed envelopes to fishermen for ease in returning catch reports to us. We have also been evaluating the form itself. We are asking fishermen to indicate on the report form if the ahi are caught by ika-shibi methods. All we've got was "ahi." Also, we want to make the fish catch reporting as easy as possible for fishermen without sacrificing information. And we hope that the fishermen realize that the information they provide us is important.

Quality information affords better chances of having sound resource management decisions and actions. Likewise, lack of information or bad information will lead to poor decisions that ultimately affect all of us. But the greatest impact will be upon the fishermen themselves.

Second issue is tuna harvesting technology. The main technical papers presented at this Conference attest to the importance of harvesting efficiency.

And we are confident that projects such as top minnow, ika-shibi investigations, fish aggregating buoys, and burnt tuna will continue to receive strong support from the fishermen as well as the decision makers. Future projects will be proposed and implemented relative to the specific needs of the fishing community and as funding may permit.

The third issue is infrastructure support for fishermen. These are boat ramps, berthing, harbor improvements, and support facilities necessary for expansion or improvement of our tuna industry.

I am neither qualified nor in the position to address these matters because they are topics under the purview of the Department of Transportation. However, we do work closely with the Harbors Division and also I'd like to say that the Hawaii Fisheries Coordinating Council plays an important role in this issue. The Director of Transportation is a member of the Council.

The fourth issue is rather complex and a difficult one. It has to do with tuna management-development regulations. As stated earlier, we don't know enough about tuna stocks locally,

as well as Pacific-wide. Now if tuna fisheries elsewhere in the Pacific is or will be directly affecting our local fisheries, then it's important that we have a broader prospective of this tuna fishery. However, the Magnusen Act which established the 200 mile U.S. Fishery Conservation zones specifically excludes tuna from management and conservation actions. Wherefore, the present position of the U.S. is that management of tunas should be multinational rather than unilateral because of the migratory and transbounding nature of this resource.

So where does that leave us? Well, we are encouraged by the recent partnership of the Pacific Fishery Development Foundation, the Western Pacific Regional Fisheries Management Council, and the Pacific Basin Development Council. And with this partnership, we hope that some form of Pacific-wide joint effort in addressing tuna development, conservation, and management issues will be made. Those were the four issues.

I added a fifth issue which Representative Matsuura reminded me of this morning that's very important. He talked about the big picture and definitely I agree with him. We need the big picture, because we have a tendency to miss the forest for the trees. And this is something that we're aware of and we have to constantly remind ourselves of as managers of fisheries.

Thank you.

OVERSEAS FISHERIES CONCERNS

Louis Agard

Western Pacific Regional Fishery Management Council

I want to thank Mike and I want to thank Howard and all of the staff and organizers who put this Tuna Conference together. I think it was important for lots of us to come together to exchange ideas and information.

I for one, never really fully understood El Nino, but I think the presentation given yesterday has given me a fairly good idea about what it's all about. In fact, I was unfortunate enough to lose my boat in El Nino in '82. It was lost off the coast of Kauai when it hit, it was full of tuna, turned over and luckily, my four crewmen didn't drown, and the Coast Guard picked them up 11:00 at night. So I felt the effects of the change of weather firsthand. And the understanding helps me from the presentation yesterday.

I'm a member of the Hawaii Fishing Coordinating Council and we hope to advise the Governor in fishing matters. Several of the things that have been brought up today, have come to our attention. We volunteer our time. We attempt to address the problems that are developing in the fishery.

I started in the fishery in 1943, about August of 1943. I signed aboard one of the vessels at the Hawaiian Tuna Packers. It was an old Sampan with the three cylinder diesel engine and I thought it would be romantic to go fishing. I was about 17 years old and we went to sea, and I promptly got seasick. I didn't give up. I stayed with the fishery ever since and rightly or wrongly, I started to enjoy it. And it has proven to be a good livelihood. I did give up in about the 1950's, when the resource started dwindling. We couldn't maintain a full-time fishery; we became part-time with a job onshore. We eventually, the type of fishing that I've done, the inshore fishery is no longer possible.

So we switched over our interest to the tunas, which we're discussing today. As a matter of fact, that's the common denominator I think for all of us. Tuna - its availability, its catchability, and its handling.

Something about the Council that I work with. Some of the information has been given to you earlier. We're one of the eight in the nation. We're one of the eight regional Councils in the United States, created by Congress in 1976 to manage and conserve fisheries and in that connection, we're also learning about some of the things that have come to our attention.

Actually, one of our big functions is to deal with the foreign fishermen. That is, the act is conceived to protect the fisheries for American fishermen. We have heavy foreign fishing off the coast of New England, off the coast of California (trollers), and up in the Alaskan Gulf. And so the result of all this heavy pressure was that the Congress reacted on behalf of the American fishermen declared unilaterally a 200 mile zone from the shoreline, actually 197 mile zone. Three miles for the State waters and 197 for the Federal people. And that's where we work. We're attempting to allocate fishery resources. We put together a few plans.

We have our Coral Plan, which was active for a while. However, the fishery collapsed with the accident that occurred off of Molokai. And since then, the fishery has not been operating. More recently, foreign fishermen have been inquiring whether they could come into the region and harvest some of our pink coral that's located there. We will be considering that in the near future. I think also some Taiwanese are interested.

We have gotten along with a Lobster Management Plan to sort of allocate the resources in the Northwestern Hawaiian Islands where we have a lobster fishery. A very unique fishery, very fragile and we're learning more about it everyday and collecting the data so that we can make adjustments.

Possibly we're looking even at limited entry. That's a bad word in the fishing industry, but that's the kind of job the Council will have to be doing and looking at. We would make decisions based on the welfare of the stocks first, domestic fishermen second. If there is any surplus, we can consider foreign fishermen.

