

NOAA Technical Memorandum NMFS



APRIL 1987

**FORCES OF CHANGE IN HAWAII'S AKU
(SKIPJACK TUNA) INDUSTRY, 1986
WORKSHOP SUMMARY**

**Christofer H. Boggs
Samuel G. Pooley**

NOAA-TM-NMFS-SWFC-72

**U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Center**

NOAA Technical Memorandum NMFS

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**U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary
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National Marine Fisheries Service
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PREFACE

This is the report of a workshop on the **Forces of change in Hawaii's aku (skipjack tuna, Katsuwonus pelamis) industry**. The workshop was held on April 30 and May 1, 1986 in Honolulu, Hawaii and was coordinated by the Southwest Fisheries Center (SWFC) Honolulu Laboratory, National Marine Fisheries Service, NOAA.

The objectives of the workshop were:

1. To review the status and current research on Hawaii's aku fishery, and
2. To introduce and prepare background material for discussion at a joint industry-government planning session to be held at a later date.

The workshop was co-sponsored by the State of Hawaii Division of Aquatic Resources, the Tuna Boat Owners Co-Op, Inc., the United Fishing Agency, Ltd., the University of Hawaii Sea Grant College Program, and the Western Pacific Regional Fishery Management Council. The workshop site was provided by Hawaiian Tuna Packers.

Sixty people, including aku boat owners, fresh seafood distributors, fisheries scientists and managers, and those in the wider public attended the workshop.

Ten people gave presentations to the aku workshop. Some prepared formal papers, but many simply summarized their current work or spoke only from notes. Four papers are available as administrative reports (see list at conclusion of this report).

This report summarizes the presentations and the discussions which followed each section of the agenda. The summaries were prepared by SWFC Honolulu Laboratory staff and are a precis of the actual presentations. Relevant tables, figures, and charts are also included.

An executive summary of the workshop follows this preface.

These summaries are intended to convey the gist of the workshop's presentations and discussions. However, they are not rigorous scientific papers and should not be viewed as such. Furthermore, since the presentations and discussions are independent contributions, they do not necessarily represent the views of the National Marine Fisheries Service.

EXECUTIVE SUMMARY

During a **decade of decline** Hawaii's annual aku (skipjack tuna) catch has dropped to about half of its long-term average of about 4,000 t. The number of commercial pole-and-line boats dropped from 15 in 1971 to 9 in 1986. Annual revenue decreased by about \$2.7 million between 1974 and 1982. In 1984 the cannery closed. Workshop participants examined fisheries data, economic analyses, and research on aku in Hawaii and around the world; looking for the causes of the local industry's decline and for ways to improve the situation.

Commercial fishing for skipjack tuna in the **western Pacific** has expanded. In the 1970's Japan introduced purse seining to this area and by the mid 1980's, 30 Japanese and 60-70 United States purse seiners were operating in the area. Japan has promoted industry stability by regulating the number of it's purse seiners and retiring pole-and-line capacity. Despite the large increase in purse seine landings, Japanese pole-and-line catch has remained proportional to effort. This is evidence against the idea that Hawaii's problems result from increased fishing in the western Pacific. It is estimated that the total stock of skipjack tuna in the South Pacific Commission area is more than 10 times as large as the commercial catch. Extensive tagging has shown that very few skipjack tuna from that area are recovered near Hawaii. (John Sibert)

Tagging and gene-frequency data show a connection between skipjack tuna in the **eastern Pacific** and Hawaii. Large "season aku" important in Hawaii are the right size for typical eastern Pacific fish after 15 months of growth. Tagging studies suggest that high natural mortality (0.16/mo in western Pacific) would permit only 10% of skipjack tuna to survive the 15 months required to swim to Hawaii. Most (17 out of 25) tagged aku recovered in Hawaii were from a single, 2-year (1975-76) period and may be unusual. Most tag recoveries are made within 250 nmi (western Pacific), of release and their distribution seems to be random. There is no link between season aku abundance in Hawaii and catches in the eastern Pacific, considering growth and lag time. Distant fishing does not seem to affect aku catch rates in Hawaii. (Robert E. Kearney)

Changes in **wind and temperature conditions** precede high skipjack tuna catch rates in areas off west Africa. Tagging studies show tuna moving between areas in synchrony with these changes, suggesting that the movements are timed to bring tuna towards new aggregations of food. Hawaii's summer catch of large aku was normal through 1973. A strong El Niño occurred in 1972-73, and the Pacific has been gradually warming since 1976. After 1973 large fish were a smaller part of Hawaii's aku catch, which declined. The rapidity of spring warming east of Hawaii (long. 140°W) appears to be correlated to the catch of large fish in Hawaii. Slower spring warming from 1973 to 1979 may reflect changes in the currents that transport or guide aku to Hawaii; or these changes may affect the food supply, mortality, or reproduction. (Roy Mendelsohn)

Export opportunities for Hawaii's industry are curbed by the depressed world price for skipjack tuna, resulting from a glut of canning quality tuna.

increased harvesting capacity, and market preference for other species. The low prices that caused the closure of U.S. canneries will remain low, favoring low cost producers. Hawaii's aku industry cannot make a profit in this market. Attempts to export fresh-frozen aku and aku sashimi will meet with stiff competition and face consumer preference for other species. Expanding the local sashimi market to absorb flash-frozen surplus aku might end up benefiting importers more than Hawaii's industry. The best market opportunity might be for a specialty pack of canned aku exploiting the Hawaiian mystique (as in macadamia nuts or Hawaiian potato chips). **(Dennis M. King)**

The abundance of aku in Hawaii, as estimated from catch per standard day fished, did not show any trend from 1948 through the early 1970's; but in 1975, 1980, 1982, and 1983 (the last year analysed) catch rates were the lowest on record. Catch rates have been below average every year since 1978. Total catch was correlated to catch rate. Standardized effort (class 2 vessel days) showed a long-term decline and dropped below all previous lows in 1980, 1982, and 1983. Qualitative changes in effort, such as searching time, distance from shore, or targetting on FAD's were not analysed. So, declining aku catches were due to reduced aku abundance and reduced fishing effort; although the estimates of abundance (catch rates) may have been lower because of less efficient effort rather than less aku. **(Robert A. Skillman)**

Since the 1960's **low earnings** have curtailed investment, many aku boats have quit, and the rest have been worked harder. Attempts to sell more high-priced, fresh aku faced market limitations even before the cannery closed. During 1970-85 price per ton rose 45% and costs rose 75% (data on 5 boats, after inflation). To offset fuel (200%) and insurance (390%) cost increases crew shares were kept low and repairs were postponed, resulting in safety problems and depreciation. Some boats can no longer be insured. Fishing operations (i.e., running time) may have changed to save fuel. For 5 years there have been no profits. Bulk fuel purchases at discount would help, and if each boat could take more trips and sell more aku it would reduce the fixed cost ratio, but this would require a larger market or fewer boats. **(Samuel G. Pooley)**

Tuna is the major component in **Hawaii's fresh fish market** and the price of fresh aku dominates sashimi prices. Large aku are preferred and their availability is greatest in the summer. The cannery was important because it absorbed excess fish when they were abundant and without this the market value of fresh fish plummets when the aku are most abundant. In 1979 the fishing was still good though bait was (and is) a problem; but by 1982-83 the harvest had obviously declined and the cannery price also declined. The cannery stopped taking small aku in 1984, but it continued to take large aku even after it closed. Dealers must find new product forms (i.e., smoked or dried aku, fishcake), or other ways to prolong shelf life. A local group has bought the rights to the cannery and hopes to promote a specialty pack. **(Brooks Takenaka)**

The timing of events suggests that **decreases in Hawaii's aku landings** were caused by fuel price increases starting in 1973, and declining aku abundance starting in 1974. The 1974 decline in large aku landings

corresponded with an increase in skipjack tuna catches in the eastern Pacific, and preceded the new restrictions on baiting by 7 years. The extra small aku catch increased in 1976 (4 years before major FAD deployment), the small aku catch declined in 1978, and medium aku declined in 1980. From 1974 to 1982 the drop in annual catch attributed to fuel price increases was worth \$1.3 million. About 25% of the remaining \$1.4 million loss in annual catch was attributable to changed aku size distributions. The direct loss from the cannery closure in 1984 was \$0.5 million and would have been greater but for the low catches. The loss of the cannery hurts the largest boats the worst, since they depend on volume sales. With the current market, the fleet is expected to shrink to four or five small, efficient vessels supplying about half of the demand for fresh aku, the rest being imported. (Linda L. Hudgins)

Albacore is traditionally a **canned product that is now successfully marketed fresh-frozen**. The albacore industry also faced declining catches and depressed prices, so some producers explored a new method for on-board freezing and packing to insure high quality fish. This process omits pithing to promote bleeding (by cutting the isthmus). The fish are then headed, gutted, vacuum packed or glazed, and frozen at -22°C . A cool down period must precede freezing and processing must be finished before rigor destroys fish texture. A crew can process 70-75 fish an hour, the on-board freezer can handle about 1,000 kg a day, and the capacity of the vessel is about half what it would be operating for the cannery. It cost about \$20,000 to convert one vessel. The cannery is still very important as an alternate market. (Kathryn Vanderpool)

That there are **fewer aku in Hawaii than in times past** may just be an impression caused by less fishing, or by fishing in different ways as boat ages and costs go up. Or there may truly be less aku in Hawaii; because they have been caught elsewhere, or because something else that affects them has changed. The two skipjack tuna fisheries closest to the Hawaii aku fishery are in the Northwestern Hawaiian Islands and in the eastern Pacific west of long. 120°W and these have expanded a lot since the early 1970's. However, research tells us that aku move fast, grow fast, reproduce at high rates, eat a lot, and die off at high rates. So aku can increase, move around, and decrease very rapidly. They are more variable than other tuna and the decline in Hawaii could be a response to environmental changes in Hawaii, or nearby. (Christofer H. Boggs)

The **future of Hawaii's aku industry hinges on expanded marketing**, without which the industry will continue to suffer. Immediate palliatives could include emergency financial assistance, product promotion, insurance pools, tort reform, and marketing agreements. Industry-wide participation and cooperation in finding assistance and solutions are needed. Currently, technical assistance is primarily needed in marketing and food technology. The lack of scientific certainty about the abundance of the resource hampers the industry in making a case for new investment. There is interest in new technologies for spotting aku schools, for obtaining and maintaining bait, for new vessels and new ways of fishing. If the market can be expanded, the opportunities for technological improvements and new investment are many. (Richard S. Shomura, Frank Goto, Wadsworth Yee, and John Robey)

AGENDA
A WORKSHOP ON FORCES OF CHANGE IN HAWAII'S
AKU (SKIPJACK TUNA) INDUSTRY

RESOURCE AND INDUSTRY ISSUES

APRIL 30, 1986 (WEDNESDAY)

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**Pacific skipjack - The status of research on skipjack
fisheries in the Pacific**
John Sibert, South Pacific Commission 1

9:15 a.m.

Skipjack tuna migration and interactions
Robert E. Kearney, Inter-American Tropical Tuna Commission 4

9:45 a.m.

Environmental influences on skipjack tuna availability
Roy Mendelsohn, Pacific Fisheries Environmental Group, NMFS 14

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East-West Center

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HAWAII'S SKIPJACK TUNA INDUSTRY

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APRIL 30, 1986

MORNING SESSION

INTRODUCTION

The workshop opened with a summary of its purpose by Richard S. Shomura, Director, Southwest Fisheries Center (SWFC) Honolulu Laboratory, National Marine Fisheries Service, (NMFS), NOAA. Shomura began with the observation that these sessions were not to be a funeral service for the aku industry. Rather, the workshop was to review the status of the aku industry and examine current research into skipjack tuna fisheries. Participants were encouraged to discuss what has happened to the aku fishery, to examine critically the biological data that have been accumulated, and to assess economic data which have been collected recently with the assistance of the industry.¹

The workshop was to be the first stage of a sequence of events to assist the aku industry. Following this meeting, a smaller group would be involved in a strategic planning exercise to generate recommendations which government agencies can use as a plan to understand where the aku industry and fisheries research are headed. [The strategic planning exercise was held July 2 and October 9 in Honolulu. A separate report has been published on the planning process (Boggs and Pooley 1987).]

WORLDWIDE INFLUENCES

John Sibert: "The Status of Research on Skipjack Fisheries in the Pacific."

Sibert reviewed the skipjack tuna fisheries in the central and western Pacific. He spoke on the history, current conditions, and possible futures for these fisheries.

Sibert began by noting that the native people of the Pacific had been fishing for skipjack tuna for as long as anyone could remember and there are many people for whom the traditional skipjack tuna fisheries are an important part of their livelihood. These traditional fisheries use pearl shell lures and the catch is hauled by hand from canoes and runabouts. This will continue to be so for many in the Pacific.

Commercial fishing for skipjack tuna was pioneered by the Japanese around the turn of the century as their fishermen began moving offshore from their home waters. Between the two wars, the Micronesian area was a

¹NOTE: On measures, participants used the scale of their own choosing. Conversion of metric scales follow: 1 kg = 2.2 lb; 1 t = 2,205 lb; 1 in. = 2.54 cm; 1 km = 0.65 mi.

Japanese trust territory and the Japanese extended their pole-and-line fishery with many local bases throughout the area from Palau to Pohnpei. This was totally changed by World War II. After the war, the movement of Japanese vessels was somewhat restricted by the conditions of the occupation and the historical remnants of that policy continue to shape Japanese fisheries. The Japanese Government currently regulates the areas for fishing by the size and type of the vessel in order to to promote stability in their fishing industry.

In the late 1970's, there were a number of experiments with purse seiners since this method became an important method for fishing for skipjack tuna, Katsuwonus pelamis, and yellowfin tuna, Thunnus albacares. The Japanese use a formula for regulating the number of purse seiners that they will operate, including retiring tonnage in pole-and-line capacity. In the mid-1980's, 30 Japanese purse seiners are operating in the Pacific. Interest in purse seine fishing by the United States in the western Pacific developed in the early 1980's and 60-70 vessels now fish the area.

Sibert pointed out that the catch of pole-and-line vessels for recent years (1982-85) is fairly evenly distributed throughout Micronesia. Important local fisheries exist in Fiji and the Solomon Islands. On the other hand, purse seining grounds are concentrated in the west and near Papua New Guinea, with an important local fishery near the Solomon Islands. The pole-and-line and purse seine fishing grounds overlap somewhat.

The skipjack tuna catches by the purse seine fleet show a dramatic increase in the past few years (Fig. 1). In 1982 the purse seine catch of skipjack tuna surpassed the pole-and-line catch. The effects of this increase are still unknown.

Despite these increases in purse seine landings, fishing success for the pole-and-line vessels has not been dramatically decreased. The total catch remains proportional to the amount of fishing. If the stock were severely damaged, the catch at high fishing effort would be lower.

In summary, the skipjack tuna fisheries in the central Pacific Ocean are widely distributed, and the pole-and-line method appears still to be a viable fishing technique despite its labor intensive requirements. The Japanese are developing new vessels which are more fuel efficient, have greater freezer capacity, and are capable of delivering sashimi quality fish. The dramatic increase in purse seine catch does not seem to have had an adverse effect on the stocks.

The South Pacific Commission (SPC) has estimated the total stock of skipjack tuna to be 6.6 billion lb (3 million t), more than 10 times the current catch. Scientists at SPC have estimated a very high turnover rate (approximately 16% per month) for skipjack tuna in the Pacific. Thus, the stock of skipjack tuna in the central Pacific is very large and the biological prospects for a continuing successful fishery are good.

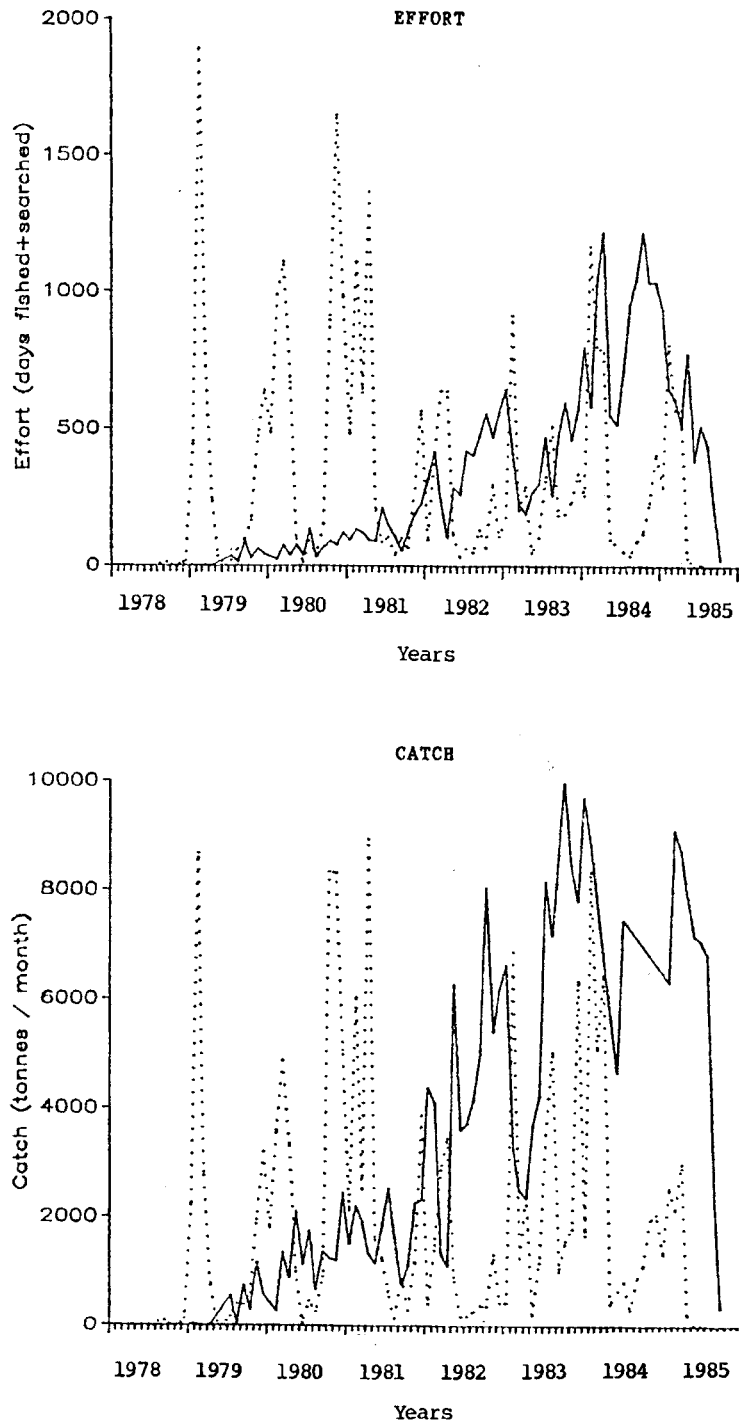


Figure 1.--Trends in skipjack tuna pole-and-line (dotted line) and purse seine (solid line) effort (top graph) and catch (bottom graph) in the western Pacific. (John Sibert)

Previous SPC work examined the migration of skipjack tuna posing a question of direct relevance to the Hawaii aku industry: Are the dramatic catches in the South Pacific affecting the fishery here in Hawaii? The short answer is, we don't really know. Evidence from fish tagged by the SPC shows that very few tag recoveries are made near Hawaii (Fig. 2). Sibert warned that tags are only returned where there is a fishery, and where the fishery is small, you would not expect a lot of tag recoveries. Despite this caveat, the probability of a large movement of skipjack tuna from the South Pacific to Hawaii is low.

Robert E. Kearney: "Skipjack Tuna Migration and Interactions."

Kearney indicated that he would concentrate on Pacific-wide skipjack tuna research results that apply to the issues pertinent to migration of skipjack tuna to Hawaii, and this would be his personal interpretation of the evidence. He acknowledged the recent work by Eric Forsbergh of the Inter-American Tropical Tuna Commission on skipjack tuna in the eastern Pacific.

Kearney began his presentation by noting that skipjack tuna are found throughout the Pacific, and that they are highly mobile, whether or not highly migratory. The evidence on their migration comes principally from tagging information but information is also available from genetic studies and catch composition data.

Kearney stressed that the skipjack tuna is an evolutionary extreme; no other animal on Earth is so evolved to sustain high speed, and some individuals, if not entire stocks, move great distances.

The eastern Pacific tagging program has released 118,000 tagged skipjack tuna of which 14,000 have been recovered (Table 1). The results indicate a reasonable amount of north-south movement and some westward movement, a reasonable amount of fish (25 recoveries) move to Hawaii, and 1 traveled over 5,000 nmi.

There have been 140,000 releases of skipjack tuna in the western Pacific, mostly in the area from Australia to Papua New Guinea. The recoveries show movements in all directions which Kearney suggested were nearly Brownian motion, i.e., random. Thus, the western Pacific tagging work suggested that the movement of skipjack tuna in an area filled with land masses was particularly difficult to predict. Despite this, he especially emphasized the fact that none of the tagged skipjack tuna came to Hawaii. Kearney considered this an extremely significant piece of information. Every place there was a fishery, there were tag recoveries, but there were no tags released in the western Pacific recovered in Hawaii.

Comparing tag recoveries with time, the evidence shows that almost all tag recoveries occur within 36 months (Fig. 3). The natural mortality rate of skipjack tuna is extremely high (0.16 per month) such that after 15 months, which is the time it would take those fish released in the eastern

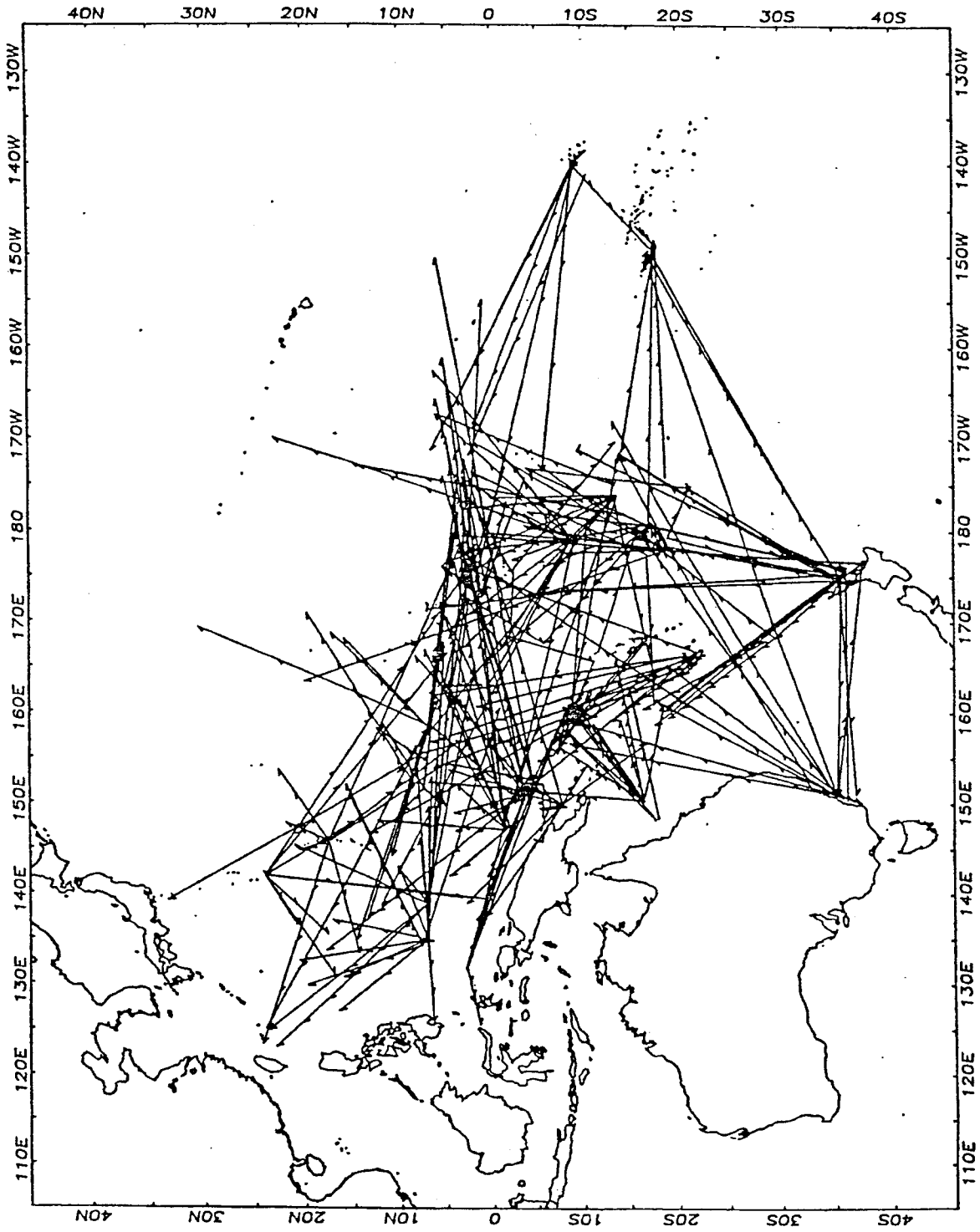


Figure 2.---Recoveries of skipjack tuna tagged in the western Pacific. (Robert E. Kearney)

Table 1.--Eastern Pacific landings of skipjack tuna and tag returns.
(Robert E. Kearney)

Year	East Pacific catch (short tons)	Hawaii catch (short tons)	East Pacific tag releases	East Pacific tag returns	Hawaii tag returns
1952	45,400	3,646	306	0	
1953	66,850	6,029	1,034	20	
1954	86,850	7,016	3,266	11	
1955	64,000	4,847	1,822	11	
1956	70,150	5,566	5,585	57	
1957	64,150	3,065	12,962	304	
1958	82,450	3,417	21,329	453	
1959	88,800	6,206	17,872	399	
1960	55,250	3,680	8,653	504	2
1961	75,468	5,447	11,353	796	1
1962	78,256	4,707	5,255	1,116	
1963	105,333	4,049	1,514	665	
1964	65,322	4,512	421	30	
1965	86,185	8,079	474	58	1
1966	66,669	4,692	0	0	1
1967	132,999	4,020	1,058	43	
1968	78,334	4,659	9	1	
1969	65,109	2,982	999	54	3
1970	61,705	3,675	548	4	
1971	115,434	6,671	237	23	
1972	36,784	5,429	48	0	
1973	48,410	5,374	1,937	527	2
1974	86,848	3,719	157	19	
1975	136,718	2,638	3,154	1,183	5
1976	140,121	4,900	12,700	6,792	12
1977	95,619	3,876	76	8	
1978	186,725	3,398	0	0	
1979	145,565	2,567	2,507	606	
1980	144,066	1,906	2,059	246	
1981	130,986	2,075	2,258	420	1
1982	108,850	1,414	0	0	
1983	63,916	1,381	8	0	
1984	66,758	1,827	0	0	
1985	54,891	--	5	1	
Total			118,606	14,351	25

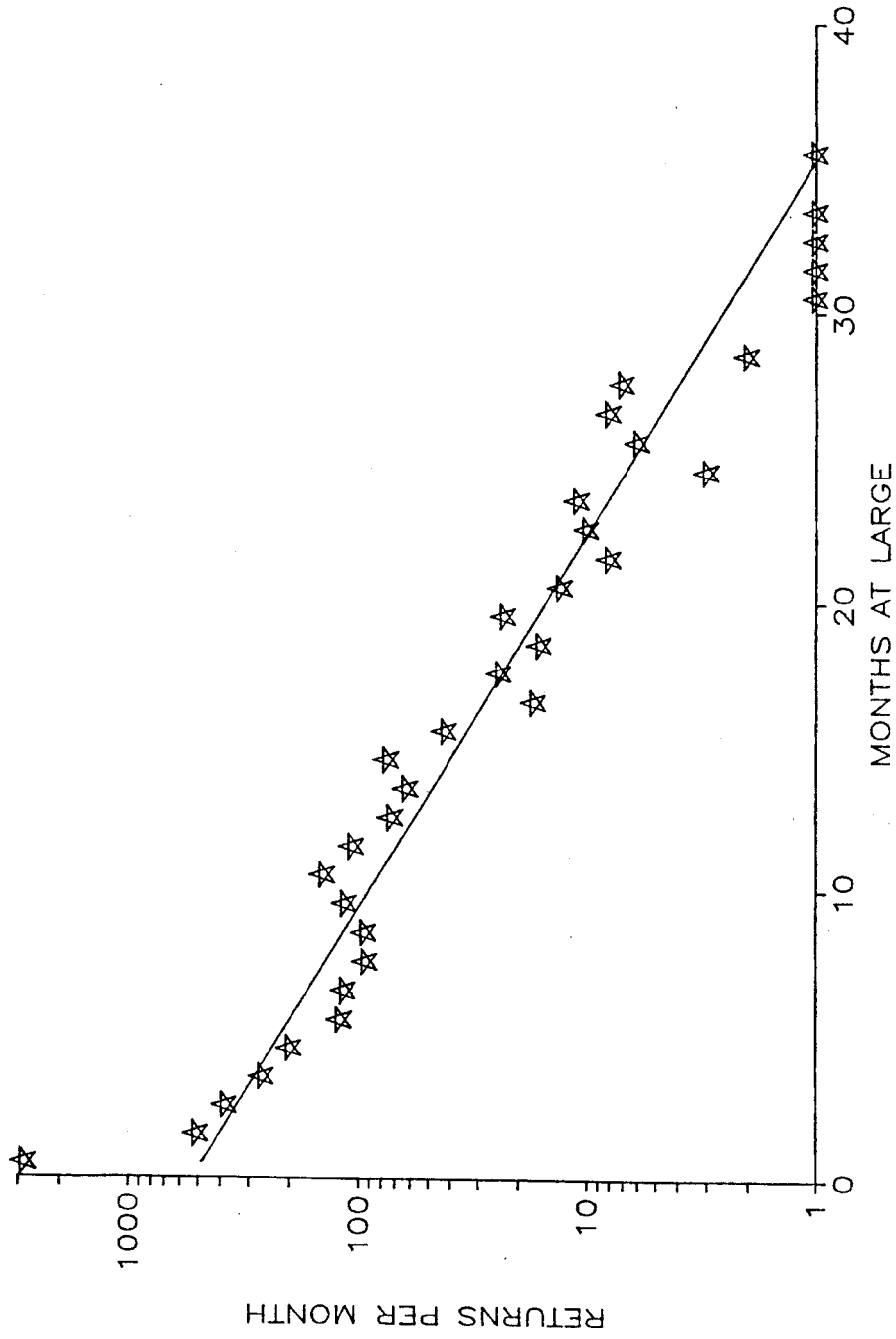


Figure 3.--Numbers of skipjack tuna tag recoveries in the western Pacific versus months at large. (Robert E. Kearney)

Pacific to move to Hawaii, only 10% of those fish are still alive regardless of what the fishery is doing to them.

The charting of distance between tagging and recovery shows that for those tagged skipjack tuna recovered within 30 days, the fish haven't gone anywhere; for those out 31-150 days, some are going out as far as 1,000 nmi, but the majority still stay close to home, and similarly for those out for more than 180 days (Fig. 4). Evidence on movement is limited by the distribution of fisheries, but it does point out that for a species with high natural mortality, it is unlikely that a great number of them go a great distance.

Kearney noted that there was a substantial argument within the scientific community over how to interpret blood genetics data. The esterase gene frequencies in Hawaii appear to be in the same group as those to the east, whereas from Hawaii westward there are substantial differences in these gene frequencies (Fig. 5). Again, this helps make the point to support the hypothesis that fish from the western Pacific do not move to Hawaii.

The catch composition shows that there are few really big fish taken in the eastern Pacific (Fig. 6). These fish are mainly <55 cm (8 lb, 4 kg). In the western Pacific, in the area of Papua New Guinea, there are also very few large skipjack tuna taken. Further north, larger fish are taken. Even the tagged fish from the western Pacific which were alive after 2 years were still <70 cm (17 lb, 8 kg) when they were recovered. Again this suggests that the western Pacific fish are not those which supply the season fish to Hawaii, which are very large.

The tagged fish which came to Hawaii from the eastern Pacific were in fact large, season fish, and they averaged 15 months in getting here. Their growth rates correspond to the norm (17-25 cm per year).

Kearney concluded that the data closely associate the skipjack tuna caught in the eastern Pacific with those caught in Hawaii but do not closely associate the fish from the western Pacific with those in Hawaii. This could be considered strong evidence to show that the expansion of the eastern Pacific fishery is responsible for the decline in the Hawaii fishery.

However, the evidence of relationship between the eastern Pacific fishery and Hawaii is only superficial as shown in Table 1. Comparison of eastern Pacific fisheries expansion, the tagging program, and the recoveries of eastern Pacific tags shows that almost all the Hawaii recoveries were from the 1975-76 tags, and most of these came from the spring seasons. Kearney concluded that it is an anomaly for skipjack tuna to come to Hawaii.

The dramatic decline in Hawaii's commercial skipjack tuna fishery in the 1970's (Table 1) is what is of concern for most people. Meanwhile, in the eastern Pacific, there is a rising trend from 1952 onwards, with a fall in 1970-71, rising again until 1980, and a dramatic decline since 1980.

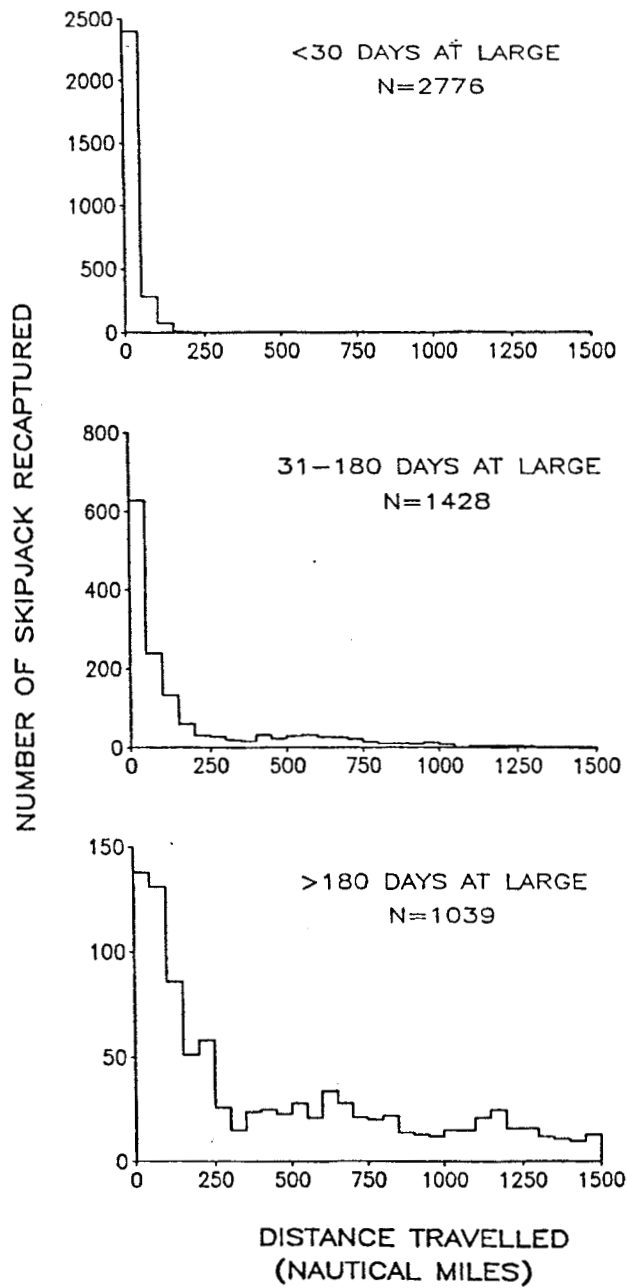


Figure 4.--Numbers of skipjack tuna tag recoveries in the western Pacific by distance traveled and time at large. (Robert E. Kearney)

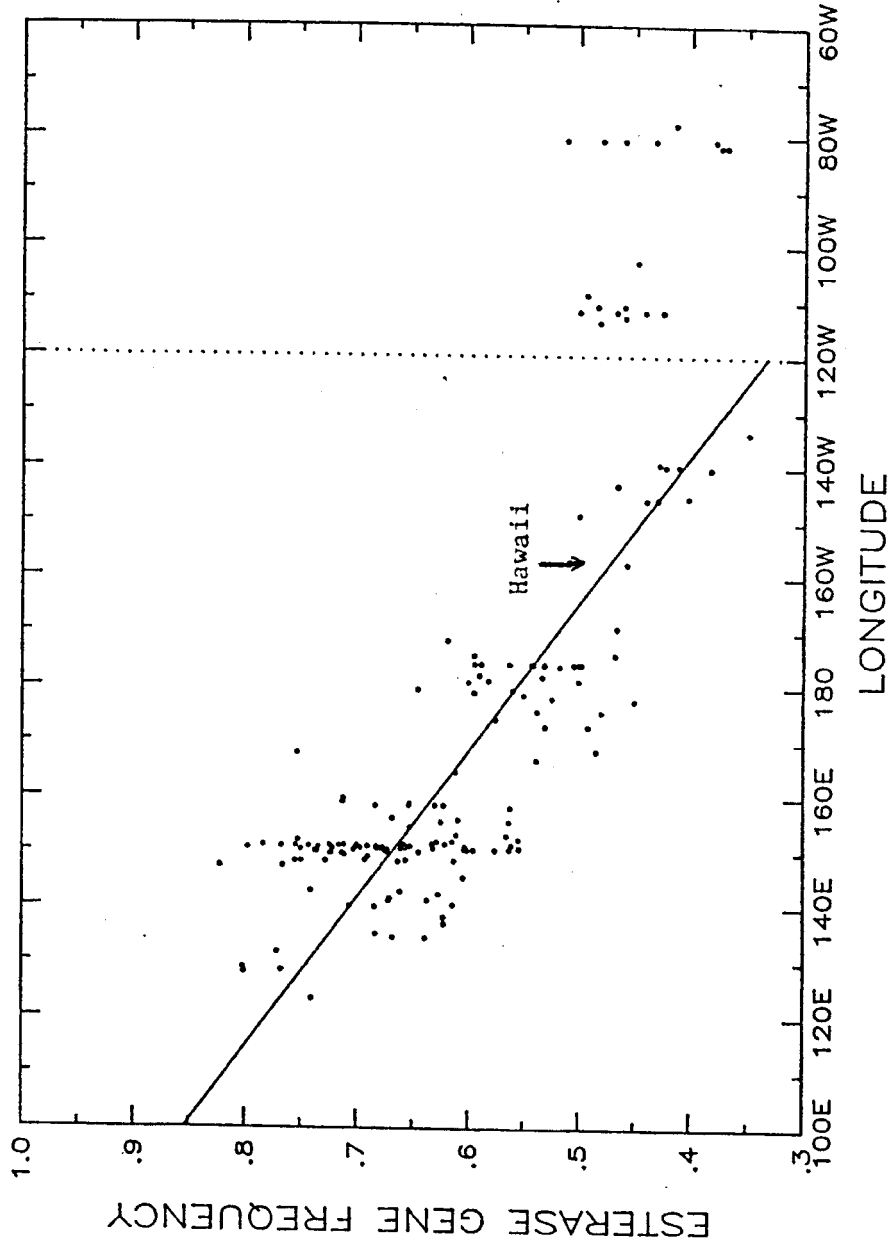


Figure 5.--Serum gene frequencies among skipjack tuna across the Pacific. (Robert E. Kearney)

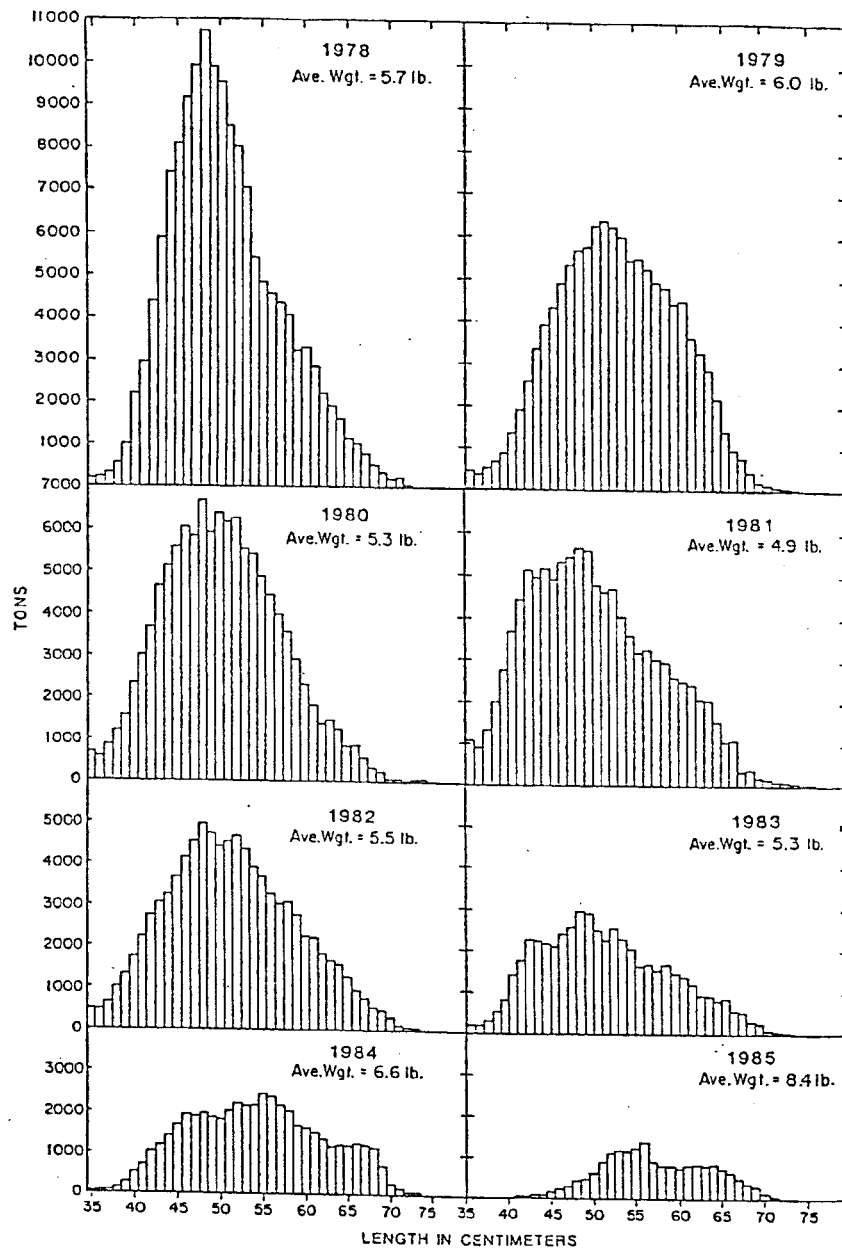


Figure 6.--Length frequencies of eastern Pacific skipjack tuna. Data for 1985 are incomplete. (Robert E. Kearney)

However, despite this decline in the eastern Pacific fishery, there was no corresponding change in Hawaii's landings.