Some of the work that we've done is that we've gone on record, in 1978 (we were put together in 1976), the Council and its deliberations felt that tuna should be put under management just like all of the other resources. Perhaps you're aware that the Congress exempted tuna from management and as we sat down and attempted to manage some of the other pelagic species like billfish, and other related pelagics, it became very difficult. The inconsistency made it almost impossible. So we've gone on record and justified that back in Washington that for the Western Pacific, anyway, for an island state like Hawaii, you need, we should be able to manage these species, which I think would be best for the people that live in the region. And that we be able to manage it, collect the data and make good decisions regarding it.

I ask for this number three slide for a special reason. If you look at the slide, look at the yellow region. There's hardly any place in the nation where there is overlapping jurisdiction from one island to the next. I think that signifies something very important. That's because that's a common

resource, that we're going to have to start talking about managing tuna on a more rational basis than we've approached it in the past. I think that's very clear if you look at that. What can and what will happen in the future? We have not arrived at that point at this time, but I think that if we can make certain decisions that affect us as a local fishery, I think we should. We should not let the decisions be made for us. And in effect, decisions can be made by default. So we're very interested. We've gone to Congress and testified that as members of the Council, before the Merchant Marine Fishery Committee, and advise them that for a place like Hawaii, we want to have something to say about the management of tuna. Even though this is a pelagic species and it roams around the ocean, most of the coastal states as you see there, have declared sovereignty over the fish in the 200 miles from their shorelines.

We've also gone before the Congress and asked Congress to consider the 200 year old Nicholsen Act. The Nicholsen Act was conceived to protect the American fishermen 200 years ago from having foreign fish landed from Georges Bank in the New England States. The oldest industry in America is the fishing industry. And this was an early move to protect it. After 200 years, I think we can reexamine it and there are benefits for people like us, especially in Hawaii. The reason we're interested in the Nicholsen Act's repeal and so is the local tuna industry, the processors that is, because we are despairing in the fact that in Samoa, a can of tuna probably costs 10¢ less than it does in Hawaii. They are able to do this because they can weigh in fish under the Nicholsen Act waiver. They have a waiver, Samoa has a waiver, Northern Marianas have a waiver, and so does Guam. I think if they all can land fish without having to comply with the Act, so that puts us in Hawaii in a disadvantage.

Obviously, with all the canneries closing around the West Coast and threatening closing elsewhere, we don't have to threaten the one cannery that is in Hawaii, which is unique. That thing was founded before 1900. It's one of the oldest around. So I think we should really protect it. Take all the measures possible. I tell you why. If that cannery closes, I think many of the tuna fishermen today don't realize this but, they're just about out of business. That cannery in Honolulu takes up all of the surplus. All of the fish that people ship from here down there for that auction, premium price, that is not sold, ends up in that cannery.

Now at one time, in 1976, the auction block in Honolulu would sell ahi for 10¢ a pound. Can you imagine 10¢ a pound on the floor? Fifteen cents a pound? There was no bottom price. I worked in the cannery. I was a new agent. We were going through a transition period in the tuna packers. I went before the auction people and I asked them would they permit us to buy or set a bottom price on all the fish on the auction floor. Not 10¢, not 15¢, not 25¢, cannery price is 40¢ a pound, minimum.

He said yes. Immediately, all of the fishermen in the industry were able to benefit because it raised your floor price. I know the fishermen are not aware of this, but it's good to let you know what happened and what could happen if you lose that cannery. If you lose that cannery, the floor price could go back down to 10¢. And that would throw the industry in the biggest turmoil you ever saw. So it's highly important that we do what we can possibly do to keep the cannery open.

Now one of the things in the Nicholsen Act was to land only frozen albacore in Hawaii. The big ones. Choice fish, big deal. Not too small fish. Big fish. Keep the cannery going, keep it healthy. It has to be viable. The stockholders, if they can't make money, are not going to be very thoughtful about our feelings or our needs. They will say close that thing down. Get rid of that cannery. And that's the way a stockholder will look. So we've got to insure its viability by saying yes. Because we don't catch that much albacore and what would be landed on a foreign vessel, waiving the Nicholsen Act, would in effect, permit the cannery to put out a good pact of high grade white meat tuna to compete in the world market. And I have no connection with the cannery. I know all the work there, but I can see as a fishermen, and having to go and fight this thing, working in there, watching a thousand pound come in, a million dollar cargo, off load. And we have to pay for instance, if the ship came out of Japan and went north of the Hawaiian Islands, above Midway and the Emperor Seamounts and picked up its albacore. That's 3,700 miles. The Nicholsen Acts says you cannot run Honolulu afloat. You go back to Japan, we know that the currents come through and all of this. They go back to Japan based on a 100 miles, come back to Hawaii, another 3,700 miles maybe. Ten thousand miles of fuel so you could buy a load of light meat tuna. It didn't make sense. And this is the basis of our argument to get the Nicholsen Act waived and so that we may keep our cannery going. It's another thing that we're supporting as a body that would be interested in the local tuna fishery for the benefit of the fishermen.

Actually, the Council is a mini Legislature. We do enact rules that will be put into effect that the community will have to work with in order to do the harvesting.

We've also considered having Congress look at the Jones Act. At the present time, we've asked them to hold things in advance. Jones Act being that you could buy foreign cars. Now you may not buy a foreign auto and use it in the American trade, but some of the Pacific islands do have the waivers. We thought we'd just look at it to see if we're practical. Take public input, people might be for it, people might say no, we don't want that. It's comparable to importing a Toyota or something like that that is made in a foreign country.

The Council has gone on record supporting the Midway Island station because we feel that this would be helpful to the tuna

industry. The albacore fleet at one time had a great interest in that area.