Combining this information with size composition data produces another conclusion. There were relatively small fish in the eastern Pacific with some bigger fish in 1985. However, the data show a dramatic increase in small fish landed in Hawaii. Kearney said he couldn't see how the eastern Pacific fishery could be blamed for the increasing catch of small fish in Hawaii, because on average the Hawaii small fish are of the same age or younger than the eastern Pacific fish.

Finally, if the eastern Pacific fishery does affect the Hawaii fishery, then one would expect a strong correlation between their catches. By making alternative assumptions about the age composition of the fish, the evidence shows there is basically no correlation between the eastern Pacific fish and Hawaii landings (Fig. 7).

It is reasonable to conclude that the Hawaii fishery has no long-term effect on itself, i.e., there is no fishing pressure on local stocks, although it is possible that heavy pressure on small skipjack tuna will affect future landings of large fish if there is a population which stays resident in Hawaii. The evidence on the movement from the eastern Pacific to Hawaii shows that this movement is inconsistent and irregular. Furthermore, Kearney emphasized that the current eastern Pacific catch is less than one-fourth of its late 1970's levels.

Furthermore, whatever the migration data, there is probably a strong density dependence on the immediate availability of skipjack tuna in Hawaii waters. The ocean around Hawaii is not particularly productive to support large quantities of tuna, and supports a relative small amount compared to the eastern Pacific. So even if the eastern Pacific tuna came to Hawaii, the local waters would not support many of them. Furthermore, the distance between the fisheries is so great, and the natural mortality is so high, that it is most likely that there is relative independence between the fisheries. Therefore, Kearney suggested looking much closer to home for reasons for the decline of Hawaii's aku fishery: changes in bait availability and bait quality, the effects on fishing pattern of the fuel crisis in the 1970's when the decline began to set in, and the observation that fishermen are fishing closer to shore than they used to and perhaps are not fishing quite as hard as they used to fish.

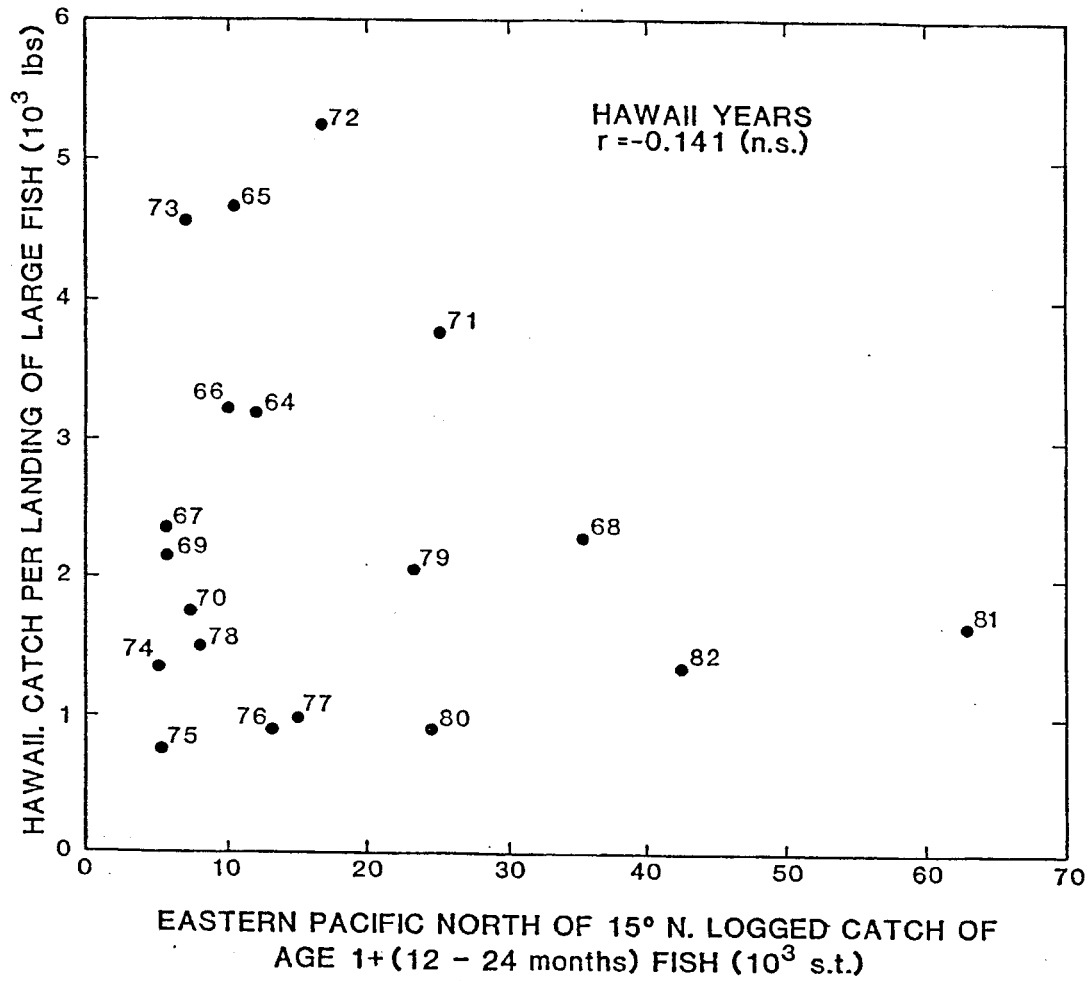


Figure 7.—Lack of correlation between eastern Pacific landings and catch rates for large skipjack tuna in Hawaii. (Robert E. Kearney)

**Roy Mendelssohn: "Environmental Influences on
Skipjack Availability"**

Roy Mendelssohn's paper was read by Christofer H. Boggs of the SWFC Honolulu Laboratory. This summary is based on Boggs' presentation. Mendelssohn's paper is available as an administrative report.

Mendelssohn posed another possibility in explaining the trends in skipjack tuna availability. There are many causes which may contribute to the decline in Hawaii's skipjack tuna fishery, not the least being the seeming decline in the number of fish available to the fishermen. In particular, the questions are whether the decline is due to overfishing, whether environmental factors have increased mortality and decreased reproduction, or whether the fish are still out there but not available to the Hawaii fishery.

A number of alternative theories have been put forward by fishery scientists. Mendelssohn cited Brian J. Rothschild's theory of year-class fluctuations in skipjack tuna stocks and Gunter R. Seckel's theory of the skipjack tuna being dispersed with the currents. Everet C. Jones developed an index based on the north-south movement of the 20° isotherm east of Hawaii as influencing the availability of season fish.

Mendelssohn separated into size categories the time-series of skipjack tuna landings in Hawaii (Fig. 8). There was very little long-term trend in the small and medium size classes, although Boggs noted evidence of periodic strong year classes for the medium size. However, for large skipjack tuna, it becomes dramatically evident that until 1973, there were regular seasonal appearances of large fish, while thereafter there appears to be an entirely different and lower level of large fish. The decline in total catch is almost entirely due to the loss of the large fish.

The transitional period, 1972-73, was marked by a very strong El Niño. This El Niño had a stronger ocean warming effect and was deeper than other recent El Niño's. It was also known to have had a strong effect on the Peruvian anchovetta. Mendelssohn found the correspondence in the timing of the 1972-73 El Niño with the decline in the Hawaii skipjack tuna landings to be the first intriguing bit of evidence connecting environmental changes to the Hawaii fishery.

Mendelssohn reexamined the index developed by Jones and found that he could relate oceanographic phenomena to the availability of large skipjack tuna in Hawaii. He used a weighted average of the January, February, and April positions of the 20° isotherm east of Hawaii at long. 140°W as a measure of how quickly the temperature changed. Temperature changes in this area may represent movements of the California Current Extension and the North Equatorial Current. Since 1972 the index has maintained itself at a different level, indicating a slower warming of the water in the spring (Fig. 9).

There is relatively little environmental information on Hawaii's fishery. However, Mendelssohn has been working with Claude Roy of the

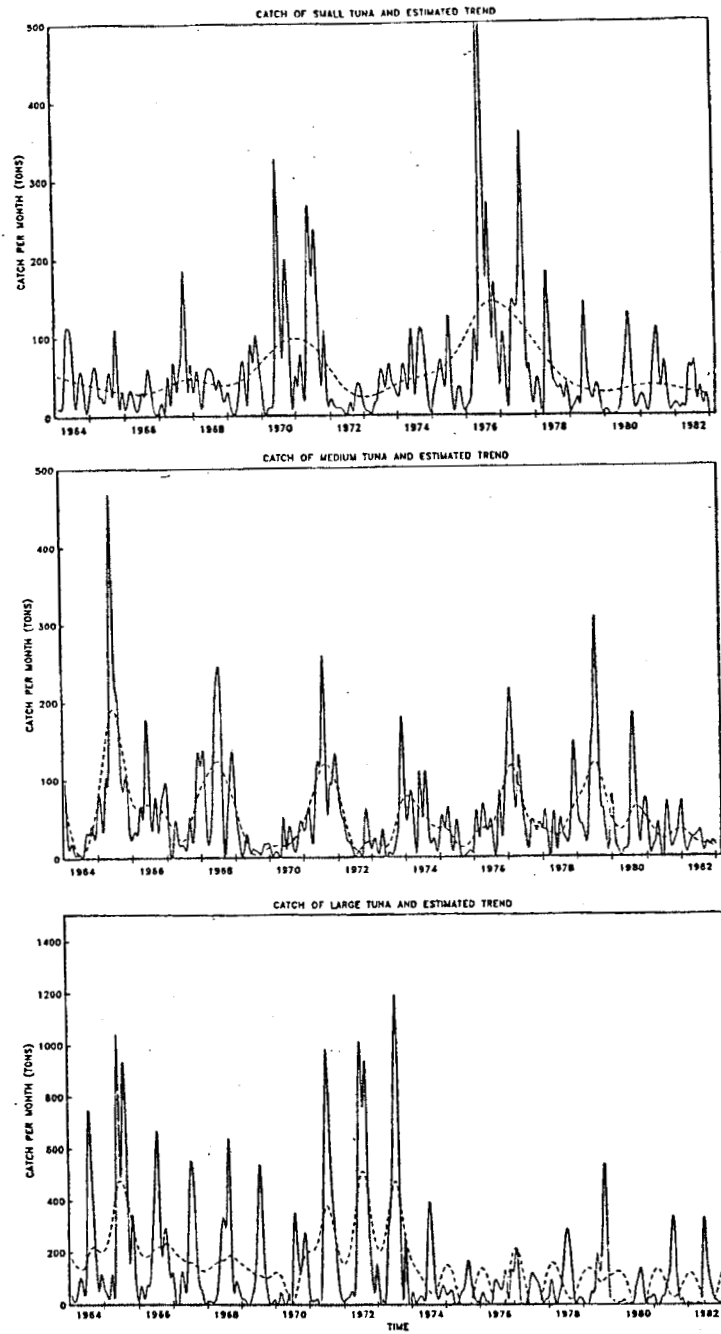


Figure 8.--Catch of skipjack tuna in Hawaii, 1964-82 (extra small not shown). (Roy Mendelsohn)

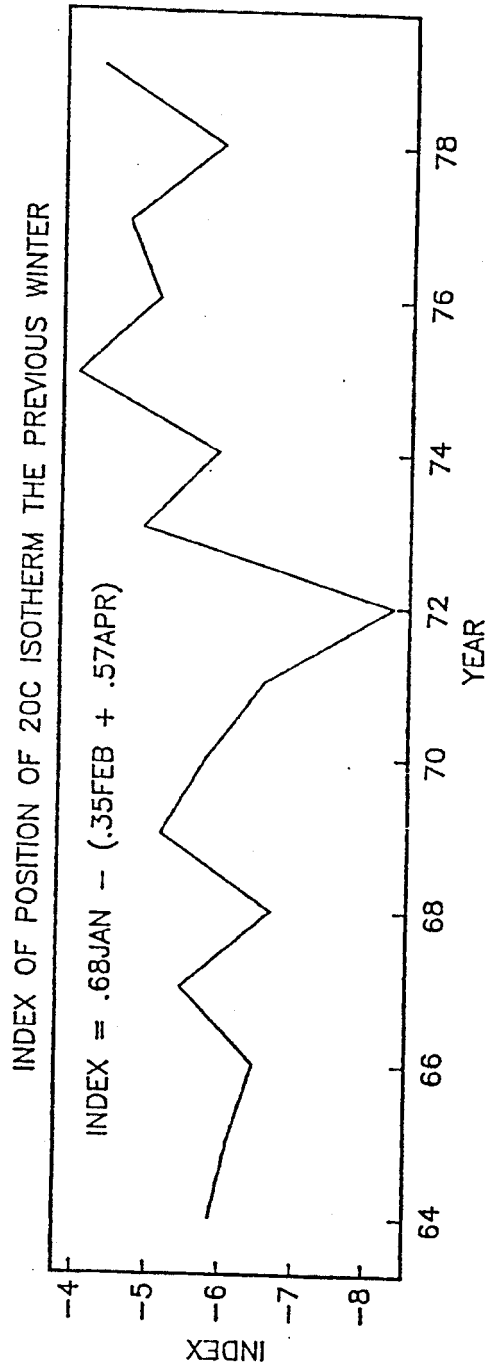
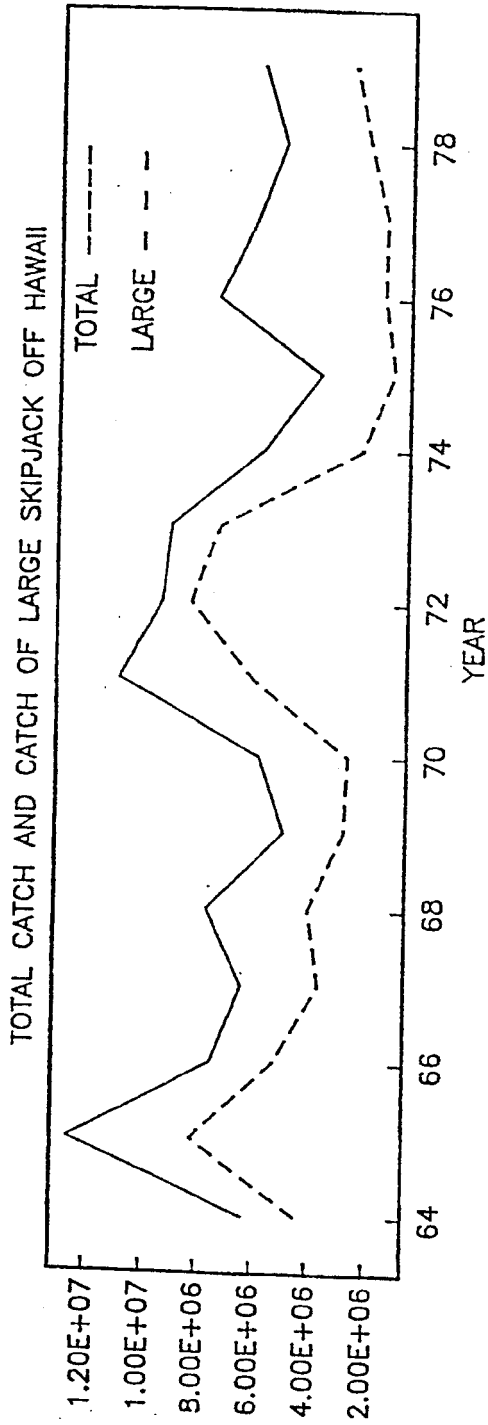


Figure 9.---Sea surface temperature index in relation to the total annual catch of skipjack tuna in Hawaii. (Roy Mendelssolm)

Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM) on the Gulf of Guinea tuna fishery off west Africa. Although there are many differences between the two areas, and the types of skipjack tuna fishing are different, the results of the Africa study may be of use to people studying Hawaii's tuna fishery.

Mendelssohn and Roy divided the Guinea fishery into 11 areas and collected data on sea surface temperature (SST), wind, and catch per unit effort (CPUE) (Fig. 10). The statistical correlation of these factors, and their 2- and 4-week lag effects, show that changing water temperatures were strong predictors of changes in catch rates. Boggs pointed out that the correlation between the explanatory variables and the fishery was sufficiently different between areas to explain why results from one area could not be used to predict when fish concentration would be found in other areas. Mendelssohn used the model to fill in missing data points to show that model estimates matched known records quite closely. The implication of this work is that oceanographic conditions can have a big impact on tuna fisheries.

Mendelssohn reported that the local winds did not seem to be strong enough to cause the upwelling and SST changes that were observed. Physical oceanographers have identified an underwater wave called a Kelvin wave which crosses the entire Atlantic Ocean, causing substantial regional changes in ocean temperatures that move polewards along the African coast.

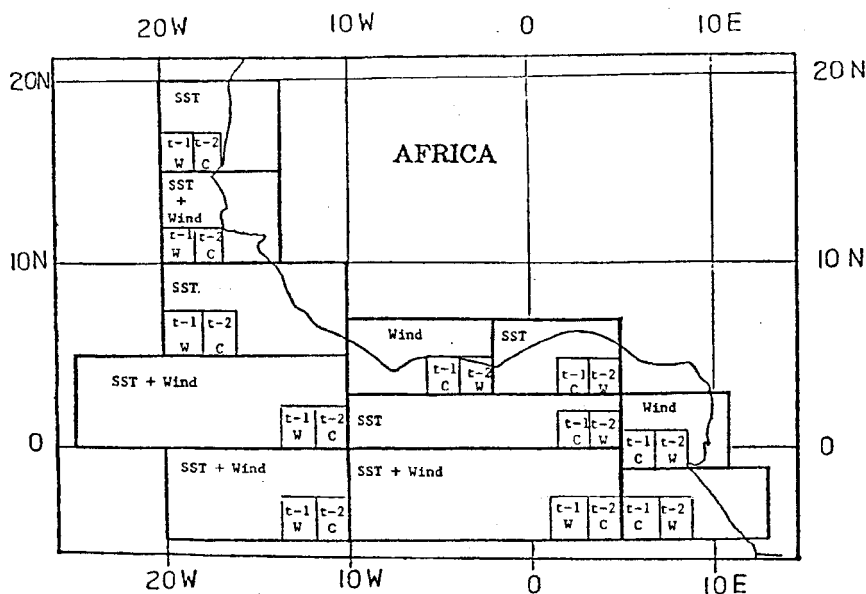


Figure 10.--Summary of area models for skipjack tuna catch per unit effort (CPUE) in the eastern tropical Atlantic. In each model area, wind stress and/or sea surface temperature (SST) contributed most to predicting CPUE. Changes from warmer (W) or colder (C) water 2 weeks (t-1) or 4 weeks (t-2) beforehand led to the best catch rates (CPUE). (Roy Mendelssohn)

Mendelssohn asked why tuna should follow changes in the SST? Previous evidence shows that the upwellings associated with such temperature changes are rich with plankton and other prey items. Therefore, the tuna are probably following their food sources which are associated with temperature boundaries and upwelling. The lag periods between temperature changes and catch rate changes are caused by the time required for the plankton and prey items to respond to the upwelling of nutrients. First, the plankton blooms, then prey items feed on the high levels of plankton, and this, in turn attracts the tunas. A recent tagging study in the Gulf of Guinea seems to confirm that tuna actually follow the progression of changing SST from area to area.

The Gulf of Guinea findings appear to confirm Seckel's hypothesis about catches in Hawaii responding to physical oceanographic conditions, rather than to Rothschild's hypothesis about year classes. Tuna are very similar throughout the world and it would be very surprising if skipjack tuna in Hawaii were influenced by very different factors. Mendelssohn also noted that there was another strong El Niño in 1982 and since 1976 there has been an overall warming trend throughout the Pacific. It is as if a change in "regime" is taking place which may help explain why the large size-classes have not returned. Unfortunately, it is not clear whether the tuna have just moved elsewhere or whether their reproduction and mortality have been fundamentally changed.

**Dennis M. King: "World Tuna Markets and the
Pacific Fishery."**

King discussed three aspects of the global tuna market; 1) Status of world tuna fisheries production; 2) Description of the factors leading to the current bleak marketing situation; and 3) Investigation of opportunities in the current marketing environment.

King began with a depiction of the "migration of dead fish," i.e., the movement of tuna from harvester to cannery (Fig. 11). In general, 70% of the world's tuna (and 85% of the world's skipjack tuna) is caught in the Pacific. Pacific tuna goes primarily to Pacific rim canneries, although eastern tropical Pacific tuna goes to European, Puerto Rican, Mexican, and African canneries, and western Pacific tuna goes to Thailand, Japan, and the Philippines. Therefore, Hawaii is essentially on the back door of a western fishery which faces west for its sales and on the back door of an eastern fishery which faces east. There seemed to have been more opportunities for Hawaii as a staging station when there were canneries on the west coast of the United States packing tuna from the western Pacific, but this is no longer the case.