But there are other fisheries that we think could be used or could be employed or developed up in that region where there's comparatively a lot of fish. I fished there for ten years, from 1946 to 1956, and I lived on a tiny coral atoll called Tern Island in the French Frigate Shoals group. And we were able to pick up a lot of fish, because it's virgin ground. Some of the studies since then have shown that possibly there is not that much fish there. But for those of us that worked there for the ten years, there was a lot of fish. All kinds. Stuffs that you don't see. Huge schools of aholehole, moi (threadfin), mullet, the ocean mullet, the hanai, you should call that, and reef fish of all kinds. So there has possibilities and we would like to keep those avenues open for people down the road who are coming into the fishery and want to become fishermen on their own. We would hate to see the resources closed off by our inactions. So what we've done is we've asked that certain doors be left open to be able to go back there sometime and do some harvesting. We are well aware of the objections because of endangering monk seals in that region.

I have found a paper by a young lady called Pamel Togash. And with your indulgence, I would like to read this to you. It is basically what I think our position is as a Council attempting to get the best deal I guess, for the American fishermen and to regulate foreign fishing.

At the present time or I should say, in 1980, there was a preliminary fishing management plan enacted by the Department of Commerce. Now this is the case where our Council was not able to put together a reasonable plan. We didn't have the data. There were many holes in the things that we were doing so we secondarily implemented the plan. Now many of us supported the plan because it meant the cessation of foreign fishing. And it has worked. Since that date, there has been no applicant of a foreign nation to fish within the FCZ of the Hawaiian Islands.

However, as time moves on, we have realized that some improvements are necessary. They are necessary because the comments that have been made earlier showing you this huge gill net fishery. It probably is the basis for many of our problems. When we left the French Frigate Shoals in 1956, there were about 1,200 monk seals in the Islands. I think subsequently after that, the fishery developed. And another count recently showed that there are only about half that many animals. What happened to them? Well, this huge fishery, I think that exists up there, the gill netters, employed hundreds of boaters. The last number I heard was 700. It's a combination fishery I think, Japanese, Koreans, and the Taiwanese are all involved in the fishery. They lay approximately an estimated 60,000 miles of net. This is the long nets that these vessels carry and lay up

there above the Hawaiian Islands. The net breaks loose, as invariably they will. They get lost. They hit miles and miles.

Two things that affects us as fishermen. We've also gone on record incidently, to oppose the whale sanctuary because we see no real benefit as a Council to the fishermen, except maybe more layers of regulations. And maybe we don't need that. So we say unless we can see something for the benefit of the whales, an increase in numbers, anything, okay, let's look at a whale sanctuary off the coast of Maui and between the Islands. But we don't. So we oppose it.

Now the whales are considered endangered like the seals, but those conditions probably are not brought on by your human activities as a fisherman. But maybe it's going to impact on you because of the demise of these animals that are protected by Federal law. Those 60,000 miles of net floating around the ocean there, some of them breaking loose, have been known to catch endangered humpback whales. It tangles it and kills them. And they've been known to catch monk seals. There's pictures of them, entangle them and kill them. That's possibly contributing to the decline of so many animals.

And therefore, we think that stronger regulations working with foreign countries about the use of the gear will be helpful to us in the long run. We're hoping that we can do something. Right now, the Council is negotiating with the Japanese for voluntary agreement. We cannot get through what they call a Fishery Management Planning.

The Department of Commerce has told us that our island proposals are too stringent. The law might not permit it. A suit could ensue and there would be trouble. So we felt the next best thing to do is go the foreign nations who want to fish, we sit down and talk to them about gear, where, when, why and what areas are voluntarily agreed not to fish. We have high hopes. We can affect some sort of management scheme, if we're able to crack it. It's a hard problem. Very difficult as you will see, to regulate tuna anywhere in the world. You have one in H.I.A.T.T.C. Excellent. You have one up in the New England, International Commission for the Conservation of Atlantic Tunas. You have two schemes that apparently are starting the management process. And we would be hoping in the Pacific because we have a lot of foreign fishing that we can get voluntary measures to open the door for us to finally get all of them in so that we can effectuate something where we've got benefit. And we have something to say about how it's done. Rather than it's put down on us because we cannot act. And that's usually what happens. If you don't act, it gets done for you.

It's like our Preliminary Management Plan. It's been placed but we can see some flaws. I tell you what the Preliminary Management Plan is now. That plan said all boats before you come to Hawaii, you have to have a permit, first with the government,

Governing International Fishery Agreement. You got to have a G.I.F.A. Then you come and apply for a permit sometime in the beginning of the year to fish in this zone that the United States claims jurisdiction over. Only for billfish, though. Tunas, that's a ghost fish. That fish doesn't exist. No such thing as a tuna according to that system. So if they come in for the tuna with a permit, they basically can come up to three miles from your shore today to catch the fish. They can bring their boat right out there and put out the lines. I don't say that they will, but that's what that plan will permit. It's a very generous plan from the start.

So we possibly could negotiate a distance farther out and eventually what we want to do is to build our own fishery, like the Alaskans have done with the Tanner crab in Alaska, where they gave an allocation to the foreign fishermen. They developed their own fishery and then they pushed the foreigners out entirely.

And listening to the members of the administration or the people who have some knowledge about the F.C.M.A. (Fishery Conservation Management Act), say that is one of the goals of the act. That you, as an American domestic fisherman, will develop the ability to push the foreigners out. There's no need for them to come in. At this point, the PMP says that they can come in. So we're looking for something that will say, no, you cannot come in. We take all the fish within the region because it's our fish and we have the capacity. We don't have any surplus. So based on those approaches, those are the kinds of things I hope to explain to you what the Council is attempting to do.

The latest thing is in about a month or so, the Japanese will be here in Hawaii and we will be talking to them about how we can come to a reasonable agreement where they will voluntarily say, we do not fish in this region because we'll negotiate with them.

They've done this on the Atlantic sea board. Their Billfish Plan does have voluntary arrangements in it. They are heading in that direction and I think maybe in the Pacific we can.

We have a bigger problem because we have more foreign fishing vessels here. There are Taiwanese, Koreans, Japanese. At one time, when we first started, there were about 5,000 of those long-liners operating out there. Probably not that many now, but they were very numerous at one time. So we have a slightly different problem. We're working at it.

But we appreciate the opportunity to come and talk to you and learn something ourselves. Because that's what this is all about. This is a learning process. And I want to congratulate

the organizers and for every one of you sitting in the audience.

Thank you very much.

OVERSEAS FISHERIES CONCERNS

Justin Rutka

Western Pacific Regional Fishery Management Council

Thank you very much and good afternoon everybody. On behalf of the Council, I want to thank the coordinating committee for sponsoring this Conference and the fishermen of the Big Island for inviting me to come down here to present some remarks on behalf of the Council.

I feel at home in many respects. Several of my bosses are here on the panel - Buzzy Agard and Trudy are Council members. We have some appointed members on the Council - Alika and Charlie Spinney there, and these other people. So I'm familiar with some of the people in the audience, but I am also very intrigued by the people that I don't recognize but I had the chance to meet yesterday. It tells me that the fishermen are quite interested in what they're doing and would like to find out more about their business and possibly other fisheries that might affect their business.

I brought some materials with me. I don't want to dwell on too many things that are not germane to the issue of this Conference which is tuna. But I brought some background materials on what the Fishery Management Council is all about. A yellow fact sheet, one page long, gives you an indication of the law on the composition of the Council, the type of fishery plans we get involved in. One page fact sheet on each of the fisheries management plans that the Council developed and implemented or some that are still in process.

Bottom fish, if anybody is interested in that, spiny lobsters in the Northwestern Hawaiian Islands, precious corals, and of course, the pelagic species in the F.M.P. which includes all the large pelagic species exclusive of tuna of course, because of the U.S. law and policy. All this information is downstairs.

I also have some other material that might be interesting to a few people here. It's a directory of seafood suppliers put together by Sea Grant and lists all the major brokers, suppliers, by products, by species and product forms. Some other brokers or seafood people or fishermen might be interested in picking up this. It primarily lists all the Big Island people, seafood brokers and also the Oahu ones as well.

There's also a write up on the Hawaii seafood market. This is primarily a condensation of a research report that was put out by the National Marine Fisheries Service on the seafood

market in Hawaii - its structure, composition - and again, tunas have a very prominent role in the market. Some people might be interested in that.

And lastly, there was the last yearbook issue of the Western Fishermen. It has an excellent article focusing on Hawaii's fisheries. I think it's well done on the ika-shibi fisheries, the bottom fisheries, some of the Northwestern Hawaiian Island fisheries. Good article. And also very good article on the growth and influx of what people have been discussing here. Basically the thrust in purse-seine fishing in the Western Pacific area. So if anybody's interested in this material, there are extra copies laying on the table downstairs. Please go downstairs and help yourselves with it.

What I would like to do today is give you a broad picture of the tuna, fisheries for tunas in the North Central, South Central, Southwest Pacific. Basically targeting on the same species that are common to the fisheries of Hawaii. I want to give you an indication in something about the magnitude, a little bit about where they're at, some maps. In the process, give you an indication on the different gear types that are involved, species that they take and try to relate it in one fashion or another or at least by analogy to the fisheries in Hawaii. (first slide)

The first slide just tells you basically what the Council's backyard is. It's one of eight regional councils established nationwide; all over the Hawaiian archipelago is in the Council's jurisdiction. The Marianas archipelago in the Western Pacific, south of Japan is in the Council's jurisdiction, as well as American Samoa down in the South Pacific, where there's a lot of purse-seiner action. As you can see, the five or six U.S. island possessions scattered in between. A substantial amount of ocean real estate. The people like to know how large these areas are. This is just basically a table in the square miles in each of the 200 mile zones around the Island chain under the jurisdiction of the Council.

It might seem like a lot of territory, this other slide will stack up the U.S. territory in the Western Pacific, compared to the economic, exclusive economic zones or fishery conservation zones of the other nations, other island nations in the Pacific. As you can see, it is a very interesting picture in one respect. That the red pink area is essentially the slide that I showed you first, predominantly centered close to the equator and above north of the equator. There's a lot of high seas out there because there is no land masses. So there is open international high seas situation up in the North Pacific. When you go down to the South Pacific, you get the opposite situation where 200 miles zones intersect because of so many islands there. And you have little tiny or slivers of high seas, just blue marks in between those areas which are

basically high seas and international waters. So there's the contrast between us up north and our south sea neighbors down south. There's about 18 to 20 island nations down there, the Melenesian countries, the Polynesian countries, and the Micronesian countries. (predominately just north of the equator, close to the equator)

We're going to talk about fisheries, we're going to talk about the principal species. Obviously these are ahi, yellowfin tuna. I think this is the picture taken here at the Suisan dock, covers some of the slides that basically are the same kind of material that Dr. Klawe presented yesterday. The broader marks are basically the distribution of the fisheries - where they are caught, either by long-line or on the surface fisheries. The slightly marked area on the inside of that is primarily reported spawning areas. Hawaii, I put a red dot. You can see that we're sort of in the center of things. But in a way, I think, we are also in the margin of things because from what I've been hearing is that it's reasonably very clear that there are three populations of yellowfin in the Pacific - the Eastern, Western, and Central Pacific. And it's probably likely that there may be some breeding groups within those populations in the Pacific. There's been more arrows that you can add to this map in terms of tagging studies down by the South Pacific Commission. I'm sure that there's more tag arrows that could be drawn in. So this is a fairly old slide.

We're also going to talk about albacore because it's such an interesting fish. It's quite prominant now, it's the tombo fish in the ika-shibi fishery and in the long-line fishery in Oahu. Again, its distributions is much more migratory, seemingly in some respects to the yellowfin makes transoceanic migrations. There might be several subpopulations in the North Pacific population and there's a southern population which is separate or distinct from what happens around Hawaii.