The total world market for tuna is approximately 1.8 million short tons (Table 2). The United States consumes 37% of the total tuna supply but accounts for a significantly higher percentage of the world tuna trade, because a considerable portion of the "supply" produced in small indigenous fisheries meets local needs but does not enter the world market. Once national market shares are adjusted to take into account accessibility, one

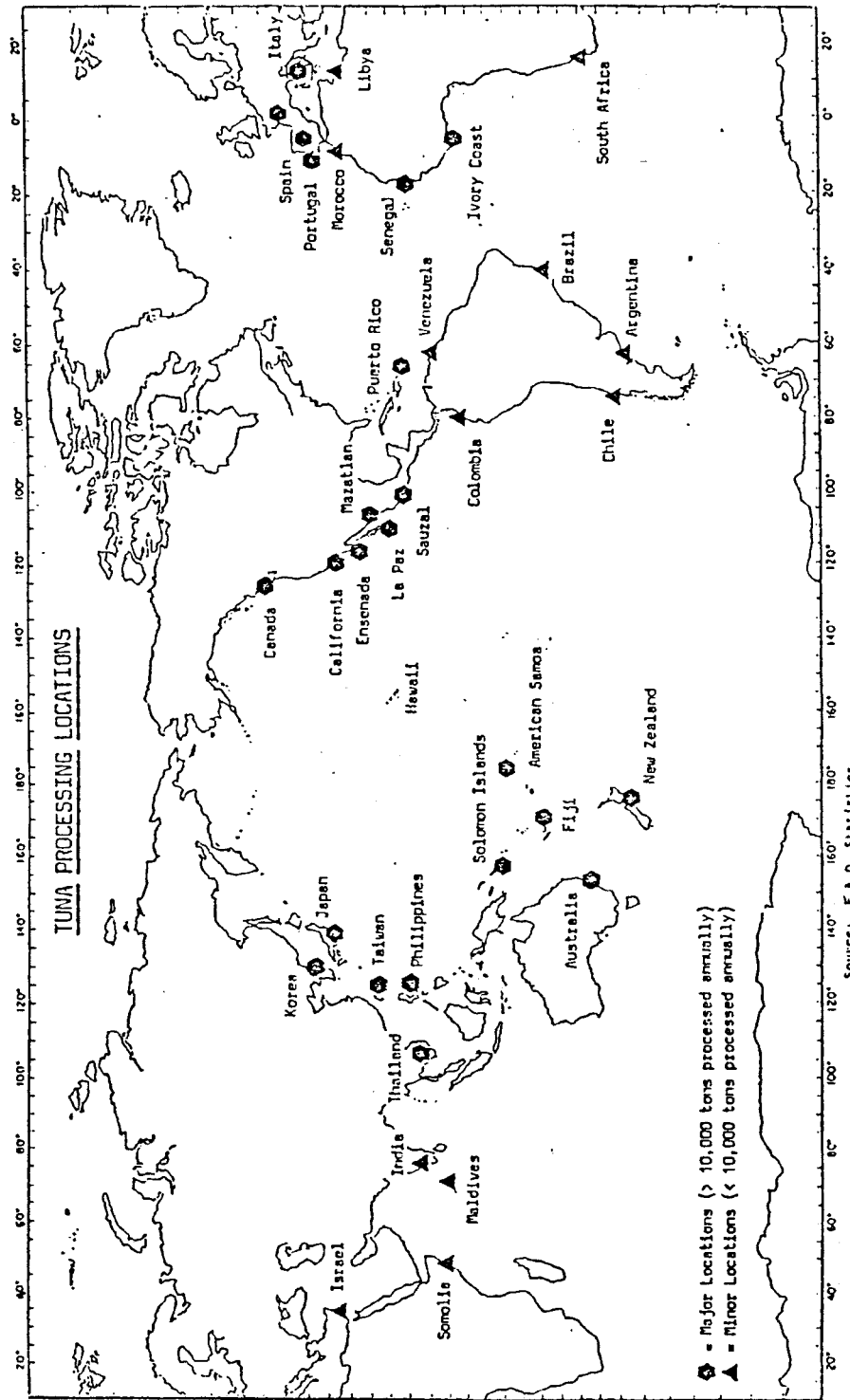


Figure 11.--Map of skipjack tuna processing locations. (Dennis M. King)

Table 2.--World supply of tuna. (Dennis M. King)

CANNED TUNA PRODUCERS (Raw Weight; thousand metric tonnes)						
NATION	1980	1981	1982	1983	1984	1984 SHARE
United States	550	574	492	536	550	35.4%
Japan	190	222	226	234	248	16.0%
Italy	96	98	96	104	118	7.6%
Thailand	*	16	30	56	118	7.6%
France	50	46	60	70	76	4.9%
Spain	86	80	74	64	60	3.9%
Ivory Coast	36	52	58	52	46	3.0%
Philippines	22	36	38	48	46	3.0%
Mexico	30	40	26	22	44	2.8%
Taiwan	*	28	22	30	26	1.7%
Ecuador	10	24	22	14	24	1.5%
Others	106	140	130	148	198	12.7%
TOTAL	1116	1356	1274	1380	1554	100.0%

* Less than 500 tonnes.

SOURCE: FAO FISHDAB

must have significant reservations about Japan and Europe as market opportunities.

Prices in the United States tend to drive the world market and evaluating U.S. consumption per capita is extremely important in understanding the market (Fig. 12). The 1982 dip in per capita consumption had dramatic impacts on world prices. Each 1/10 lb (45 g) per capita consumption in the United States represents 22 million lb (10 million kg) of tuna (916,000 cases or \$36 million in wholesale value). The 1982 reduction in consumption meant that 20,000 tons of raw/frozen tuna were available on the world market.

The growth of U.S. consumption of fresh-frozen tuna has been substantial but potential of this market is not as great as has been reported. If you take a ton of raw tuna and assume a 50% yield, there is 1,000 lb (460 kg) of product. If you assume a portion of fish is 1/2 lb (230 g) then there are 2,000 servings per ton. To distribute 5,000 tons of skipjack tuna (Hawaii level of production) implies a dramatic increase or substitution in consumption, i.e., 10 million new skipjack tuna portions or dinners. King concluded that attempts to market fresh skipjack tuna would

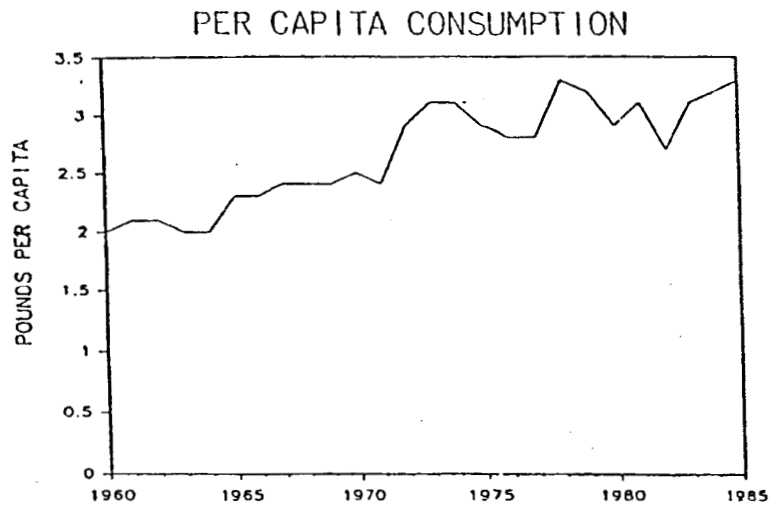


Figure 12.--Per capita consumption of tuna.
(Dennis M. King)

be faced with a relatively small initial market and with direct competition from west coast tuna fishermen and the promotion of albacore.

The Japanese market appears to be even more limited. Japan's tuna exports were 69% skipjack tuna whereas their imports were only 4%. What may be worth investigating is that 50% of the skipjack tuna in Japan ends up in dried form (katsuobushi) which may provide a market niche for Hawaii producers.

The European market is dominated by the southern countries (France, Italy, and Spain) which consume 70% of all tuna in Europe. People say the British market and markets in northern Europe are increasing, but these markets are generally very small. The large markets in southern Europe are obtaining most of their product from French canneries in Africa. More particularly, the French are net exporters of skipjack tuna, trading for yellowfin tuna when possible. Most of Italy's canned pack is from large yellowfin tuna. There are also substantial European economic community tariffs. In summary, the prospects for export of skipjack tuna to Europe are not considered promising.

In 1979-80, the canners noticed that there was going to be a glut of tuna harvesting capacity, and so they shifted out of long-term contracts with vessels and began to sell their own vessels. While they did this, they tried to let the price of raw, frozen tuna rise to the point where these newly independent vessel owners could succeed financially. Transferring the increased costs to consumers meant that the retail price of canned tuna exceeded \$1 a can. Consumers resisted the price increase on canned tuna, particularly because both the price of substitutes and the level of personal disposable income had declined. The canners tried to cut the price, but by that point, retailers had discovered that although at \$1

a can the quantity sold declined, their profit margin was greater. Therefore, retailers kept prices high while allowing the volume of their canned tuna sales to diminish.

At the same time, there were extreme exchange rate differences between United States dollars and foreign currencies, particularly the Thailand currency. These favorable exchange rates and high retail prices made conditions perfect for foreign canners to enter the market. In the meantime, some of the institutional buyers discovered that the quality of foreign pack was quite acceptable. Eventually the retail price began to move down, and this was reflected in ex-vessel prices. The vessels became more efficient, cutting back on crew shares, but it was basically too late for both U.S. vessels and U.S. supply.

As a subsidiary factor, King noted the countercyclical behavior of insurance rates and the prime interest rate. As interest rates increased, the insurance companies were eager to obtain premiums for investment. As soon as interest rates declined, premiums increased (Fig. 13). This has had a severe impact on purse seine tuna vessels.

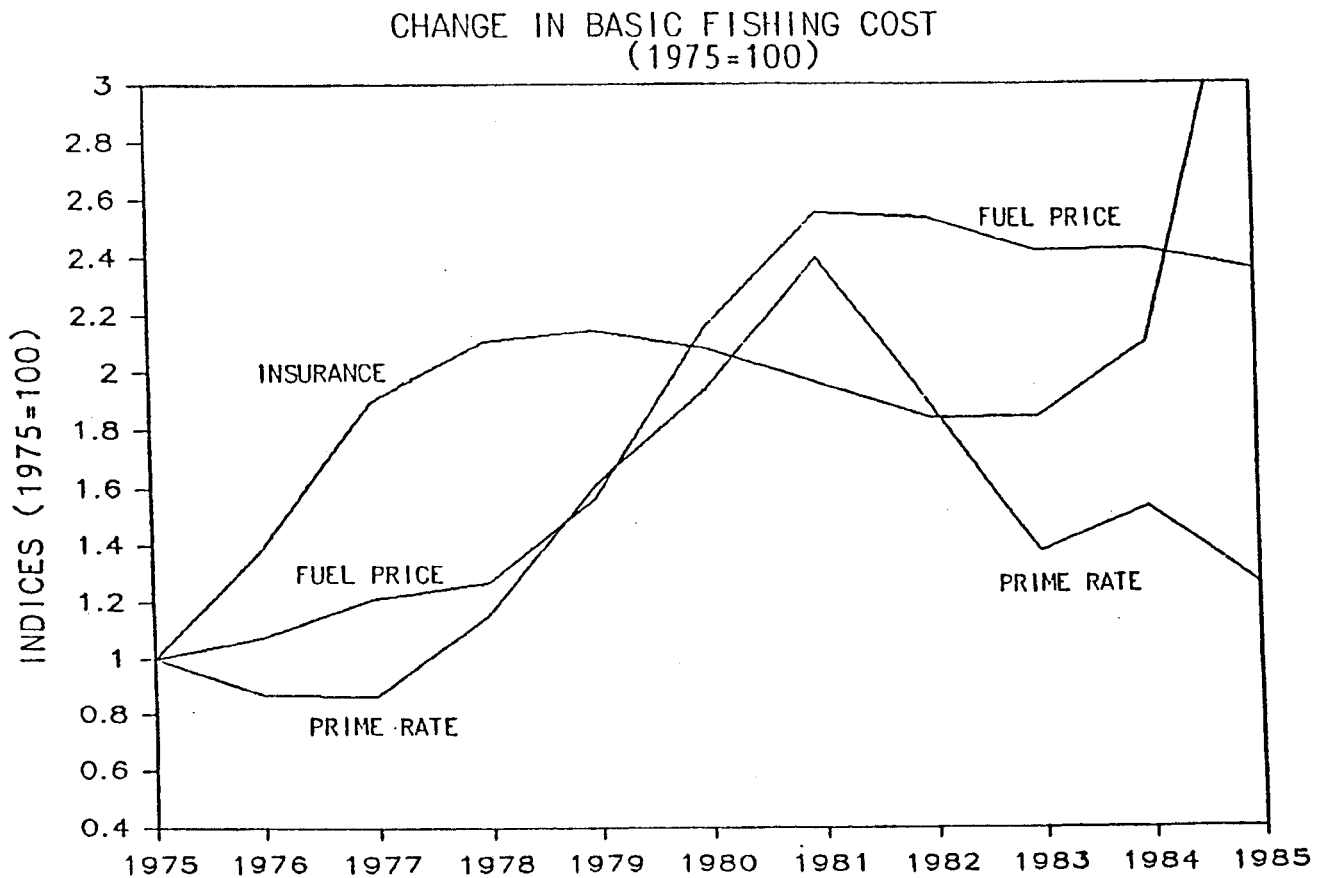


Figure 13.--Fishing cost indices, 1975-85. (Dennis M. King)

King considered the prospects for Hawaii skipjack tuna in either the raw or canned fishery to be poor because of the basic structural change in the world tuna industry. Although the profit situation has been poor over the past 5 years, there is also no indication it will get better soon. The only options which are available involve bold steps with good coordination such as breaking away from the traditional 6.5 oz (185 g) canned pack and developing a specialty pack and a market for it. Some knowledgeable people believe that the recent disruption in U.S. production has left small niches for such specialty packs, i.e., those markets too small for the big canners to explore.

Domestic annual production of 10,000 tons of skipjack tuna would create 5,000 tons of product, i.e., 480,000 cases of 6.5 oz (185 g) cans. King concluded that if Hawaii producers developed a specialty pack exploiting the Hawaii mystique the way the Alaska fisheries have done with their product, then a well-packed, high-quality aku pack sold in 6-packs with distinctive markings and marketed for under \$10 (\$1.67 per can) might be a possibility.

DISCUSSION SUMMARY: Worldwide Influences on Hawaii's Aku Industry

The discussion was chaired by David Douman. He opened the discussion with the observation that the economic reports dash some hopes that the tuna canning industry can pull out of its current depression, and he concurred that the industry has gone through a fundamental structural change.

A boat owner remarked that despite all the nice words, a whole day of news as depressing as that in the morning's talks was more than he could stand, since it all seemed to be a way of saying he would go broke.

Tag Recoveries

An initial question challenged the assertion that the 25 tag recoveries in Hawaii from releases in the eastern Pacific implied that skipjack tuna migration to Hawaii was infrequent and unimportant to the Hawaiian stock. It was asked how many tag returns were expected. Kearney replied that total tag returns range up to 14% (average 6%) in the western Pacific and up to 70% in the eastern Pacific. Recoveries vary depending on fishing intensity. When exploitation is heavy, many tags may be recovered soon after release. Most of those 25 recoveries in Hawaii came from just 7,000 tagged fish, 50% of which were recovered in the eastern Pacific. The high rate of natural mortality implies that <10% of skipjack tuna tagged in the eastern Pacific could be expected to even survive the 15 months required to reach Hawaii (if they came here) and once here, recovery was dependent on fishing intensity. An unknown rate of tagging mortality and loss of tags adds to variability and uncertainty. The fish responsible for most of the Hawaiian recoveries were heavily exploited in the area where they were tagged, yet those fish that did make it to Hawaii after this heavy exploitation were caught during one of the best years of skipjack tuna fishing in Hawaii (1976), implying that heavy exploitation in the eastern Pacific was not detrimental to Hawaii's fishery.

It was noted that almost all the tagging data on the western and central Pacific are from the south and that there have been no viable skipjack tuna tagging studies in the waters between Hawaii and Japan, although a few tags have been recovered in Hawaii from releases to the west. Kearney repeated his opinion, based on South Pacific tagging studies, that it is proximity of different areas that determines the degree of competition between skipjack tuna fisheries in those areas. It was also stated that mobile fisheries that can search a wide area surrounding a stationary fishery will be more likely to have an impact on the stationary fishery.

Kearney clarified the term "turnover," cited as being 3 million tons of skipjack tuna per year and 16% per month. He defined it as the rate at which the population is renewing itself due to natural deaths, reproduction, recruitment, and growth. This estimate was for the area of the SPC and it was stated that this amount could be caught without doing any harm to the stock. Kearney said that it would be virtually impossible to damage the skipjack tuna resource in the long term through any feasible rate of exploitation because they are essentially like cockroaches: they reproduce rapidly and the juveniles are dispersed widely.

Japan's Skipjack Tuna Industry

Next, there was discussion of why Japan regulates purse seine versus pole-and-line capacity by requiring reduction of the latter to match increases in the former when there is no evidence that these fisheries impact each other or the stock. The reasons were said to be the maintenance of employment and of a stable supply of fish. Spatial segregation of the fisheries, through government policy and the constraints of baiting operations, helps to prevent the fleets from affecting each other's catch.

It was pointed out that the internal politics of Japanese fishery associations has a lot to do with the balancing between the number of purse seiners and pole-and-line boats. The Japan Fisheries Agency, Ltd. has been successful at keeping the competing interests happy. The Japanese fishery associations take care of the people that own the boats pretty well so that they don't suffer really terrible economic damage. There are programs within the Government of Japan to do what they call "harmonize" the system, taking care of the owners while unemployed fishermen get benefits from the social service system.

Tuna Markets

The discussion turned to marketing. It was noted that imports to Japan are increasing, especially from Korea, and that the dollar devaluation increases the potential for American exports to Japan. The Japanese trading firms are buying boatloads of tuna on a negotiated basis, and less fish is going through the auctions. The hope was expressed that this could represent a chance for foreigners to penetrate the Japanese market. However, it was also noted that the Japan Tuna Association recently restricted imports, and that very little of Japan's tuna imports are

skipjack tuna, and that is mostly dried. Most tuna being purchased by the Japanese trading houses from Korea is from fleets financed by those same houses, and represents a return on large investments in foreign longliners made about 10 years ago. The opportunities in the Japanese tuna market are greatest for tuna other than skipjack tuna. For example, the Australians have succeeded in marketing sashimi grade southern bluefin tuna, Thunnus maccoyii, and yellowfin tuna through proper handling.

No one answered a question on how the new imports of flash-frozen aku from Japan was impacting the local market.

King pointed out that Hawaii's fishery produces only a quarter of a percent of the world's supply of skipjack tuna, so that small changes in the eastern and western Pacific fisheries affect the local industry commercially (i.e., the viability of a local cannery, the opportunities for export) even if they don't affect the fish population. Although the opportunities for increasing the local fresh aku market and for developing specialty products locally may be somewhat independent from the world market, it was stated that the opportunity to market fresh-frozen aku on the mainland was small due to consumer preference for fresh tuna that don't taste as fishy (i.e., albacore, Thunnus alalunga, which is being aggressively marketed). King concluded that there was no chance of the mainland U.S. market absorbing thousands of tons of skipjack tuna from Hawaii at anything except the cannery price controlled by the world market.

Fuel Prices

The idea was put forward that the El Niño in 1972 and 1973 caused decreases in the skipjack tuna population and then the oil price shock of 1973 caused such financial distress to the boats that the fleet has never recovered. Two possible responses to increased fuel prices were mentioned. People may cut down on the amount of fishing they do, or they try to maintain their income, so that as their costs go up they tend to fish harder and try to make more money. In the latter case, driving the boat harder may increase costs even further due to increased needs for maintenance. This could cause a decline in effective fishing effort, or fishing efficiency.

Nontraditional markets were again cited as an antidote to the bleak outlook of the economic situation. It was stated that the days when fishermen could drop dead fish on the dock and hope somebody else would make it worthwhile are over. Emphasis was placed on coordination; getting the fishermen together to take a bold step in a new area, and trying to minimize the risk that the processors and harvesters make for each other.

Japanese Fishing Around Hawaii

The magnitude of the Japanese catch along the Northwestern Hawaiian Islands (NWHI) and the size of the fish being caught there were brought up. Published Japanese baitboat landings for the NWHI through 1977 were cited as showing increasing catches. Shomura noted that since 1980, the Japanese have not published any data in detail. Japanese representatives were

invited to the workshop and information was solicited from previously helpful sources in Japan with no result. Shomura noted the interesting correspondence between the dramatic drop in Hawaii's catch from 1973 to the present and the initiation and increase of Japanese fishing in the NWHI during that time. The Japanese catch in Hawaii's fishery conservation zone has exceeded Hawaii's catch since 1976.

The size of the fish caught by Japan was not known to anyone present but it was suggested that when U.S. Coast Guard personnel board Japanese baitboats for violations of the fishery management plan on mahimahi, Coryphaena spp., and ono, Acanthocybium solandri, they keep their eyes open for the size of the skipjack tuna.

Environmental Influences

The impact of environmental changes on the Hawaii aku population was discussed. It was stated that the last 3 years represent the worst drought in Hawaii's written history, and that this could affect nearshore production of food for aku, since in places like Oregon, they've correlated high rainfall stream discharges with bumper Dungeness crab catches for 15 years. The multiplicity of factors that could have an impact on aku stocks and the difficulty in quantifying those impacts was brought out in discussion of the El Niño. No significant correlations were found between El Niño events and Hawaii aku catches. Rainfall is affected by these events and the strong anti-El Niño following the 1982-83 El Niño caused abnormally dry weather from Hawaii through Kiribati. Kiribati subsequently experienced the worst skipjack tuna years in their coastal fishery, suggesting that there was a strong impact by the drought.

The problem in assigning causes for declines in catch was illustrated by the suggestion that people in Kiribati, knowing that an expanded purse seine fishery was going on around them, might be very quick to blame the lack of aku on the purse seiners, rather than on the drought. It may be that there was some impact by the purse seiners but there was certainly the worst drought in history as well. The test of any explanation for the cause of events is in seeing if the association (i.e., drought and low catches) can serve as a predictor (i.e., when the drought goes away, the catches will increase).