I think these are bigeye tuna, which are premium sashimi grade species in the Japanese trade. This is a picture of Japanese brokers or traders in sashimi products. You notice how the fish are prepared with portions of the gill plate cut off. I think that aids in cleaning the fish, in gilling it, and it also aids in handling. It's probably easier to move the fish around for proper storage, etc.

Bigeye distribution again, is actually quite wide. It's a deep water fish. Sometimes you get it at the surface, especially juvenile forms. Again, the breeding seems to be concentrated in the tropical waters. Again it's a truly cosmopolitan fish. And Hawaii again, (I've marked it again in red) shows where we stack up relative to where the fishes are.

Again, this is some of the aku coming in, in Honolulu.

And aku has a much more interesting and more confusing picture. As you can see, some of the points of capture and points of returning of the tags. There's been much more work done by the South Pacific Commission. I think they tagged over 150,000 fish and got a real interesting phenomenon going on down in the South Pacific. Seems like there's a possibility of many sub-populations in the aku fisheries.

Now I want to get into the gear type fisheries. This is sort of stylized, romanticized, optimist version of the long-line fishery. Fishermen would love to catch fish every five or six hooks and get a 20% catch rate. This is more of a pessimist's view on the long-line fishery. In reality, I think catches average about 2 to 3%. Sometimes higher, sometimes lower over the last decade.

I want to talk a little bit about the foreign long-line fishery. It's truly a Pacificwide. It's primarily dominated by the Japanese, the Koreans, and the Taiwanese.

This is the typical picture of a Japanese long-line vessel. The boats range in size from about 60 to about 120 feet. Some of the larger boats carry ultra-low flash freezer refrigeration. And they are marketed as sashimi fish in Japan. The gear is set as many as 50 to 60 miles of long-lines per set. Average somewhere around 2,000 hooks per set.

Given an indication of the worldwide distribution of this fishery, this is a map of all the ports where the Japanese Fishery Association had agents to help provide intrastructure - fueling, and R and R and food and provisions for their fishery. It's truly worldwide. You'll see Kahului on there, you'll see Honolulu also on there. And it's a quite common sight to see foreign long-line boats come into Honolulu Harbor and Kahului. They might come into Hilo, I don't know, for provisioning.

Here's an example of the older Korean long-line boats fishing primarily for albacore and yellowfin tuna down in the southern hemisphere. Albacore goes into tuna pack and some of the yellowfin gets sold to Japanese sashimi markets, I think.

By contrast, here's a classical long-line local boat. We've had some growth in this fishery. Actually, it's been quite phenomenal. There are about 30 long-line boats operating out of Oahu right now.

These are target species which long-line fishermen, both domestic and foreign like to catch. These are also yellowfin I believe. I think these are either troll-caught fish or hand-line fish and I think they are quartered for a closer inspection to see if there is burn and the extent of the burn. But

basically, the long-line fishery and the hand-line fishery are targeted.

This is another product of the long-line fisheries. These are striped marlin caught in the Japanese long-line fisheries. These are striped marlin quarters. They also go into the sashimi trade. It's actually quite surprisingly when you examine the price structure of what marlin sashimi sells for at the Japanese auction block. Bluefin tuna is the top. Bigeye tuna is $4 a pound, second to bluefin. Then you have the marlins and the yellowfin tunas hovering at about $2 to $2.50 a pound. So marlins are indeed a valuable fish in the long-line fisheries. They make up about 10% of the long-line catch. In earlier years, it was higher when long-line fisheries just started growing. Again, these are also prize fish taken by a recreational fisherman. Of course, this is common during the HIBT blue marlin. Blue marlin are also taken in fairly substantial numbers in the long-line fisheries.

I want to talk about something that really wasn't discussed at this Conference yet and that's primarily high seas gill net fishing. It's a relatively new phenomenon. It's been in existence in California for thresher shark and swordfish. But in the Central and North Pacific, it really didn't start taking place until the early and mid 1970's. The gear is essentially a unit gear called a tan and several are connected together. They are strung out basically up to 8 to 12 miles in length. It's about 30 meters deep. The yellow area there, (I got Japan in red) gives you basically the outer limits of that fishery as it has developed since the early 1970's. The one started off the coast of Japan is primarily a fishery for tunas and also for billfish. In the area north of Midway, one of the principal target species is albacore tuna. It also takes substantial numbers of striped marlin in the gill nets and a variety of other species that inhabit those waters.

Here's a table that gives you a composition of magnitude of the catches in the marlin and tuna gill net fisheries on the high seas. These are only Japanese boats. The year on the left and the number of boats participating in the fishery is something like 560 in 1981. You notice that the proportions between marlins and tuna are exceptionally high in the earlier years (in '75), because the fishery basically started there and striped marlin runs off the coast of Japan and expanded eastward into the albacore fisheries. So as you progress through the more recent years, you'll see that 1981, that the tuna catch was 17,000 metric tons, compared with billfish, 75,000 metric tons. So we have more tuna being taken now, less billfish compared to some of the early years, but the fishery has expanded out over the Emperor Seamount area and quite a bit north and west of the Hawaiian Islands. It also takes skipjack. The Japanese don't really classify skipjack as a tuna, but it's a distinct category because it's

marketed in so many different fashions there. And the other is miscellaneous, everything else, mahimahi, ono, shark, pomfrets or whatever other species that you find out there. There's actually quite a significant fishery started in the early 1970's. It's ten years old. And it's probably mushroomed to something about 1,000 boats if you include Taiwanese and Koreans in this.

It's creating problems, lots of talk. There will be a workshop sponsored in November, an international workshop co-sponsored by National Fishery Service in Japan and, I think, also scientists from Korea, to address the problems of the debris and gill net fishing. Not just in the fisheries concept, but primarily all the other problems that come with it in terms of fouling of gear and marine-mammal interactions and the like.