Impacts on Hawaii

The gist of the morning's talks was summarized by a local aku fishing industry representative who said that the local aku industry should be able to succeed since: 1) There is plenty of aku out there; 2) the eastern and western Pacific fisheries have no impact on the Hawaii fishery; and 3) the local fishing industry has no effect on its own fishery resources. The industry representative then asked if he could have the backing of the scientific community, in writing, and signed, so that he could approach local bankers, legislatures, and so forth, and say "we have a resource out there that can be exploited."

There was some joking about this and the industry representative was asked if he meant to have the statement "cosigned." However, an objection was raised that this summary ignored the impact of worldwide fisheries on marketing, even if there was no impact on local stocks. The response was that this didn't influence the local market and in any case that was another subject.

Focusing on why Hawaii's fleet is catching fewer fish, it was asked if the reasons were the fuel crisis, fishing closer to shore, and maybe the fishermen not working as hard; and if the resource is out there but not being caught because of bait problems, fuel, and so forth, wouldn't this be an incentive for our local financial institutions, and for state, local, and federal people to help the local fishing industry in the matter of getting better bait, and helping to finance the maintenance and even the purchase of new boats? The group was asked if it would endorse this conclusion. The problem was one of not knowing if the fish were out there because the fishermen only knew they weren't catching as much anymore, and that could be due to boats being in bad shape, fishing close to shore, etc. The scientific community was asked for a firm conclusion on the status of the resource, to solve the dilemma over whether the lack of fish was due to changes in the stock or changes in fishing operations.

In discussing the possible impact of other fisheries on the local skipjack tuna stock, Kearney mentioned that the conclusion of little impact from the eastern and western Pacific fleets did not include consideration of the Japanese catch in the Northwestern Hawaiian Islands or the gill net fishery operating north of Hawaii. Because of high natural mortality, the closer a fishery is to Hawaii and the closer the size of the fish to those being caught in Hawaii, the more likely that fishery is to have a major impact on our own. The disadvantage of being a stationary fishery such as one based on an island, surrounded by a mobile fishery that catches fish on its way in and out, was again emphasized. The eastern and western Pacific fisheries were said to possibly have some impact (perhaps several percent) but Kearney reiterated that this could never explain the 50% reduction in local catches, and that to explain such reductions required looking closer to home. The idea was expressed that lack of bait, less hardy bait, fuel prices, and vessel age restricting search areas and forcing fishing effort closer to shore, the tendency for larger fish to be offshore, the tendency of FAD's to consistently attract small fish, and fishermen, and changes in the people doing the fishing, all have had at least as much impact on local catches as other fisheries may have had. This doesn't necessarily mean the fishermen aren't working as hard as before, no offense intended, it may be that the effort is not as efficient as it once was.

Boggs suggested that it should be possible to document that the type and quality of fishing effort have changed; that the CPUE has not declined if effort is standardized to account for changes in distance from shore, search time, bait availability, etc. Then there would be strong evidence that the resource was still out there. Currently the only evidence shows that the catch has declined, but so far no data on fishing patterns or catch per unit effort were presented. It was hoped that this subject would be addressed in the afternoon session.

APRIL 30, 1986

AFTERNOON SESSION

HAWAII'S SKIPJACK TUNA INDUSTRY

Robert A. Skillman: "Trends in Hawaii's Aku Production"

Skillman's presentation was based on a draft manuscript by Bert S. Kikkawa of the SWFC Honolulu Laboratory which is an update of the local skipjack tuna assessments undertaken by Richard N. Uchida, SWFC Honolulu Laboratory, in 1967 and 1976. The historical trend of recorded Hawaii landings of skipjack tuna (Fig. 14) shows a steady decline. The peak year was in 1965, 16 million lb (7,200 t) of skipjack tuna landed and the low was in 1983, only 2.5 million lb (1,100 t). Since 1971-72, there have been no years with consecutive high volumes. The trend shows a negative slope but this was not tested formally.

The number of boats in the fishery has declined from 32 in 1948 to 20 in 1962, and by 1971 the fleet was down to 15 boats. There are only nine boats available for fishing in 1986, and several of these are not in operation.

Kikkawa identified two classes of vessels and calculated a standardized unit of effort to estimate the trend in catch per day fished over the period. The data show a similar trend to the catch, i.e., a marked decline in the past few years (Fig. 15), but there is no apparent long-term decline in the catch rate. The highest catch rate was in 1965 at 7,300 lb (3.3 t) per day fished, with catch rates at 6,600 lb (3 t) per day fished in the early 1970's.

However, if all fishing effort was measured with a standardized unit, such as the larger fishing vessels, then the data show a long-term decline and a sharp drop in the last 2 years (Fig. 16). These measures do not measure qualitative changes in fishing effort over the period, a problem which had been identified in the earlier discussion at the workshop.

A plot of the estimates of total catch and CPUE shows a strong correlation between the two measures, so that the catch is a function of the density of skipjack tuna in the fishery (Fig. 17). This is not a typical occurrence in most fisheries.

Skillman concluded with a brief comment on baitfish which was the topic of a previous workshop. The data show the rising importance of the sardine beginning in 1971-72, including its largest reported use in 1982 based on the reported statistics. Also noted was a higher occurrence of other baitfish in the fishery, replacing to a degree the still dominant nehu. The bait fishery is almost entirely a day fishery, as night fishing has now almost completely ceased. This represents quite a change from 15 years ago when night baiting was most important.

The high point in bait usage in the recent period was 40,000 buckets of bait in the early 1970's, compared to 16,000 buckets in 1983. There has

SKIPJACK TUNA CATCH

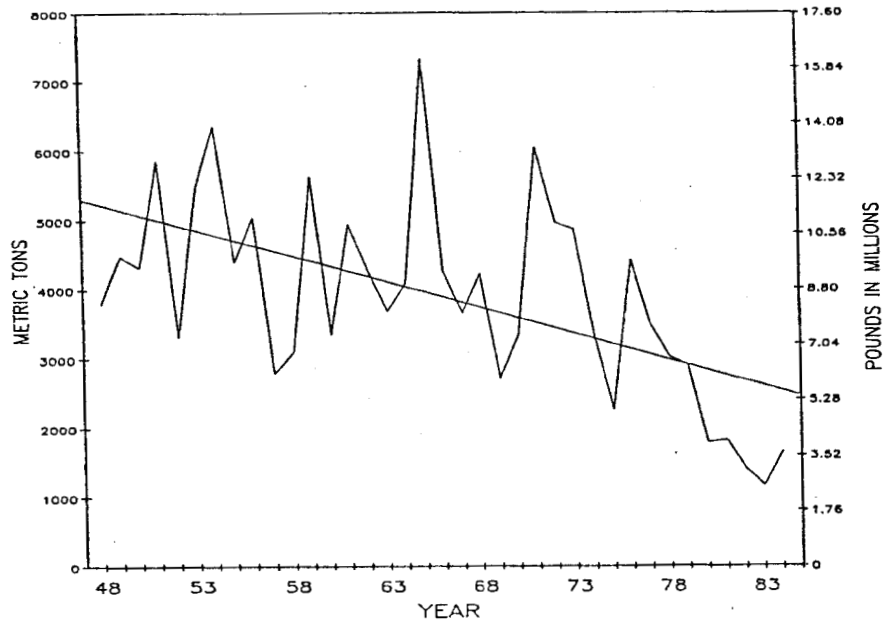


Figure 14.--Historical trend of Hawaii skipjack tuna landings. (Bert S. Kikkawa and Robert A. Skillman)

CATCH RATE IN CPSDF
(CATCH PER STANDARD DAY FISHED)

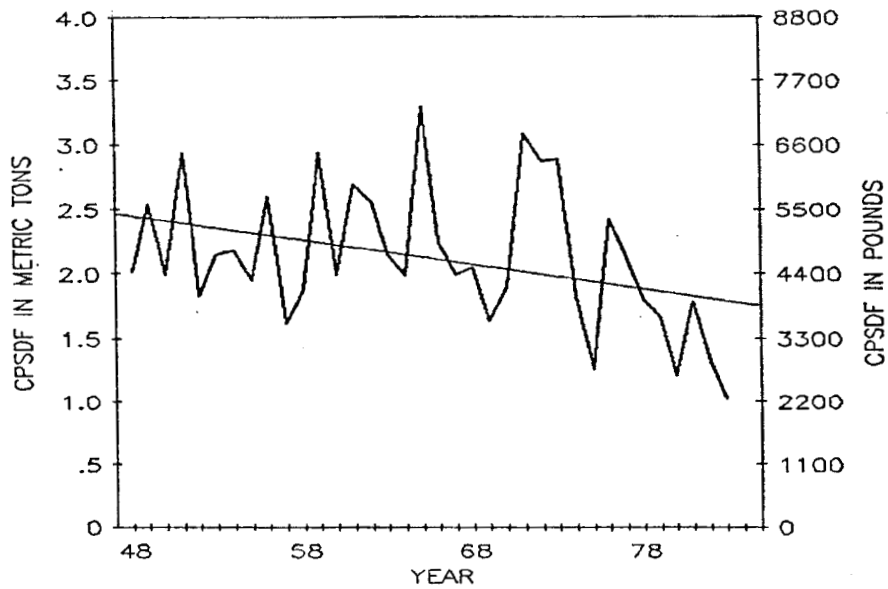


Figure 15.--Standardized catch rate analysis. (Bert S. Kikkawa and Robert A. Skillman)

RELATIVE FISHING INTENSITY
IN CLASS 2 VESSEL DAYS

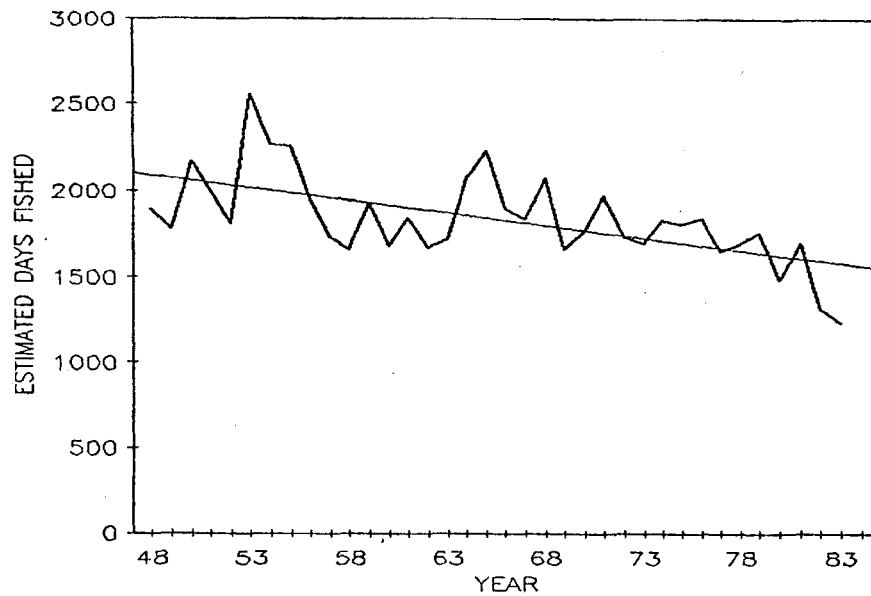


Figure 16.--Standardized effort analysis of Hawaii skipjack tuna landings. (Bert S. Kikkawa and Robert A. Skillman)

SKIPJACK TUNA CATCH AND
CATCH PER STANDARD DAY FISHED

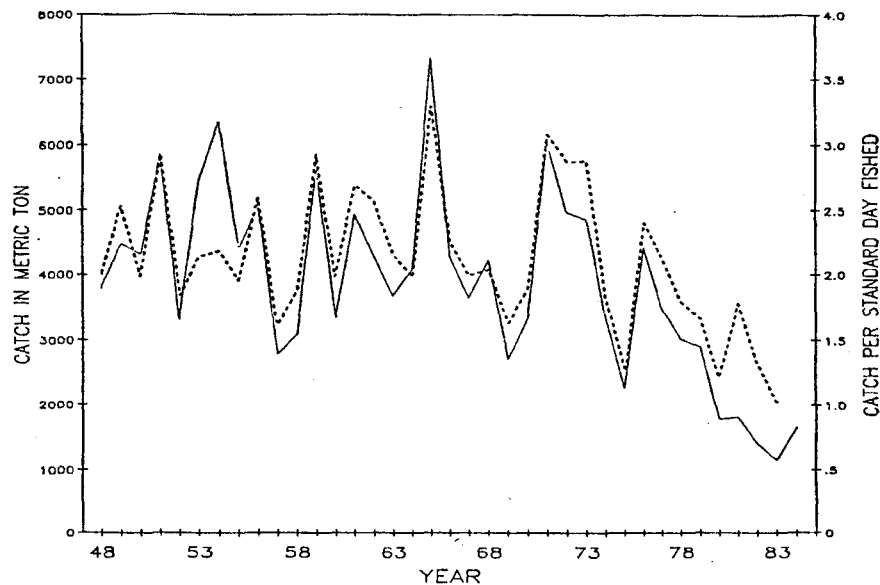


Figure 17.--Correlation between catch (solid line) and catch per unit effort (CPUE, broken line) in the Hawaii skipjack tuna fishery. (Bert S. Kikkawa and Robert A. Skillman)

also been a decline in the fishing effort, although it is uncertain which is the cause and which is the effect.

Samuel G. Pooley: "Economic Profile of Hawaii's Aku Fleet"

Pooley's presentation covered historical economic problems in the aku fleet and a detailed analysis of recent cost and revenue trends for a sample of aku boats. He began by noting that the passage of the Magnuson Fishery Conservation and Management Act (MFCMA) in 1976 led to a shift in NMFS policy away from tuna which had a significant impact on research agenda. In terms of economic research at the SWFC Honolulu Laboratory, less time has been spent looking at tuna fishing and more time spent on bottom fish and lobster. Despite this lack of recent research, the SWFC Honolulu Laboratory has a commitment to look at the local tuna fishing fleet to the extent necessary to answer current questions. Nonetheless, Pooley cautioned that his presentation was based only on a quick study of the aku fleet and its status, taking advantage of information provided by a number of boat owners.

Pooley acknowledged aku boat owner Richard Kinney's previous comment about pessimistic outlooks among the researchers but was forced to admit that research generally follows reality and, as a result, there will be more pessimism in this examination of the cost structure of local aku boats.

In 1969, Y. C. Shang examined the aku industry and identified the low incomes being earned by owners and crews, even in a period of dramatically higher total landings, as being a source of low investment in the industry. Certainly there has been no new investment since then, although there has been replacement investment in the form of vessel maintenance.

A few years later, A. E. Ashan, J. L. Ball, and J. R. Davidson concluded that the limited fresh market for aku made it impossible for the owners to offset the rising input prices with higher fresh market revenues. Furthermore, market limitations made it impossible for new vessels to take advantage of more productive technologies. In 1977, S. Comitini asked what was necessary to get new investment into the industry and concluded that a dramatic change in industry conditions was required. As it turned out, the existing vessels were being fished harder and harder for a few years, with the number of trips per vessel per year increasing until the cannery closed late in 1984. So conditions continued to deteriorate.

Other problems identified in the interim have been bait availability, as mentioned by Skillman, and the perceived impact of FAD's (fish aggregating devices) as researched by K. C. Samples. There is some dispute over what FAD's do in terms of the volume and size structure of commercial catches, but gear competition with other types of vessels has led to proposals to restrict the use of live bait (such as used by aku boats) around the FAD's, which would be reserved for recreational fishing.

The overall economic problem for the aku fleet is very straight forward--a lack of profit in the industry--and this is generally agreed by

people in the aku industry. Possible causes include the limited range of the older vessels; declining bait availability; rising fuel prices leading to a decline in scouting; a smaller fleet making it more likely that even if the fish are available, the schools may be missed by the boats; and rising repair costs which mean that the vessels are being physically depreciated through use. Altogether this amounts to a vicious cycle in which more expensive inputs to the productive process limit harvesting and where the physical investment is more and more limited. Combined with outside events, such as the cannery closing determined by a corporate decision on structuring multinational assets, and the natural variability in the availability of skipjack tuna, there is a continual crisis in the skipjack tuna industry. Pooley acknowledged that this was an old story. He said that research often did not discover new facts, but it often presents these facts in a new light.

Cost data were taken from a sample of five aku boats from various years between 1970 and 1985 which by 1986 represents half the remaining fleet. A composite picture of costs and revenues in 1983 for the five vessels is shown in Table 3. The average vessel was losing \$30,000 a year, a loss rate of 10% on investment. Revenue was 94% of total cost. Fixed costs were 20% and operating costs were 80%. Fuel was 22% of total costs and crew share was 40% of total cost, based on a share system of 60% of revenue less fuel and other tangible operating costs (Table 4).

On a per trip basis, revenue was approximately \$2,100 per trip, with \$500 fixed costs per trip, \$800 operating costs less crew share, and \$900 for crew share for trips which catch fish. On a per ton basis, revenue was approximately \$1,635 (\$1,800 per metric ton) while total costs were \$1,745. Fixed costs were \$350, operating costs (less crew share) were \$695, and crew share was \$700. Fuel costs were \$385 per ton.

Pooley indicated that the aku boats are really small business enterprises which are small compared not only to multinational corporations like the tuna canners but also in comparison to foreign fishing fleets and foreign fishing vessel resupply operations in Honolulu harbor. Despite this, the aku fleet continues to be an important business in Hawaii because of its link to Hawaii's cultural past and potential linkage with future fisheries development.

Cost trends were examined for 1970, 1975, 1980, and 1985 for a select number of boats, although a full analysis would require multiyear data on a larger sample of vessels to smooth out variation in costs, operations, and revenues. Costs were compared on a per ton basis and the values were corrected for inflation. Price per ton rose by 48% over the period 1970-85 (although in nonadjusted dollars the increase was 290%). Total costs went up 75% in inflation-adjusted dollars, indicating the scope of the problem. Fixed costs rose by 120%; while operating costs went up only 66% (Fig. 18). The latter finding is interesting because of the importance of fuel prices in operating costs. Two factors led to this result: Fuel prices rose by 200% but crew share costs rose by only 25%, which means that the crew bore part of the increase in fuel costs. For fixed costs, insurance payments rose by 390% and repairs by 60%.

Table 3.--Hawaii aku boat average financial position, 1983.
(Samuel G. Pooley)

Income Statement		1983
Revenue		\$301,893
Fixed costs		\$64,698
Vessel loan	\$1,681.50	
Interest expense	\$8,445.50	
Annual repair	\$28,130.75	
Vessel insurance	\$17,420.00	
Administrative	\$5,375.25	
Other	\$3,644.50	
Operating costs		\$257,326
Fuel and oil	\$71,030.00	
Ice	\$5,310.25	
Bait	\$.00	
Provisions	\$635.50	
Medical	\$6,631.75	
Supplies	\$1,435.25	
Gear	\$.00	
Other	\$.00	
Subtotal		\$85,043
Crew share	\$129,034.00	
Handling	\$22,781.25	
FICA, FUTA	\$13,247.50	
Excise tax	\$5,137.25	
NES	\$2,083.00	
Total cost		\$322,023
Net revenue		-\$20,130
Taxable depreciation		\$9,084
Taxable income		-\$29,214
Operating Characteristics		
Trips	144	Trips
Catch per trip	2,565	Pounds
Annual landings	369,360	Pounds
Days per trip	2	Days
Days fishing	1	Days
Crew share	59.50%	Crew
Investment	\$114,618	
Product price	\$0.82	Per pound

Table 4.--Hawaii aku boat cost share trends,
1970, 1980, 1983/85. (Samuel G. Pooley)

Category as percent of total cost

Category	1970	1980	1983/85
Revenue	113.1%	95.7%	94.4%
Fixed costs	15.0%	19.9%	20.4%
Repairs	3.3%	9.2%	4.6%
Insurance	5.9%	5.1%	9.7%
Operating costs	85.0%	80.1%	79.6%
Fuel	9.8%	21.3%	16.9%
Crew	60.1%	41.0%	42.6%
	1970-72	1980	1983
Price			
Actual	0.36	0.93	0.97
Inflation-adjusted	0.92	1.22	1.05
Catch per trip	4826	3258	2508
Trips per vessel	144	85	85

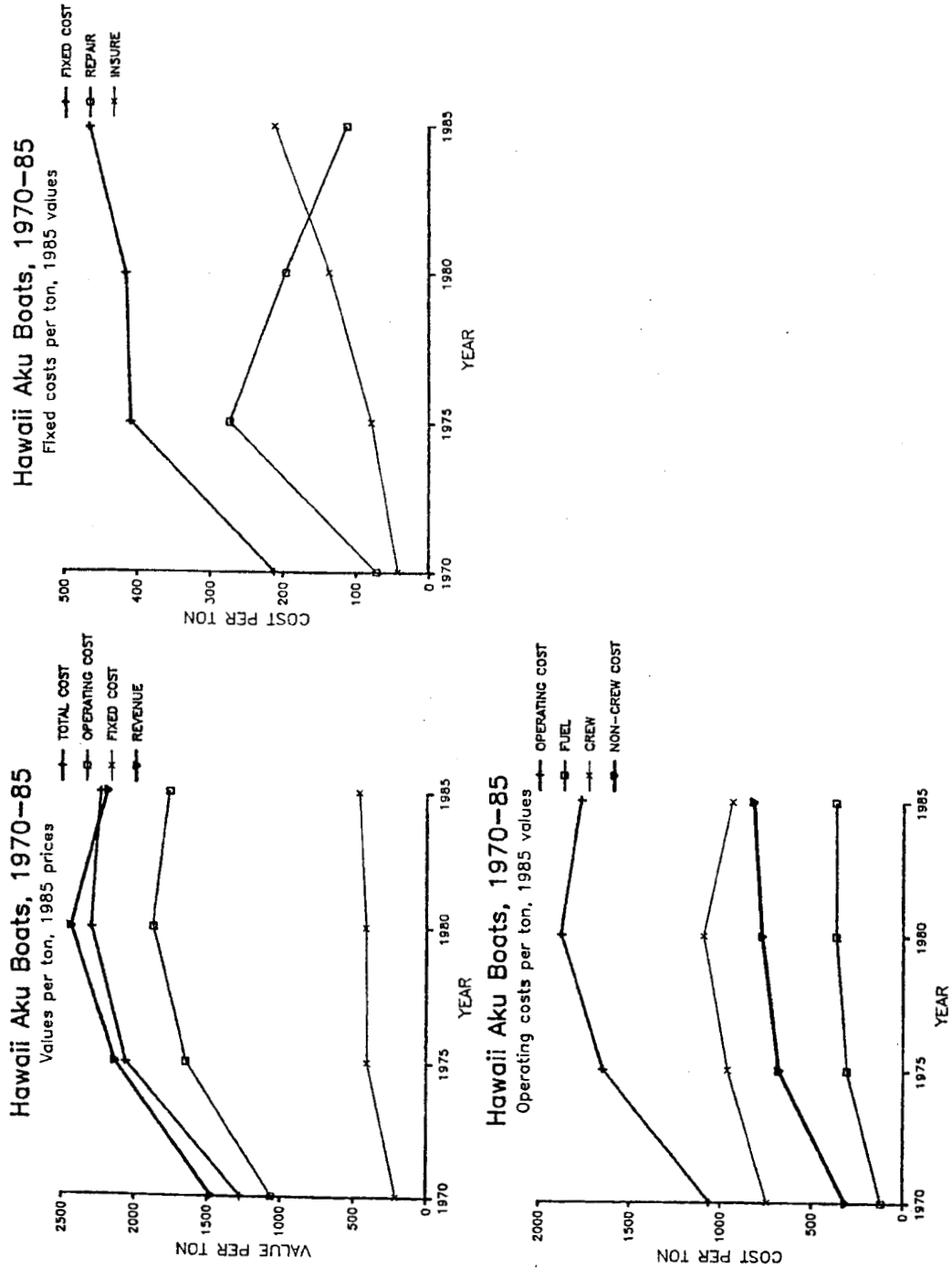


Figure 18.---Hawaii aku boat cost trends, 1970-85. (Samuel G. Pooley)

Vessel operators have limited operating choices. They can substitute use of more bait (if they can find it) for fuel consumption (running time), or vice versa, but only to a limited extent. Bait carries an implicit price whose search reduces the time aku boats can spend fishing. The last look at the time employed in different activities by aku vessels was in 1967 by Richard N. Uchida and Ray F. Sumida, SWFC Honolulu Laboratory. Pooley cited the problems faced by the County of Maui in attempting to estimate the economic value of cultured bait as indicative of the problems faced in economic analysis of a fishery with imputed costs.

Inflation-adjusted prices for skipjack tuna in the Hawaii market (fresh and cannery sales) rose by 95% over the period from 1970 to 1985 which partially offset rising costs and declining landings, and was the only factor saving the aku boats. Most of this price increase represented an increased proportion of sales to the fresh market, even before the cannery closure.

Finally, in terms of fishing cost shares over the 15-year period, Pooley identified a switch between repair and insurance cost shares. Owners have choices over how often to repair their boats, and with rising fixed costs for repairs and insurance, maintenance problems increase. This increases the risk, which probably has an effect on insurance. If the vessel is insured for a lower percentage of its value, then the vessel owner is taking an equity risk. [Dennis M. King had identified structural problems in the insurance business as also affecting their premium rates.]

Some vessels have acute fixed cost problems while others have operating cost problems. This represents different scales of production, with the larger boats having more difficulty in covering their operating costs in the absence of the cannery. Furthermore, with crew shares declining, labor issues become more important, with more turnover and other symptoms of labor problems.

A hypothetical vessel could attempt to overcome the more rapid rise of fixed costs by taking more trips, amortizing these costs over a greater level of activity. To make the vessels work harder, it means making further investments, improving the technological level of the fleet. However, with 5 years of no profits, it will take very "deep pockets" to finance such improvements. Pooley suggested that perhaps the State of Hawaii vessel loan program could be used as a source of working capital for maintenance and upgrade investment.

Pooley noted that the insurance problem was not specific to the fishing industry or to the aku fleet in particular. As a result, there is relatively little 10 vessels can do about the effects of mainland insurers attempting to reduce their risks. However, the boatowners may be able to reduce the apparent risk of wooden vessels by some sort of formal assessment of the vessels' seaworthiness through shipyard surveyors. On the other hand, if because of poor maintenance the risk actually exists, then their insurance costs become a cost of previous business decisions and the poor returns to the industry.

In terms of operations, the vessel captains could try to run the aku boat more efficiently, but this may lead to problems with reduced catches. Possibly bulk purchases of fuel may help offset input prices.

In the long run the industry must attract new investment in new vessels. In this there is a positive prospect--the decline in interest rates in the United States. There is less incentive for investors to leave funds in money market certificates and more hope that people may be induced to take on the higher risk of fisheries investment with the hope of earning a higher rate of return. However there are a number of structural problems with the U.S. economy as a whole which suggest such productive investment may be hard to generate. Furthermore, although nominal interest rates are down, inflation-adjusted interest rates are still relatively high. Productive investments simply aren't being made on an adequate scale.

If the fresh market can be expanded, or a lot more fish landed (which would require a cannery), then the cost situation would be ameliorated by increased revenues. Pooley concluded that these are the kind of economic problems facing the aku industry, which in fact are the reason this workshop is being held.

At the conclusion of Pooley's presentation, Brooks Takenaka of United Fishing Agency, Ltd. clarified that the insurance situation was such that insurers were not even looking at Hawaii's aku boats and that without insurance the boats could not fish for bait in Pearl Harbor. Where the insurers have made quotes, the quotes have been astronomical. So this was a real crisis. Some boats are not even operating because of their inability to get insurance.

Brooks Takenaka: "Hawaii's Tuna Markets -- Future Directions"

Takenaka opened by emphasizing that when one speaks of the fresh fish market in Hawaii, one is really speaking of the tuna as the major component of the market. There is a saying in Hawaii that as goes aku, so goes the entire sashimi market. The availability of aku affects the market for all other fresh fish. When there is a lot of aku, it tends to stabilize prices, and when there isn't much aku, it tends to increase the price of ahi (yellowfin tuna, *Thunnus albacares*).

Historically aku has been marketed through two organizations, the Tuna Boat Owners Co-op, Inc. and the United Fishing Agency, Ltd. Today there is a third company marketing aku, Seafood Hawaii. Aku is marketed primarily within Hawaii to fresh fish wholesalers and retailers. There are seasonal size differences in availability and the larger fish are the preferred size.

Examining the marketing situation for aku, one must consider the importance of the then active Hawaiian Tuna Packers (HTP). The reason for this is that HTP provided a means for the industry (and not just the aku industry) to bring excess fish into the cannery. In the absence of the cannery, the market price of fish has declined. Over the years, the boat owners had been able to negotiate increases in the cannery price,

increasing the offset price on the fresh market. This was especially important in the summer when there was a glut of fish on the market. The cannery closure has meant that the three distributors have had to look at other markets, and other means of processing aku.

One of the other realities has been the decline in the number of vessels from 14 in 1979 to 8 today. In 1979, fish was relatively available although bait was, and still is, a problem. And of course the cannery was still operating. By 1982-83 there was a more obvious decline in harvesting and the cannery price also declined. By 1984 production had declined further, cannery prices declined further, and the cannery no longer accepted smaller aku.

By the end of 1984, there was no cannery. No longer is there an alternative for the vessels to catch more fish, and price fluctuations in the market increased. Now there is the problem of maintaining a price and maintaining a livelihood for the fishermen. On the one hand, the market can't ask them not to go out and catch the fish, i.e., not to catch whatever they can, but on the other hand, when there is too much fish is on the market and nothing to do with the excess, the price plummets.

The industry is having to look for new markets. One good aspect, Takenaka said, is that aku is more available to the neighbor islands, and people there are very happy about that. Exporting large fish to the mainland is a possibility. But the small sized fish is a real problem. Another key problem is the shelf life of aku, and Takenaka suggested maybe the scientists can help here. If shelf life can be extended, then aku can be marketed more easily on the mainland. The Hawaii Seafood Promotion committee now exists, and there will be an effort made to promote aku.

In 1985 the production problem continued, and the insurance problem increased. Fortunately, a group has been put together and has purchased the rights to HTP. Unfortunately, it is not known what kind of operations will be allowed under the existing lease, and if the conditions for the lease change, then it has to be put out to bid again. [Editors' note: The lease was put up to bid in October 1986 by the State and the same local investment group obtained the operating rights.]

In 1986, the hard reality is that there may not be any more boats. Nobody knows exactly what is going to happen. We are experimenting with new markets and new types of products. Last year Dennis Goto of Red & White Foods, Inc. and Takenaka experimented with aku kamaboko, and they are looking at the economics of this experiment. People are getting into other kinds of processing, like smoking and drying, but considering the volume, that's a lot of smoked and dried fish. It is hoped the kamaboko (fish cake) situation will help with the small sized aku.

Takenaka concluded by noting that right now the marketing situation is very grim. The cannery is still accepting aku, but only the large fish. These are being frozen with the idea that the situation will improve and a one or two line operation will be restarted, but the situation is still unsettled.

**Linda L. Hudgins: "Economic Prospects for Hawaii's
Skipjack Tuna Industry"**

Hudgins began by noting that she would address two important local issues: changing size composition of the landings and total catch, and the effects of the closure of the cannery.

The issue of changing size distribution of local aku catches came about because it related biological issues to the structure of the industry. Five years ago Hudgins asked a local industry representative what he perceived to be the major problem with the local aku industry, entirely expecting the answer to be bait or FAD's. However, the answer was that something was happening to the fish, the fish weren't there anymore, and the large sizes in particular had disappeared.

Hudgins found that no one was investigating that issue. She developed three research questions: Have there been changes in 1) seasonal patterns, 2) total aku availability, and 3) the availability of large aku? The received wisdom was that migratory species were not subject to the same pressures as nonmigratory species, which meant there were plenty of fish available. Therefore, the observed decline in total catches would imply a change in some aspects of the fishery.

The economic evidence shows that large fish command a premium price, comprising a large share of a vessel's revenue. If large fish are no longer available, then there would be a significant impact on fishermen's incomes. Furthermore, if the largest fish have a price premium, the fishermen are going to target the largest and there will be no "expected" distribution of landings across sizes. Even if there is a natural distribution, the size composition of the catch will be distorted by the price incentive.

The data cover 1964-82 and there is no obvious pattern in the trends. Hudgins found that all sizes had changed in availability in absolute numbers and as percentages of the total catch (Table 5). In 1974, large aku declined in absolute terms, and so the total catch declined, compared to the previous trend. In 1976 the extra small aku increased in absolute terms, in 1978 small aku declined in absolute terms, and in 1980 the medium aku declined in absolute terms.

There were a number of possible economic causes for the changing size distribution. The decline in bait availability does not explain changing size composition. The new regulations on baiting in Pearl Harbor took effect in 1981, which follows by 7 years the decline of large aku. The placement of FAD's may have had an effect, but the first year they were in place for a full fishing year was 1980, long after the small sizes increased, but the same year that medium sizes declined.

Table 5.--Percentage size composition of total Hawaiian skipjack tuna landings, 1964-82. (Linda L. Hudgins)

Year	Percent large	Percent medium	Percent small	Percent extra small
1964	0.6954	0.1059	0.1612	0.0373
1965	0.6496	0.2618	0.0759	0.0124
1966	0.6981	0.2253	0.0709	0.0055
1967	0.5712	0.1615	0.2043	0.0628
1968	0.5260	0.3240	0.1229	0.0270
1969	0.5692	0.0673	0.2219	0.1414
1970	0.4558	0.0881	0.3576	0.0984
1971	0.5563	0.2182	0.2233	0.0020
1972	0.8859	0.0607	0.0406	0.0126
1973	0.8025	0.0994	0.0799	0.0180
1974	0.4012	0.2021	0.2313	0.1652
1975	0.3137	0.1493	0.2674	0.2695
1976	0.2091	0.1800	0.5453	0.0654
1977	0.2439	0.2739	0.4452	0.0368
1978	0.4210	0.2215	0.2337	0.1236
1979	0.4544	0.3596	0.1397	0.0462
1980	0.2827	0.3751	0.2369	0.1050
1981	0.4570	0.1716	0.2283	0.1429
1982	0.4856	0.1578	0.2264	0.1300

Fuel prices could also explain the changed landings. Hudgins estimated that a 10-cent increase in real (inflation-adjusted) fuel prices would lead to a decline of 13,000 lb (5,900 kg) per month in catch per vessel. This does not explain the change in the catch of large fish but it may explain the falling total landings since 1974 and may explain the recent rise in landings as fuel prices have decreased.

Even considering uncertain migratory patterns, increased fishing pressure in the eastern and western Pacific suggests that the fish are being intercepted before they get to Hawaii. The decrease of the eastern Pacific fishery in 1980 was a direct cause of the U.S. fleet being denied entry to the Mexican exclusive economic zone. The amount of fish landed from the eastern tropical Pacific (ETP) also has increased in recent years. The tagging information is uncertain and does not rule out the possibility of the ETP fishery affecting the Hawaii fishery. The ETP fishery expanded dramatically in 1974 with the requirement of U.S. canneries for more skipjack tuna mixed in their pack to decrease the mercury content.

The total value of Hawaii's aku catch declined by \$2.7 million a year (Table 6) from 1974 to 1982. Part of this loss can be attributed to the operational impact of rising fuel prices, approximately \$1.275 million (1982 prices) or 47%, and part can be associated with the decreases in

Table 6.--Revenue losses to the Hawaii aku industry, 1982.
(Linda L. Hudgins)

Fuel cost increases	¹ \$1,274,958
Absolute decline in fish abundance	² 1,086,084
Change in size distribution	³ 362,529
Total decline in Hawaii fisherman income	\$2,723,571

¹ Decline in total annual catch in 1974-82 not attributable to decline in fish abundance or changed size distribution.

² Decline in total annual catch in 1974-82 not attributable to fuel cost increases or changed size distribution.

³ Decline in total annual catch in 1974-82 solely attributable to changed size distribution. Includes decrease in "large," relative increase in medium, small, and extra small fish.

quantities caught, approximately \$1.1 million (about 40%). With the price of aku rising because of diminished supply, the cost of the change in size composition is less than it would otherwise be, amounting to \$360,000 per year (13% of the total loss of revenue to the vessels).

Finally, the closure of the cannery affected vessels in the aku fleet very differently. Hudgins examined the data from 1970 to 1978, during which the industry was relatively stable, and compared this period with 1985. During the previous period, there were 12 boats in the fishery. Annual sales were approximately \$5 million, of which \$3 million was cannery revenue, with \$2 million from the fresh market.

With the cannery, the various marketing agents were able to enforce a price floor. The sellers would make enough aku available on the fresh market until the marginal price equalled to the cannery price, at which point the remainder would be sold to the cannery. This would maximize industry revenues.

With the cannery out of business, there was direct loss to the industry of \$500,000. Total catch was down but this loss is attributed to lower market prices than otherwise would have been the case. Today total production is going to the fresh market. The total annual demand for aku in Hawaii is about 4.7 million lb (2,100 t).

Therefore, the closure of the cannery means that the biggest boats can no longer operate, as shown by the FV Anela being tied up. It means the fleet will contract, insurance problems or not. And it means that catches will fall even further.

With the cannery, the relatively large vessels could capitalize on economies of scale, fish farther and longer, and be assured there was an outlet for their catch. This also meant that the smaller vessels could also operate, since there was always an available market. Why would a large vessel cooperate with a small vessel in the fresh fish market, and not run its smaller competitors out? The particular constitution of the industry meant the two types of vessels were symbiotic: both sides could co-exist. No collaboration, no collusion, no oligopolistic behavior needed because of the nature of the market. Furthermore, the fishermen are exempt from antitrust laws by the Fishermen's Cooperative Act of 1933 which allows them to cooperate in marketing their product. There are very few industries in the United States that have that protection.

Once the cannery closed, this situation changed. The larger vessels no longer have an outlet for large catches. Unless they are very efficient, their cost per ton will increase and they may be forced out of the fishery. Only small vessels will be able to exist. They will supply only part of the fresh market. Four or five vessels will be able to supply 2 million lb (900 t) to the fresh market, probably priced around \$1.25-\$1.75 per lb. The rest of that demand will be supplied by frozen imports.

Another scenario is that new investment will lead to a much more efficient and less expensive fleet. However, Hudgins concluded, unless there is a new market, the local fresh market will only grow 3% per year, to <5 million lb (2,300 t), which wouldn't leave much leeway for new vessels.

DISCUSSION SUMMARY: Hawaii's Skipjack Tuna Industry

Henry Sakuda chaired the discussion session and began by summarizing certain points. He said that looking closer to home, from our statistics, the trend of the fishery resource doesn't look so good. The aku fleet, from the profile that Pooley presented, appears to face a limited market, which limits expansion. Insurance costs have gone up and fuel and repair costs have also gone up. This is, however, partly offset by increasing fish prices. Sakuda said that it's uncertain what can be done about prices, whether attempts should be made to increase the fish prices a little because this might backlash and cut down on the fish purchasing. Looking at the market situation, no one knows whether the cannery will be opening. The cannery evidently will purchase only large aku. Essentially the industry is trying to diversify the types of uses of aku. Sakuda cited Hudgins' prediction that the aku fishing industry in a number of years will end up with something like four or five small vessels and there will be about a 2 million lb (900 t) supply of fresh aku, with another 2 million lb of frozen imports to stabilize our aku markets.

Data on the Hawaii Aku Fishery

The analysis of catch and CPUE trends that showed a steady decline over the period of records was questioned since the decrease appeared to begin in the early 1970's. It was suggested that an attempt be made to

statistically determine the point at which the change began, since this would help to focus on the causes of the decline. Skillman noted that although the number of boats fishing declined during the earlier years, the remaining boats increased their effort, keeping the total level of effort steady for a long while. In recent years, the continuing decline in the number of boats has affected total effort, which has declined.

Next, the accuracy of the data used in the analyses presented during the afternoon session was questioned. Pooley stated that although the financial statements of any industry or any business are always subject to interpretation and question, for the local baitboats, spot checks (testing the data on financial statements with alternative sources) showed them to be quite consistent. The reported figures were consistent with the kind of production expected of the vessels. It was conceded that the financial reports might be off by 5 or 10% but it was felt there was no reason to expect that the bias changes year by year, in which case it makes no difference. The same was said to be true of the State compiled catch statistics. Hudgins used only proprietary industry data and claimed 100% confidence in that data, which indicated that other data sources were biased by underreporting.

There was some argument over whether biological data had been ignored in the economic and catch trend analyses. In defending the interpretation that greatly expanded fisheries in other parts of the Pacific have had major impacts on Hawaii's catches in recent years, Hudgins claimed that the biological (tagging and recapture) studies were not ignored, but that no statistical analysis of these biological data or other data supported the contention of some biologists that fishing pressure here or elsewhere has had little or no effect on Hawaii's aku catches.

It was asked whether anyone had analyzed the State catch reports that show the number of trips, the area fished, and the size composition of the catch to see if there is evidence that fishermen have not been going out as far in recent years and if they have been catching smaller fish inshore and larger fish offshore. Skillman indicated that although CPUE had been quantified by inshore and offshore, the trends had not yet been analyzed. One of the problems in such an analysis is that zero catch trips are not reported and this biases the data. The dire need of establishing any change in the quality of a unit of fishing effort over time and the need to document trends in fishing patterns were emphasized since there could be no definitive conclusion about the status of the local stocks without such information.

Hawaii's Market

A suggestion was made that although starting up the cannery could help the industry, it might amount to "butting heads" against the world market, which Hawaii is not in a position to do. It was proposed that the cannery be opened in conjunction with using the new process that Japan has developed for freezing the fish so that when thawed, it almost tastes fresh. The flash-freezing process could be used on the small fish that the cannery doesn't want and these frozen fillets could be the basis for a

state supported attempt at market penetration on the U.S. mainland using air freight or taking advantage of freezer shipping container which tend to go back to the U.S. mainland empty. Secondly, it was suggested that to meet new demand generated by this enterprise, the State should initiate a program to help the owners build new, smaller ships that go out farther and help organize a cooperative effort to meet the rising cost of insurance through self-insurance.

The subject of imported, quick-frozen aku fillets and their impact on the local market was raised again. No one could say how much was being imported, but it was noted that in times when fresh aku was not available, people have turned to frozen aku. There are people who have indicated that it tastes as good as the fresh product. There are many people, however, who have indicated that if the product sits out too long, it tends to get a little watery and mushy. Local marketers said they hear a wide range of opinions about its quality and taste. The opinion was expressed that the product has certainly made an impact in the islands, but that people will still prefer fresh aku when it is available.

It was noted that on Maui, people have accepted the use of frozen aku for making poki and acceptance may go further if it is competitive in price. The added convenience of using the frozen product as opposed to the trouble of cleaning and boning whole fresh aku was also mentioned, and the convenience of it being regularly available. The likelihood that fresh aku would be cheaper than the imported frozen aku, and the increasing volume of imports due to the large demand were mentioned. It was suggested that the test for the local industry would be to see, when the the fresh supply comes back strong, if domestic aku can push the imported aku off the shelves.