This is another gill net fishery for squid. It's not for tuna, it's targeted for squid. Again, it's a relatively recent phenomenon. You see it next to Japan in 1978, '79, extends to 1980, and '81 again to the Northwestern Hawaiian Islands. The mesh size on the marline fishery in tuna fisheries is about seven inches. I think on the squid fishery, it's about five and a half inches.

Here's a breakdown of the landings from the squid gill net fishery - the fresh and frozen by-product forms totals and by the different gear types. You notice in the mid 1970's, jigging was a predominant way of how the Japanese supplied their own squid markets. Gill netting was for squid and did not take place till '78. And then you had an increase from '78 to '79 and '80, basically, the growth of the high seas gill net fishery for squid. I imagine we have a five inch mesh. It'll take other species besides squids. But they are not recorded in terms of what else is caught other than just squid.

Here's a map that basically outlines it. Yellow areas are areas where the Japanese basically internally had prohibited their gill net fishermen from operating. You notice that the waters south of Japan were closed off simply because of internal problems with the coastal water skipjack fisheries, with the jigging fisheries, problems with propulsion, plain traffic out there basically. Lot of political problems. Areas around Australia were closed off. Areas off the Eastern Americas, where the Inter-America Tropical Tuna Commission Fisheries, purse-seine fisheries operate. And of course, 5^{o} angles around Hawaii. The Hawaiian areas are basically where the Japanese gill net fisheries are allowed to operate under their own government regulations.

Again, I'll go into purse-seining a little bit. This is a schematicized picture of a purse-seine operation. I think the nets would be as long as a mile and the depth of the nets,

I don't have the exact figure. But they are actually quite deep. Again, that's a type of purse-seining operation that happens in the Philippines area, Malaysian area; the 'payao,' fish aggregating devices that catch a lot of mixed schools, a lot of juvenile fishes. It is a common method of fishing in the far reaches of the Western Pacific.

This is an artist's rendition of purse-seining operation, in the Eastern Pacific when they fish under porpoises. The yellowfin tuna have an affinitive to move from porpoises for whatever reasons. There may be and this shows you some of the procedures that enable the porpoises escape because of a provision of the Marine Mammal Protection Act.

The purse-seining fishery is about 130 U.S. purse-seiners. About 60 of those have shifted their operation into the Western Pacific. The one which I outlined there is again in relation to Hawaii, the Southwest Pacific, that stippled area, right above New Guinea, and corresponds with one of the slivers of the high seas. That is where most of the action was reported in 1982, when the international fleet of about 40 to 50 U.S. purse-seiners and 30 to 35 Japanese purse-seiners and miscellaneous Koreans and other nationalities were fishing in that area. In '82, they caught about 200,000 metric tons which I think basically equaled the same kind of magnitude as what the purse-seiners caught in the Eastern Pacific. In '83, the U.S. estimates are somewhat around 170,000 metric tons. Possibly more. I think if you can add on about 100 to 130 for the foreign fleet, you probably have a fishery that exceeded the amount caught in the Eastern Pacific.

Here's a picture of purse-seiners in American Samoa. The two canneries there - Starkist and Van Camp. A lot of purse-seining activity there right now.

There is a tremendous amount of transshipment activity in the Marianas. Tinian, which is one island south of Saipan and several islands north of Guam. There's always a fleet of purse-seiners in there from the various nationalities unloading it to a reefer boat for transshipment to canneries as far away as Puerto Rico.

Here's some of the top of the line U.S. boats on each side, with a reefer vessel in between. You can see that sort of super structure. And they off load each boat simultaneously onto the reefer vessel and other boats coming in. This is a type of off loading operation.

I was looking at the species composition. They were pretty mixed, mostly dominated by skipjack, but there's some yellowfin with different size classes.

This gives you some idea of scale. This is at Kewalo

Basin, Bumble Bee. This is not the top of the line. This is sort of a medium sized U.S. purse-seiner with a spotter helicopter. The boat to the right of it is one of the typical albacore troll boats from the Pacific Northwestern and California. It is considered a fairly decent sized boat by Hawaii standards when albacore troll fisheries started here. So it gives you an indication of some of the sizes of the vessels.

Now I'd like to talk a little bit about the aku fishery. It's still predominantly one of the largest producers of skipjack and one that still uses predominant gear types. This is a picture of the local big boat fishery that operates out of Kewalo Basin. Here's some of the catch. Some of it ends up in the fresh fish markets, a portion of it is sold in the cannery. Normally, marketed under the Coral brand and Bumble Bee right next door, it is primarily caught by albacore troll boats or by foreigh caught long-line albacore.

Again, skipjack has a worldwide distribution. These spots show you that occurring in the Eastern Pacific, you can also notice those in the Western Pacific. Again, skipjack is everywhere. What its population structure is, I'm not exactly sure but it's apparently confusing. It's an interesting problem.

California bait boats - many people don't realize that the bait fishery has been in existence there for a long, long time, fishing sometimes for skipjack, sometimes for albacore. In Mexican waters I think that fishery had difficulties there too.

Japanese still predominate in the skipjack fishery. Here's a typical coastal vessel. The 60 ton type that plies seasonally fishing for skipjack close to Japan.

Here's a picture of a much larger distant water Japanese bait boat. Basically, a type of vessel that was shown in the film yesterday, if you people saw the movie. It was an excellent movie.

Here's just a schematic version of skipjack fishing - the aft of the boat and sides - some boats are already equipped with automatic poles manned by hydraulics. A typical baiting operation very similar to what happens here. The fight is on, and a scene of basically some of the skipjack ending up in the Japanese stocks for sale in the Japanese markets.

So when we add up all the fisheries, you've got purse-seine fisheries somewhere in the 400,000 ton range in the Western Pacific. There are skipjack fisheries, I don't know, they're still actually somewhere in that same vicinity, you've got long-line fishery - 250,000 metric tons, and gill net fishery approaching 1,000,000 metric tons. That's a tremendous amount of fish by Hawaii standards. It's mind boggling because we do have many fisheries here targeting adult species, same species whether they are the same stocks, and what the extent of the

interactions might be in the water fisheries around Hawaii, actually quite far away from it. This is something that I think we eventually have to look at.

So thank you very much.

HAWAII FISHERMEN'S CONCERNS

Glenn Nishihara, Clayton Yamada
Directors
Hawaii Fishing Coalition, Inc.

Thank you Mike. First of all, I'd like to thank the organizers also in asking us, the Coalition I mean, to give some background on the formation of the Hawaii Fishing Coalition and its concerns, goals, and objectives.

First of all, I'd like to say I have been a recreational fisherman as well as a part-time commercial and full-time commercial fisherman since 1974.

My wife also has been an active participant, both in the fishing as well as an administrative part of the fishing management of our resources. She is also a member of the Western Pacific Fishery Management Council. So you can see the fighting within our house alone.

First of all, in September of 1982, a public meeting was held at the Halawa Gym on the Island of Oahu. The purpose of the meeting was to survey and discuss if enough interest existed among the various fishermen to unite and create their own organization.

The primary purpose of which was to encourage and preserve recreational and sport fishing interest in the State of Hawaii through legislative and other means. The concept being that fishermen from all the various groups, joining and working together, could accomplish much more than on an individual basis.

The meeting was most productive and the participants expressed that there was a need for an organization and that we should proceed to create one. Then, in October of 1982, at Oceania Floating Restaurant in Honolulu, the first Hawaii Fishing Coalition public meeting was held. Through the overwhelming interest and help from the various fishery groups, the goals and objectives were defined. The meeting also focused on how the different fishery groups were interrelated and shared almost identical concerns regarding the fishery resource.

Many fishermen in the State of Hawaii regardless of which group he belongs to now, have at one time or another experienced other types or methods of fishing. Many of us have been involved in some form of skin diving, shore casting or spinfishing, trolling, bottom fishing, netting, fresh water

fishing or what have you. We've all grown up in Hawaii with many different involvements in our fishery and therefore are unique in our understanding of each other's problems.

From this meeting, the Hawaii Fishing Coalition was born. The HFC consists of many members at-large who elects delegates who in turn nominates directors. The directors are then confirmed at the general meeting by the members. The members also nominate and elect Hawaii Fishing Coalition officers for a two year term. The Board of Directors of the HFC are State-wide and are selected on the basis of their individual expertise in the broad areas that will be covered by the organization. Selection was based also on individuals who are representative of and respected by their fishery group and who could express and resolve the concerns and problems that exist in their fishery.

We are very fortunate to have as Board of Directors, a dedicated group of people who have spent many hundreds of hours developing and creating the by-laws and charter with emphasis on equal representation and equal voice for all. Our large reservoir of delegates represents a broader range of input from the fishermen which helps to facilitate inter-communication throughout the membership. The delegates help form a means for the fishing community or the fishermen to relate and express his likes and dislikes to the particular problems or issues at hand.

To help us better understand the governmental and judicial system, we have as advisors, attorneys, as well as individuals who are versed in governmental regulations and procedures. They help to guide and steer us toward a better understanding of how and where solutions can be found. They are an important formative part of the organization.

The Hawaii Fishing Coalition is financed by membership dues and other donations. The executive officers are elected by its membership and are responsible for the administration of the policies, programs, and finances of the HFC. All directors and executive officers are voluntary fishermen who have unselfishly devoted their time and effort with no monetary compensation.

Our functions of the Hawaii Fishing Coalition including its newsletters, are done by its members on a voluntary basis with no paid staff or personnel. The newsletter is a quarterly publication to update the fishermen with current fishing and marine use which may have some impact on them.

Now at this time, I'd like to turn the program over to Clayton Yamada, who is also a director of our board and who will further explain the functions of the Hawaii Fishing Coalition.

Thank you very much. First of all, I'd like to reemphasize that the Hawaii Fishing Coalition is a State-wide organization representing approximately 2,500 members from all the major Islands. Our members include a wide spectrum of interest. We have divers, scuba and free divers, recreational and commercial divers, researchers, even industrial divers are in our organizations. We have shore casters, and one of their main concerns is beach access. We have trollers, offshore fishermen, who are both recreational and/or commercial fishermen who help with the State's economy. Then we have bottom fishermen, who depend greatly upon our marine resource and add much to our local markets. We also have netters. The tradiitional subsistence type netters, the commercial netters, the recreational netters. We have a long range commercial fishermen group. These people add much to our tourist industry. We also have fresh water fishermen who are really the recreational fishermen in the State. Then we have the independent fishermen, the subsistence type fishermen, and even aquaculturists. There are also numerous limu pickers, photographers, researchers, environmentalists, and people who just want to preserve our fishing rights.

Now each group has overlapping interests. There are divers who troll, bottom fishermen who surf cast, netters who pick limu, sports fishermen who also commercially fish, and all of this develops into conflict of fishing methodologies and techniques as well as many larger problems.

For an example, our State harbors. We need much improvement on our present facilities. Critical improvements in many cases such as range light, boat ramps, channel markers, safer overall design, toilet facilities, better security, and increase berth and morrings.

But during the recent years, the emphasis has been placed on the larger commercial boats mostly from the mainland. And at this year's legislative session, a resolution was passed to invite the multi-million dollar purse-seining boats from the West Coast to use Hawaii as an off loading base. This will probably add approximately $200,000 to the State's economy for every boat that stops here. However, because of the efficiency of these super seiners, and their non-selective gear, the Hawaii Fishing Coalition presented testimony at the legislative hearing asking the legislators to please not only consider the immediate economic gain to the State, but also the long range negative effects that could happen to the fisheries in the Pacific.

It's time that we are recognized as an industry that is contributing its share to the State and more consideration must be given to the voices of fishermen for future fisheries and harbors development.