Economic Analysis

The question was then raised as to whether an analysis of the economics of the boat operation that split the year into two components, season and off-season, would suggest the feasibility of a fishery that operates for only 6 months out of the year. The reply indicated that such an analysis would not make any difference on total fixed costs such as insurance, and that although the operating costs might differ seasonally since the off-season was used as a time to repair and maintain the vessel, this would have to be applied as a cost to the on-season. The data to permit a seasonal analysis probably exist, and it was noted that other fisheries have operated in that fashion, but the problem of the crews being unemployed during the off-season and then unavailable for the on-season was raised as an objection.

Bait Supply

The adequacy of the bait supply in an expanded fishery was questioned but others claimed that this was not pertinent since the problem was survival of the industry at levels that had been supported in the past. The real question was again emphasized as being: "Are the fish there to be caught?" If the answer is yes, the other issues become important but

impatience was expressed over the discussion of these other issues before the question of aku availability was answered. Subsequent issues raised were access to bait in Pearl Harbor, a nehu (a baitfish, Stolephorus purpureus) enhancement program, and new boats.

Local Aku Abundance

An attempt was made to clarify the question on the status of the resource. The continued Pacific-wide abundance of aku may not mean that the fish are still around Hawaii in the abundance that they were in the past. Sea surface temperature and salinity data collected at a Koko Head sampling station for the last 29 years were cited as showing a warming trend since 1976 and an increase in salinity, which according to previous research, indicates reduced skipjack tuna abundance in Hawaiian waters due to changes in the movements of major water masses.

It was pointed out that the local industry doesn't care much about the abundance of aku ocean-wide, it is only concerned with the abundance within 300 or 400 nmi, since it is the fresh fish market that will make or break the local industry. It was emphasized that if the aku are "out there" but beyond the reach of local boats due to oceanographic changes, then there is little that can be done to improve the situation. Disbelief was expressed that slight changes in temperature and salinity would keep aku away from Hawaii. It was explained that it is not intolerance by the fish for the different water but just the association of tuna with certain types of water and with boundaries between water types which may represent places where food is concentrated or pathways for movement.

Locating such ocean features using satellites, and the question of whether they are within fishable range were then discussed. The experience of the albacore vessels in using satellite-produced charts of sea surface temperature, wind velocities, and color boundaries was cited as showing the usefulness of such measures in that fishery, but others claimed that such methods don't work as well for skipjack tuna as for other tunas. The statistics on ocean conditions were said to be available, but no one has worked out a relationship for their use in locating skipjack tuna around Hawaii. It was suggested that the seasonality of skipjack tuna abundance around the islands could also be a result of the seasonal warming and cooling trend brought about by the movements of water masses and by aku movement into the area around Hawaii. Some work off the Kona coast showing a positive correlation between the presence of offshore gyres located with military equipment and the abundance of nearshore reef fish larvae was cited, but no one has tested the hypothesis that there might be tuna associated with those gyres.

Clarification of an explanation for the resurgence of large aku in the catch during 1985 was requested, and the idea was expressed that decreased fuel prices permitted longer trips, more searching, and fishing farther from shore. The suggested method of testing this hypothesis was to question the fishermen as to the length of their trips during this last year compared to previous years.

The discussion returned to the question of whether the aku are there to be caught by the present day fleet. One opinion expressed was that no biologist will ever be able to give a straight answer because the only data are those available from the fishery and those data are hopelessly compounded by the experience of the fishermen. Another opinion was that the answer is obviously no, or there would be no need for this meeting. It was again suggested that since the fleet was old, there needed to be investment in new boats.

Ocean Conditions and Aku Abundance

An industry member asked if aku availability really could be correlated with some oceanographic feature, such as an isotherm or the thermocline. It was stated that the local aku fishermen say the aku go where the food is. Perhaps this means they follow temperature boundaries if that is where the food is. If aku were known to associate with certain oceanographic features, and we could track those features, this would tell us where the aku are and where they are not. Then we would know when they were out of range of the fishery, and we could answer the question: "Is the resource out there?" It was noted that at this point, the problem is being blamed on everything (El Niño, other fisheries, etc.), but no one knows for certain.

On the issue of blame for the problem, the possibility was raised that increasing numbers of sports fishermen were dispersing the schools of aku and, therefore, interfering with the commercial fleet's success. The only responses to this idea were negative. It was said that the local sports fishery for aku was not significant.

Local temperature and salinity patterns were said to be uncorrelated with the pattern of El Niños in recent years. It was stated that the El Niño is known to affect the thermocline, that the aku are known to be associated with the thermocline, and that the thermocline must rise to bring the fish up to be caught.

The most recent El Niño was 1982-83. It was asked if the El Niño perhaps affected Hawaii several years before it reached the west coast and this was explained to be impossible since the El Niño affects the entire Pacific in any given year that it occurs. The most recent one was very severe. Tahiti had nine cyclones in 1 year where it had none for the previous 9 years. Other El Niño years were given as 1979, 1976, 1973, 1972, 1969, 1965, 1961, 1958, 1957, and 1951. Some of these were a lot stronger than others and they had slightly different impacts, but it was pointed out that there was no relationship between the El Niño years and the catches in the Hawaiian fishery. The El Niño years were not all good years, or all bad years, or all average years, nor was there a pattern in the quantity caught in the years before or after an El Niño.

It was suggested that although the tagging studies by the SPC were good and showed a high turnover in the areas central to the range of aku

surface fisheries, Hawaii was at the edge of this range and thus at a disadvantage. It was suggested that the changes in local water temperature, salinity, and perhaps other changes caused by nearly constant volcanic eruptions in recent years have had a bad impact and that in addition, being at the edge of the distribution, far from the source, and having a fishery that depends on the larger, older fish mean that Hawaii's fishery is hurt by other fisheries between it and the source of aku.

Frustration was again expressed at the lack of information on the abundance of aku around Hawaii and the fishery biologists were also criticized for not communicating with the oceanographers nor keeping in touch with the new technologies that could be useful for monitoring ocean conditions. In defense it was pointed out that several fishery biologists did attend the recent Pacific Communications Conference where new technologies were displayed, and that the NMFS research vessel is outfitted with a state-of-the-art satellite receiver for mapping ocean temperature boundaries in real time. It is being used in research on albacore in the South Pacific to show that they are more available where there are strong surface temperature gradients. However, around the Hawaiian Islands, there are no strong surface temperature gradients. There is also the problem that cloud cover eliminates much of the satellite data. It was pointed out that at one time, NMFS had three vessels, including one specifically designed for tuna research and aku fishing, but due to budgetary constraints, NMFS lost the use of that vessel. Without it, it is impossible to sample aku abundance except through the domestic fishery and impossible to know anything about the abundance of aku beyond the range of the domestic fishery.

The use of oceanographic data by purse seine fleets that range the ocean, plot their own temperature observations, and communicate their findings to each other was noted. The use of sea surface temperature data obtained by airplanes using infrared radiometry was once the whole basis for the southern bluefin tuna fishery in Australia. It was pointed out that to use information to locate distant (more than 300-400 nmi) tuna aggregations, a highly mobile fleet is needed, and Hawaii's dependence on the fresh tuna market limits this fishery to fishing grounds closer to port. It was also said that skipjack tuna are the least responsive of all tunas to temperature fronts.

It was suggested that data on the Equatorial Countercurrent be examined to determine its role in dispersing aku more towards the eastern side of the Pacific, and to see whether this dispersal affects the amount of aku in Hawaii. It was suggested that the data on troll-caught skipjack tuna be analyzed to see if these show the same trends as the baitboat data. And it was suggested that someone should summarize the series of events that seem to be coincident with the decline in Hawaii's aku fishery.

MAY 1, 1986

MORNING SESSION

RESEARCH AND FISHERY DEVELOPMENT

Richard S. Shomura opened the second day of the workshop by commenting that this was one of the few occasions in his participation in fisheries meetings where economists were present in more than token force. Jack R. Davidson, an economist and Director of the University of Hawaii Sea Grant College Program, chaired the morning session.

Kathryn Vanderpool: "New Marketing Technology"

Vanderpool opened her presentation by noting that although she was neither an economist nor a biologist, she had over 20 years experience commercially fishing from Mexico to British Columbia and west of Midway Islands.

Albacore has traditionally been a cannery product, and the albacore boats like to think of their product as the filet mignon of tunas. Vanderpool said that the albacore trollers saw the canneries closing and their traditional way of life disappearing. They realized that old methods of handling fish were no less than poor to tragic. The fish were caught, thrown on deck, dropped into the hold, and either brine or blast frozen on board.

Vanderpool belongs to the Midway group which comprises albacore trollers with the capability of staying on the grounds for up to 100 days. The vessels have seen their catch rates decline in the mainland U.S. fishery, moved to Midway for a late spring and early summer season, and now are exploring a South Pacific winter fishery.

Vanderpool led a Salstonstall-Kennedy project which asked whether albacore could be processed and frozen on board and delivered to market with a consistent quality product. What did processing mean? What could vessels handle in terms of on-board processing? Vanderpool thought they could deliver a frozen loin, processed on the vessel, but because of the time required and the 40 knot winds, safety factors precluded that possibility. That was discovered the second day out.

They discovered that new bleeding procedures were required. If the isthmus artery of the albacore was cut before the fish was placed on the wash down area, allowing the heart to assist in pumping out the blood, the product was improved.

The killing factor is also important. The Japanese are pithing but Vanderpool found that it was better to maintain the natural tremor of the fish to assist in extruding blood. They land the fish very gently, on carpets, and the fish is flushed forward on a PVC pipe to avoid damaging its exterior.

Vanderpool allows the fish to bleed in this manner for up to 20 min and then the crew cuts the gill area. Albacore are 10°-12°F warmer than

the water. If the fish are not previously cooled down, the skin will split on freezing. The body heat must be allowed to diffuse through the meat from the core to the exterior.

The crew then heads and eviscerates the albacore. This is important to remove enzymes and bacteria associated with the stomach. This can reduce the enzyme and bacteria count from 87,000 to 2,700 parts per million. Initially the crew did 50-55 fish an hour, but now her crew does 70-75 fish an hour. All work must be done before rigor mortis. Rigor exudes oils onto the deck which is extremely dangerous, and rigor leads to the condition in which the flesh of the fish becomes dry and boardlike in texture.

Because freezing has a drying effect, they now use a vacuum pack on board. The vacuum packing machine should be large enough for the larger fish sizes. Vanderpool has had to glaze larger fish because their packing machine was unable to handle anything over 14 lb (6 kg) round weight. They were concerned that on board glazing would lead to a thick and thin glaze which was very negative from a marketing standpoint, but the glazing has been relatively uniform. However, glazing is very difficult and time consuming in manpower costs.

Vanderpool uses a 36,000 BTU evaporator with a blower system driven by a 10-ton compressor system for refrigeration. They can handle up to 20 tons of albacore overall. The vessel is steel hulled and has 6 in. of foam insulation with a fiberglass overlay. Freezing capacity is 2,000-3,000 lb (900-1,400 kg) per day. The freezer system achieves -22°C in 12-18 h.

A number of vessel operators had experience with frozen albacore for the cannery and thought freezing to 0° was sufficient. What we know now is that freezing to 0° is concentrating an enzyme and that temperatures below -22°C are required to keep the enzyme inactive.

When Vanderpool looked at the aku boats, she questioned whether they had the capacity to freeze on board. For onshore freezing, Vanderpool recommended a plate or tunnel freezing system. Her question to the aku people was the histamine problem if the fish are not frozen on board. The albacore trollers' product is <60 min old when freezing begins which avoids the histamine problem. A possible solution is an on board chill tank which will also avoid the split skin syndrome which drives down the price. There is still a problem of shelf life. Oxidation leads to loss of eye appeal. She disagreed with the Japanese practice of calcium chloride brine, and she concluded that it is not worth working with the salt content problem. The albacore boats blast freeze only.

Vanderpool's albacore boats grade their catch on board by appearance and size. Some vessels under contract to Vanderpool have experimented with bleeding but not processing on board. Onshore loining has led to a 49% recovery rate. The next step is a cut to keep the dark meat against the bone for stock pot purposes. Of course all this takes special training for both the processor and the chefs.

Even with this, albacore prices have been hit very hard. The cost of changing over from cannery pack to a frozen loin operation was approximately \$20,000 for the vessel. The practicality for the aku fleet must be carefully explored.

Vanderpool commented on the previous day's statement about fisheries marketing associations being exempt from antitrust laws, and emphasized that this was not the case for individuals or between associations. This fact was not well understood by many within the albacore industry.

She agreed the industry was not in a slump; it was in a period of total change, and the change is in marketing the fish. The fish on deck are 100% more valuable than any fish in the water. The vessels are learning to move off the fish schools to take the time to properly process this catch. If the fish are not well handled, then the buyer cannot get premium prices, and the end user isn't happy. The vessel must assure consistent quality control.

The cannery is still very important. For alternative marketing, one must begin very small and keep quality high. The cannery is an assured market but the new markets must be developed very slowly and monitored very carefully.

Christofer H. Boggs: "Review of Biological Research on Skipjack Tuna"

Boggs began by commenting that yesterday the workshop had heard what the biologists can't say about aku. Biological research is still involved in trying to describe what kind of a fish an aku is. We are not yet at the stage where we know what the aku are doing or what they will do next. The economics of our research has something to do with this: The more expensive kind of research is the kind in which the scientists do some fishing (which requires a boat to catch fish) to find where the fish are, and use tagging experiments to estimate abundance, production, and movements. This kind of work has not been done around Hawaii because of cost. Therefore, the NMFS biologists have been doing the less expensive kind of research: Onshore research on life history and physiology to learn what kind of animals aku are.

Both kinds of research (at sea and onshore) have been telling us a lot about aku. Aku appears to be like a cockroach when compared with other fishes. It is a very strange fish with many puzzles and paradoxes. The scientists are trying to explain these puzzles, so that what the fishermen tell the biologists can be explained and used.

One of the paradoxes is the very high consumption of energy by aku, their very high metabolic rates, and the fact that they live in a part of the world with the very least amount of food, a desert among the oceans. They are unusual fishes because they have developed a system for retaining heat in their body. This seems to force the large aku out of the habitat of the Pacific Ocean which is most productive in food, the eastern tropical Pacific (ETP). Aku spawn very little in this area, even though they spawn throughout most of the rest of their range.

The puzzles are numerous. Aku are very fast swimmers and have magnetic sensors that allow them to know where they are, but tagging results seem to suggest they wander around randomly. Their movements may have more to do with water movements (currents) than with directed movement. Aku are cannibalistic. An important food item is their own young. Their growth rate is highly variable and hard to describe by the usual fisheries models. Although they are large fish, they are very short lived. Despite a lot of movement from one part of the Pacific to another, there are still clear genetic differences between skipjack tuna in different areas. The final paradox is that despite being one of the most exploited fish in the world, we cannot seem to overexploit them.

Boggs' work has been on tuna energetics. Skipjack tuna consume oxygen at much higher rates than other fish. They also tend to swim faster than other fishes and other tunas, and they do it all the time which takes a lot of energy. Yet they also grow more rapidly than other fishes. Therefore, aku must eat a lot more than other fishes and other tunas, even when there is not a lot of food available. This was a real puzzle for the ecologists. The answer came from looking at other small animals, and in particular at a comparative study of small mammals which showed that those with the highest metabolic rates grew and reproduced fastest. This type of animal requires high quality food, and thrives when conditions are good but may rapidly diminish in numbers when conditions turn bad. Compared with other fishes, aku seem to be this type of animal. They need a lot of high quality food and have a fast time scale for all their activities, but if they make wrong choices about where to find food, they die. If they keep finding food, they multiply and grow very fast which is why they are sometimes likened to cockroaches. This explanation does not help the fishermen, but it helps explain the sudden appearance and disappearance of aku and it suggests that aku are going to be less predictable than other fish.

Some other recent research on aku deals with spawning. Aku spawning areas are slightly more restricted than the total range of the aku (Fig. 19). The spawning range is limited by the 20° isotherm and the total range by the 25°C isotherm. A number of continental currents sweep from the mainland Americas toward Hawaii, and along the Equator, there is a current in the opposite direction. The movement of the California Current Extension north and south appears to affect the availability of aku to Hawaii. The Equatorial Countercurrent is probably important in bringing young fish into the ETP, since there is little spawning there. Some research shows that changes in wind and temperature in the central Pacific 1.5 years earlier can account for 50% of the variability of 1.5 year-old fish in the ETP. So, environmental conditions can have a major effect on the reproductive success and availability of skipjack tuna, which contradicts the more traditional fisheries concern over the size of the spawning stock. And there is a lot of evidence that the environment is changing.

Studies on aku show highly variable growth rates and cannibalism even at small sizes, which suggests that their survival may be density dependent. One technique which could be used to find out how many fish are available is to count the number of eggs or larvae. However, the fact that

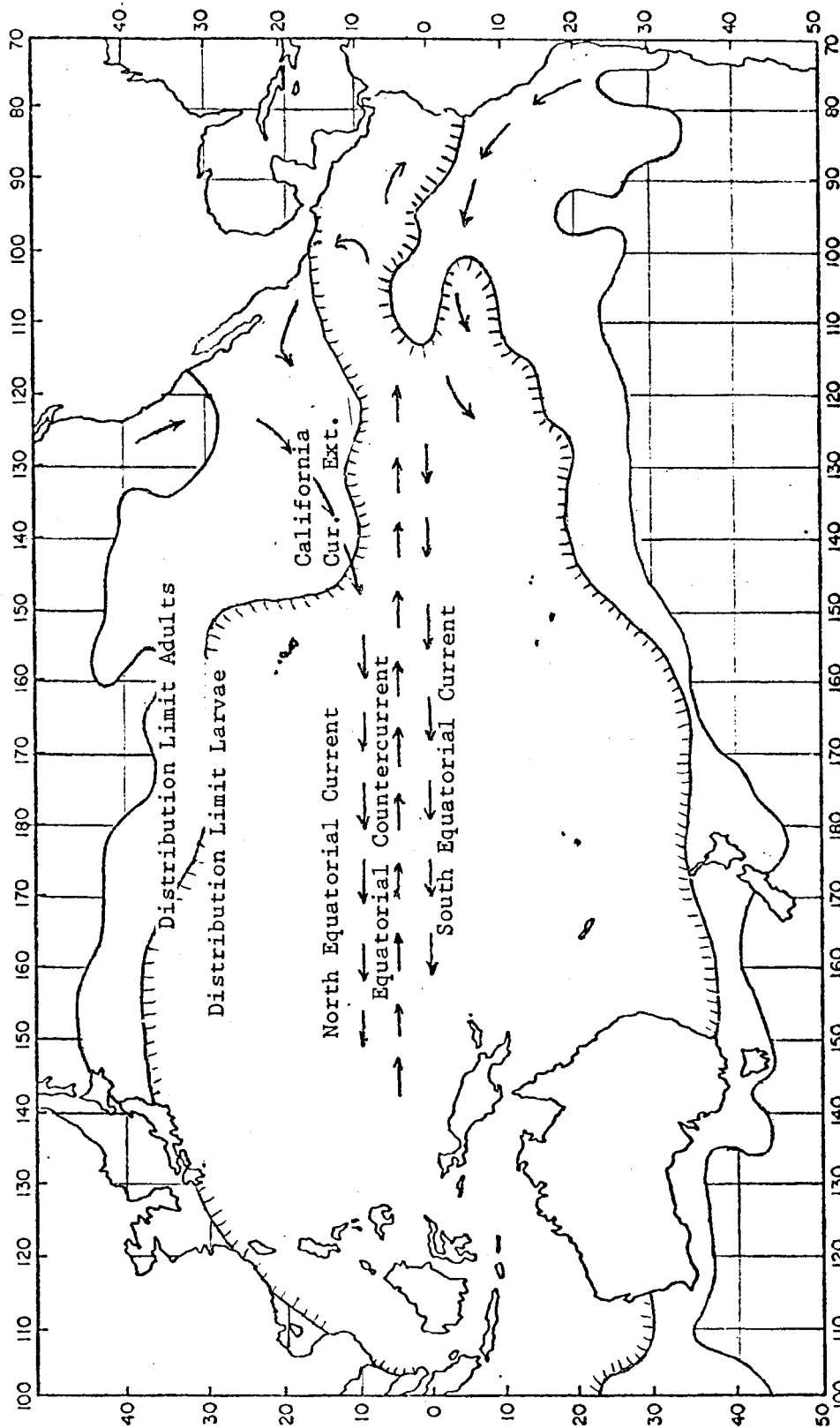


Figure 19.--The range of aku (skipjack tuna) and aku larvae in the Pacific and some currents that may affect their distribution (adapted from Matsumoto, W. M., R. A. Skillman, and A. E. Dizon, 1984, Synopsis of biological data on skipjack tuna, *Katsuwonus pelamis*, NOAA (Natl. Oceanic Atmos. Adm.) Tech. Rep. NMFS (Natl. Mar. Fish. Serv.) Circ. 451). (Christopher H. Boggs)

skipjack tuna are cannibalistic means that larval counts may not be a viable technique. Egg counts combined with knowledge of the frequency of spawning might be an alternative method. Recent studies show that female aku may spawn every day. Advanced genetics work allows DNA composition to serve as a means for identifying eggs to species which is not possible by microscope. Instead of examining plankton samples under a microscope, the whole mass might be ground up and genetic techniques used to identify the species of eggs and their quantities.

Boggs noted that this returns to his answer to Tuna Boat Owners Co-op, Inc. Manager John Robey's question the previous day about satellite work: It could be done, but it isn't being done because of the cost. He said the biologists are developing techniques that can be used if research economics become less prohibitive.