The Hawaii Fishing Coalition has also spent much time in its efforts to have included into the proposed management plan of the Hawaii Humpback Whale Sanctuary, a clause that would guarantee that no regulations or restrictions be imposed on our fishermen, not only now, but in the future. Although many fishermen sincerely would like to see that the whales are protected from harassment, this cannot be accomplished through such a vague and ambiguous management document. This proposed sanctuary would include approximately 2,100 square miles of Hawaiian waters surrounding all the population centers of Hawaii and would also give away control to the Federal Government what is rightfully ours.

In our effort to further the Hawaii Fishing Coalition's goals, which is to nurture and unite the common interest of all fishery groups in the State of Hawaii, we have been trying our best to live up to our motto to preserve and encourage the recreational sport fishing interest. We have tried autocratic regimentation. We have tried the awesome spectacular. We have tried small encounter groups. We have tried large encounter groups. But we have found that just plain listening works the best.

Seriously speaking though, the Hawaii Fishing Coalition is proud to serve as a unified voice of Hawaii's fishermen. Although we are still in our infancy, we are confident that we will be able to adjust and change to the needs of our membership as our ranks continue to grow. Fishing as we now know it will be changing greatly in the years to come. And we must be prepared and be informed of the various governmental regulations that could affect us. We need to unite, to make our concerns and wishes heard by the people who will be managing our fishery. In this era of computers and high technology, we must utilize whatever is available and try to work together to develop and improve our resources.

Even during our lifetime, many of us have experienced a realization that many species of fish are no longer found in abundance. The good ol' days are no longer here. Our resources are being depleted. There are more fishermen now than ever before. We must seek the solutions so our children can enjoy and experience the pleasures we once knew.

All of us, together with the State Government and the Federal Government, must develop viable fishery management programs, but must do so without disregarding our traditional and cultural heritage.

But you ask what have the HFC done since its conception? For that, I must return you to Glenn.

Thanks Clayton. Although not publicized, the Hawaii Fishing Coalition has been very busy in its first year. Not

only in organizing, but in the following accomplishments.

Development in weather forecasting. Marine weather and wave action forecasting and tide reporting in Hawaii has improved over the last year. On June 6, 1983, the National Weather Service, the Coast Guard, Dillingham Tug and Barge, and the Hawaii Fishing Coalition held a meeting to discuss the weather forecasting needs of Hawaii's fishing and boating community.

This meeting led to several beneficial changes and additions to Hawaii's weather reporting. The morning report was moved back from 7 a.m. to 6 a.m. Dillingham Tug and Barge base radio instituted a direct line to the National Weather Service, so the weather and sea conditions radioed to Honolulu by their tug captains while at sea, could be summarized and passed on to boaters frequently and accurately. I might add also, Dillingham did this at their own expense. This has matured and improved the formation base for the National Weather Service to work with.

A marine report or a 'marep' program was initiated for recreational boaters. This marine weather radio reporting program eventually developed into a significant contribution to weather's data base. The sample 'marep' card, which is what I have in my hand now, and which is available at the registration desk, shows the instructions published and distributed by the HFC on Oahu. Eventually this program will be expanded to the neighbor islands where the Hawaii Fishing Coalition is represented by several of its directors and delegates. Periodically, relays from Scripps Institute wave action buoy off Makapuu that have provided accurate and regular wave action reports for the western side of the Molokai Channel.

A new sequence in the components of the National Weather Service program is being planned so that boating fishermen will receive their portion of the local marine conditions soon after 5 a.m. each morning.

The Hawaii Fishing Coalition has received numerous comments from boating fishermen indicating these improvements have been noticed and appreciated by the recreational boating community.

We, the Hawaii Fishing Coalition, have also presented testimonies at various public hearing and at committee hearings of the Legislature and nurtured support needed in passing the resolution opposing the Hawaii Humpback Whale National Marine Sanctuary from both houses of the Legislature. However, this designation process is still continuing.

Now, the future. The Hawaii Fishing Coalition will continue to monitor and be involved in many issues such as:

1. Correcting the Waianae small boat harbor, wave and surge problem. The HFC initiated a State House resolution asking them to please correct or try to find some solutions to the problems that we are experiencing there. I'm sure this is not the only unsafe harbor in the State.

2. Striving for improvement and emphasizing safety in all State harbors.

3. Monitoring the U.S. House of Representatives' proposal to require all states to license recreational marine fishing. By this, all fishermen, including the guys that are down at the docks with their hand poles, sticking the line into the water, people who go papio and halalu surf casting, spin fishing or what have you. So long as you fish in the ocean, you will be required to have a license.

4. Evaluate the ocean leasing proposal in the State House of Representatives.

5. Formulate and propose modifications in the State's netting regulations.

6. Coordinating the implementation of fish aggregation devices.

7. Urging congressional allocation of funds for U.S. Weather Service reporting buoys for Hawaii.

We were surprised to know also that at the meeting with the weather people that their only means for them to forecast weather in the State, is through a satellite that covers the whole Pacific region. There is no single instrument or device that they can use that singles out the Hawaiian Islands. And what they have requested is assistance in helping to get funds to have some weather buoys implemented a few hundred miles away from the Islands at a few strategic points.

Some of the future goals and ideas of the Hawaii Fishing Coalition are:

1. Completion of an ongoing program impending legislation.

2. Planning, coordinating and conducting educational marine workshops.

3. Maintaining a continued vigilance on new impending legislation and issues.

4. Participation in marine oriented fairs and functions.

5. Continued membership drives.

6. Increase member participation in Hawaii Fishing Coalition activities.

7. Monthly newspaper columns.

We, the Hawaii Fishing Coalition and you, need to merge our ideas and to harmoniously work together with mutual understanding, to accomplish those things that individuals could not normally do. Let us all continue to encourage and preserve the recreational and sport fishing interest in Hawaii.

Again, this concludes my presentation and I'd like to thank the organizers again for inviting us over to at least give you some idea of what the Hawaii Fishing Coalition is and the concept and the goals that we are striving toward.

Thank you.