Boggs reexamined the genetics work briefly described by Kearney. In theory you want to see if there are independent populations and whether there are commonalities. The puzzle with aku is that differences exist despite evidence of plenty of interchange. The most recent summary is based on alleles in skipjack tuna blood across the Pacific. There seems to be a graded change across the western Pacific until Hawaii, and basically no differences to the east. This suggests that if there is going to be interaction, it will be between Hawaii and the ETP. However, this does not say that there is no mixture between the western Pacific and Hawaii, which is included in the genetic cline. The lack of tagging results showing movements from the west to Hawaii may be a result of a lack of tagging in the northern portion of the western Pacific, especially in the areas close to Hawaii.

Boggs noted that Kearney suggested we should look closer to home for the sources of problems in Hawaii's fisheries, meaning looking at how we are fishing, but Boggs suggested it might also be important to look closer to home in terms of what the fisheries around Hawaii are doing. The two closest fisheries to Hawaii are the Japanese pole-and-line fishery in the NWHI and the offshore ETP purse seine fishery. These fisheries have grown larger in recent years. Although the overall ETP purse seine fishery has not increased in recent years, the offshore fishery outside the CYRA (Fig. 20) has increased a lot since the 1970's. This portion of the fishery is adjacent to the California Current Extension which is implicated in whether the fish get to Hawaii or not. The Japanese pole-and-line fishery in the NWHI was limited before 1972 but it rose through 1977 (the last year of data²), and by the time Hawaii started to experience problems, the Japanese NWHI fishery was catching as much as Hawaii's long-term average (Fig. 21).

The one biological question which hinges on this data is what is our stock and what isn't our stock. We have the firm assertion that the stock can't be overfished, that natural mortality and turnover are very rapid. But the generalizations made about aku turnover rates from tagging

²Updated through 1984 after this workshop (Fig. 21).

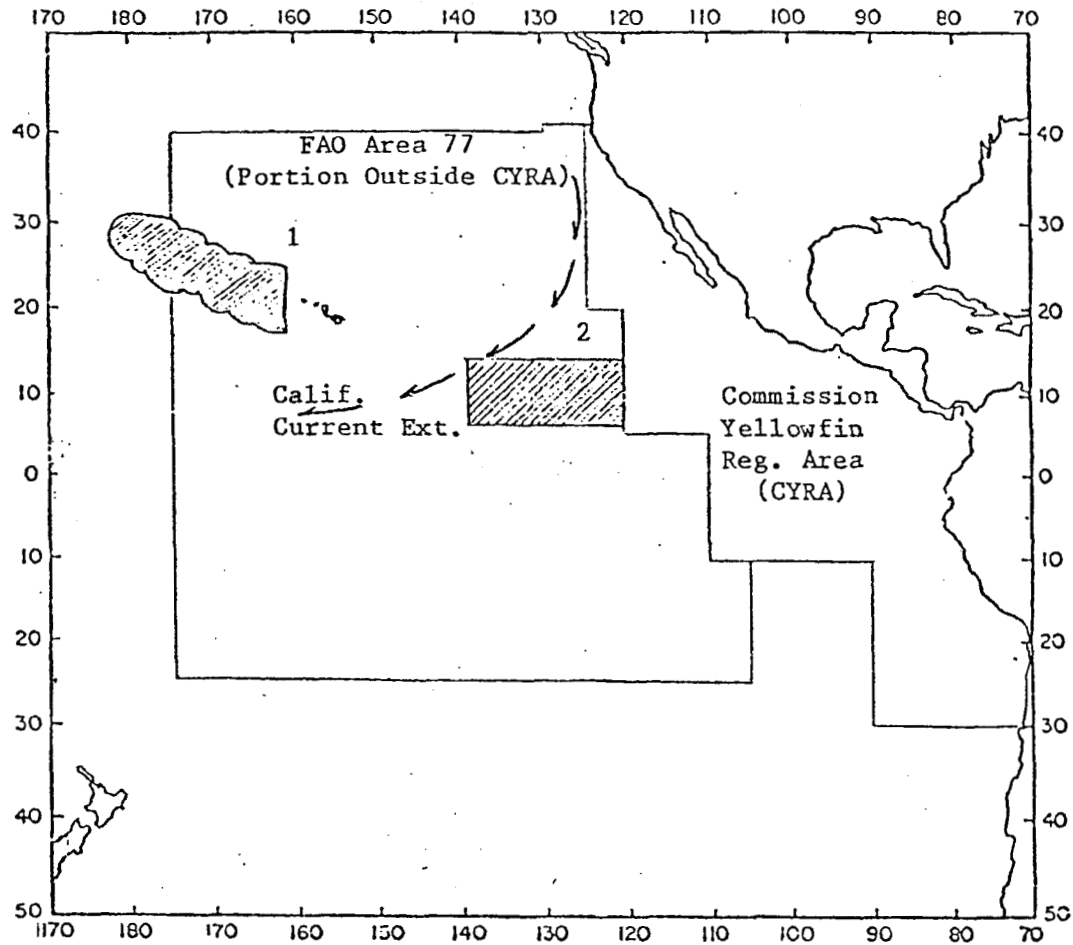


Figure 20.--Aku (skipjack tuna) fisheries closest to Hawaii. Shaded areas show 1) the 200-nmi zone around the Northwestern Hawaiian Islands fished by pole-and-line boats from Japan, and 2) the area outside the Inter-American Tropical Tuna Commission Yellowfin Regulatory Area (CYRA) fished by domestic and foreign purse seiners. Japan also catches a lot of aku in FAO area 77 outside the CYRA. (Christopher H. Boggs)

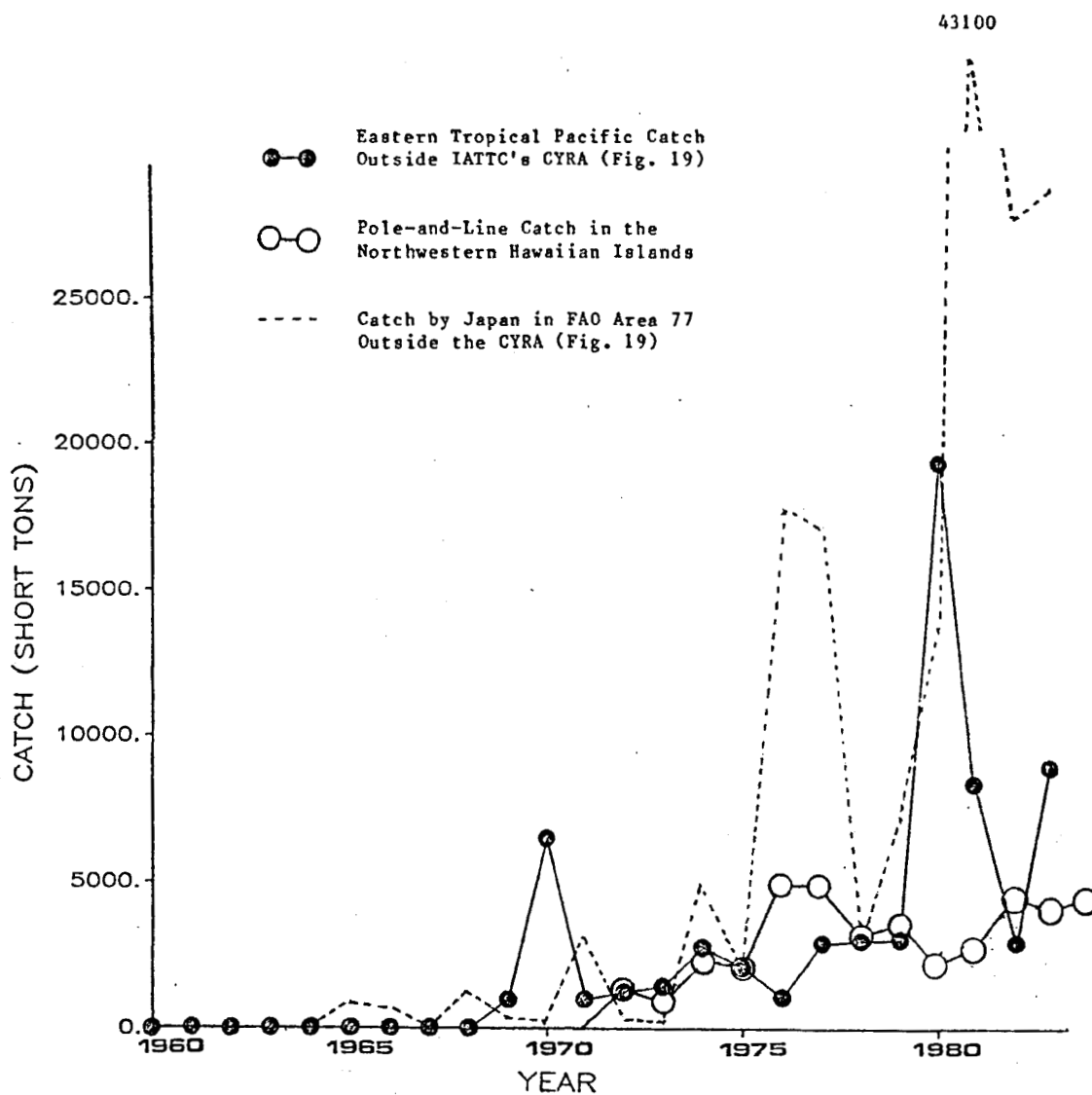


Figure 21.--Catch by aku (skipjack tuna) fisheries operating near Hawaii.
(Christopher H. Boggs)

studies mostly in the western Pacific may not be applicable to Hawaii's fishery. The Hawaii fishery is at the edge of the range for the other fisheries and has a very different size composition than that associated with the high rate of turnover. If there is a very high mortality rate, then the proportion of large fish should be very small. But with aku, whole size groups seem to appear and then disappear. Being on the edge of a range may be entirely different than being in the center of a stock or a spawning area. It seems hard to extrapolate from the eastern or western Pacific to Hawaii for a species which changes in character based on its environment. Hawaii's seasonal fishery for large aku may be more susceptible to depletion by other fisheries close to home than skipjack tuna fisheries in other areas.

The role of biological research is to try to help explain these phenomena. To try to make any predictions takes detailed statistics on what is being caught. So what we really need is cooperation from the people who catch fish. This can be illustrated by looking at the current dilemma on what is happening in Hawaii's fishery. There seem to be three possibilities: We aren't fishing as we used to, or the fish are being intercepted by other people, or there has been an environmental change which changes the habitat and the behavior of the fish. The hardest possibility to test is the one that the environment and the biology have changed. The easiest one to prove is about fishing habits, so in the short term, the answers we need to take to the bank are the answers about how we are fishing.

Boggs added some additional comments on size composition. He noted trends in French Polynesia for the percentage of large fish to drop, just as it has in Hawaii. It seems unlikely they are catching the same fish, but the price of fuel was going up in both places. Looking at the size composition of fish in the ETP, there was a shrinking size from 1971 to 1983, but in 1984 there was a new group of larger fish. The 1985 data show even larger fish, so maybe we'll see big fish in Hawaii a year later.

Boggs ended with a note on traditional Hawaiian fishing, which was that you should stop fishing for aku when the kapu (taboo, closure) went on, and you should fish for opelu (mackerel scad, Decapterus spp). As our aku fishery declined, the opelu fishery has gone way up.

DISCUSSION SUMMARY: Research and Fishery Development

Baitfish and Tuna Forage

Jack R. Davidson chaired the discussion and began with the observation that research had been done in the past to help the aku fishermen find ways to keep nehu longer and to reduce nehu mortality. The research was successful, but the projected cost of these methods was found to be more than the cost of the aku boats. A lot of research on alternate types of baitfish didn't seem to improve the situation very much.

Richard Kinney, an aku fisherman and boat owner, complained that the importance of the plankton squids, crabs, fish, and shrimps that are food

for the aku was not brought out in the talks. He explained that the bad years are years when there is very little "bait" or food for the aku in the waters around the Hawaiian Islands. He said that when there is little food in the water, you get traveling fish, and the fishermen do not catch fish in places where the fishing was excellent the day before. He emphasized that in times when the aku are feeding heavily, they don't move around as much. It was asked why the fishery biologists haven't investigated this theory?

Boggs responded that research on the relationship between feeding and aku catchability would require a lot of field sampling around the islands to measure what food is out there; and aside from not having the resources to conduct such a sampling program, it would seem more efficient if the fishermen could report this type of information since they are out there and making such observations. It was noted that communication between the fishermen and biologists could help to establish if there is more or less "bait" around the islands in these bad years.

The oligotrophic (unproductive) nature of Hawaii's offshore marine environment was noted and it was suggested that coastal input to the offshore areas is important in supplying food for pelagic predators like the aku. The extreme drought in Hawaii for the last 3 years was suggested as being partially responsible for reduced coastal input to the food chain. Reduced stocks of akule were cited as an example, and it was noted that unusual prey are being seen in tuna stomachs, especially filefishes, Pervagor spilosoma.

Concern was expressed over the effects of El Niño on the abundance of food for tuna. Rudy Kuniyama, a businessman familiar with Pacific tuna fisheries, noted that from the ETP all the way west to Christmas Island, many birds have died, the sea surface temperatures went way up, and a lot of "bait" must have died. He noted that the prevailing drift comes this way from the eastern Pacific. The difficulty in knowing the scale and duration of such major, long-term impacts was mentioned. Craig MacDonald of the Ocean Resources Branch, Hawaii Department of Planning and Economic Development, noted that The Hawaii Ocean Experiment (HOE), contains plans to monitor ocean conditions around the main Hawaiian Islands over the next 5 years and to develop models to forecast those conditions. The HOE will be a major attempt to rectify our lack of understanding of local environmental changes.

On the subject of the amount of "bait" or forage in local waters, a fisherman noted that even the buoys (fish aggregating devices (FAD's)) that are put out now don't have much "bait" around them. And he said that mahimahi, ono, and the other pelagic predators would not hang around the buoys unless there was a lot of food, as there was when the FAD's were first put out some years ago. He said he was waiting for the biologists to explain this decline in forage.

Some confusion by those not familiar with the terminology was revealed in a question as to whether the data on the abundance of the baitfish caught for use by the local aku fleet could be used to show patterns in

natural "bait" or forage abundance in local waters. The "bait" or forage that is the food for the aku at sea is not the same bait that is caught in the bays and harbors for use by the fishery.

Satellite Technology

The possibility that satellites could assist in monitoring coastal production of food for pelagic predators was mentioned, and the work off Kona showing that high primary productivity and abundant nearshore reef fish larvae were associated with offshore gyres was cited. The military equipment used in that study was said to be five to seven times as sensitive as NOAA satellite equipment (detecting temperature changes as small as three-fourths degree Celsius). However, the availability of such equipment on any regular basis was questioned. Vanderpool cited the experience of the albacore industry as indicating that some satellite capacity is reserved for experimental charts and that compatible uses for this capacity could be worked out between government and industry. One researcher complained that some types of research have been discouraged by the government because the research could be done better with satellites, yet access to the satellite data can be difficult or expensive.

The new technology in sea surface temperature receiving and processing equipment being marketed by three Japanese firms was mentioned. These portable units have been mounted on several hundred fishing boats operating in Japan's coastal waters and they allow a real time reception and processing of temperature data down to a resolution of about 4 km and half a degree Celsius.

It was again asked if satellite temperature charts can be useful for locating aku around Hawaii. Boggs noted that the paper linking skipjack and yellowfin tuna abundance to ocean conditions off west Africa was based on conditions 2 to 4 weeks previously whereas, in Hawaii the concentrations of aku were said to be present 1 day and gone the next.

Physiological and Behavioral Research

The subject of applying research on tuna sensory abilities (sight, sound, smell, magnetism) in order to increase fishing power was brought up next. Kim Holland from the Hawaii Institute of Marine Biology said it was hard to predict when such applications would be economically viable, but that increases in the price of aku could increase the likelihood. Potential applications, such as the use of odors to attract aku, were noted, and the importance of basic research to lay the groundwork for such applications was emphasized, as was the need for more work on the immediate biological environment around Hawaii.

Impacts of Other Skipjack Tuna Fisheries on Hawaii

The subject of the impact of aku fisheries near Hawaii was raised. Kearney acknowledged that the proximity of the Japanese pole-and-line fishery and the purse seine fishery outside of the Commission Yellowfin Regulatory Area in the eastern Pacific made these fisheries more likely to

have an impact than the eastern and western Pacific fisheries as a whole; but even closer to home, there appeared to be the lack of forage items for aku cited by fishermen. He agreed with the fishermen that a change in the local environment was a very likely cause for reduced aku abundance.

The idea that patterns in the size distribution of aku in the eastern Pacific are similar with those in Hawaii and that this correlation implies a relationship between the fisheries in these areas was discussed. Kearney suggested that although skipjack tuna size increased in the eastern Pacific the year before large fish showed up again in Hawaii, this doesn't mean that there is a major migration of fish from one fishery to the other. It could just mean that there was good recruitment of that age class generally across the central and eastern Pacific due to anomalous oceanographic conditions. It was pointed out that the extra large fish that were caught in Hawaii last year were too big to match the size that would result from the growth and movement of fish from the eastern Pacific to Hawaii. And furthermore, Kearney reemphasized that the data do not support the idea that heavy fishing in the eastern Pacific significantly decreases the abundance of aku in Hawaii, since the recent history (1983-86) of reduced fishing effort in the eastern Pacific fishery does not correspond with increased aku abundance in Hawaii. In response, Boggs argued that whether or not there was significant movement of skipjack tuna from the eastern Pacific to Hawaii, it could be very helpful to know that changes in size seen in the eastern Pacific tend to precede similar trends in Hawaii. There was disagreement with this idea and it was stated that the trends in the eastern Pacific do not always precede those in Hawaii.

Japanese Fishery Data

A local fishing industry member asked why the NWHI Japanese pole-and-line fishing data are not reported to NMFS and he asked what NMFS could do to get those data.

Shomura responded that, as the first agenda for the workshop showed, there was a space allotted for a Japanese representative. He said he had asked two sources in Japan if they would be willing to provide us with the catch statistics in the NWHI area where the Japanese baitboats have been fishing with the idea of trying to get catch per unit effort, species composition, and especially size composition information. Pretty much as he expected, the response was negative. The Japanese have refused to release any very detailed catch and effort data on their tuna fisheries in recent years. This goes back to the business of having access arrangements with various countries and the role of data is negotiating those agreements. Since 1980 they have not published detailed catch statistics of any sort. Shomura said he hoped to try some other sources to see if the Japanese would permit us access to that data since there is no doubt that they have that data.

It was suggested that we need not be concerned with that data because the aku caught in the NWHI are small, 1- to 2-year old fish that are caught in the high salinity, North Pacific gyre water that was discussed earlier.

The statement was made that Japanese fishing for these 3-4 lb (1.4-1.8 kg) fish should not be of any great concern to us. A local fishing industry representative disagreed, saying that we don't know if that's true unless the Japanese fishermen report the size of the aku they catch and the failure to do so indicates that they have something to hide. It was suggested that they might be baiting in the NWHI, which would be a violation of the 200-nmi zone established by the MFCMA. It was seen as unlikely that a Japanese baitboat could catch 200 tons of aku in the NWHI with bait brought in from outside the NWHI. However, other people pointed out that Japan has a well established bait fishery and advanced technology for transferring bait.

Some publications from Japan in the late 1970's were cited as saying that the experience of the Japanese fishermen was that they caught small skipjack tuna in very unstable schools in the NWHI, which they didn't like, and so they didn't stay there. They said they did most of their fishing farther offshore, and then got into the bigger fish. Based on that information, it was suggested that a major Japanese fishery for aku in the NWHI operates 100 to 200 nmi from shore at about lat. 20°N, and it can be large aku that are caught.

That information was criticized as being out of date, and defended as being the latest published information available.

Predicting Aku Catches

The predictions of aku catch that used to be made by the NMFS were mentioned, and it was asked why these had stopped. The forecasts were praised for their accuracy in predicting how many tons of aku would be caught. It was asked whether the forecasts were discontinued because the funding had been cut or because the researcher who had produced them had left and subsequent researchers had not been able to produce the forecasts. Shomura explained that after several years, the accuracy of the forecasts degenerated and they were discontinued when they became no more accurate than flipping a coin. The forecasts had been produced over the years by the same person from the same information on sea surface temperature and salinity that were presented yesterday.

Insurance Pools

Several questions were asked about insurance pools, on-board freezing and packing operations, and the cost per trip in the albacore fishery. Vanderpool explained that most of the albacore vessels operating in the Midway fishery belong to what they call "insurance pools." They have insured themselves by investing their own money and building equity in those insurance funds. Dividends from the money are returned to pay off quarterly insurance payments. Two of these vessels which fished in the South Pacific were requested to pay \$40,000 on top of the regular amount for the 2 months they were in the South Pacific. They are now trying to convince their pools to cover the South Pacific runs for just double the regular premium for that amount of time, on the basis that the potential

liability is no greater since they do their own towing in the case of breakdowns.

The laws regarding insurance pools in Hawaii were not known, but interested parties were referred to the pools based in Seattle for more information. The insurance on one vessel owned by Vanderpool was cited as an example. This boat had to belong to two pools because its value exceeds the maximum covered by a single pool. Initially the cost of insuring in a pool was greater than the normal insurance rate but over a prolonged period, a vested interest was accrued and the owner eventually received returns based on the operation of the pool. The only reason their insurance pools are successful is because of a highly selective membership, i.e., the pool is insuring ability and integrity of the captain and owner more than the vessel itself.

Processing

Regarding aku processing, Vanderpool suggested that if on-board freezing and packing were not possible, then an onshore operation using a plate or tunnel freezer would be best. The on-board processing used by the albacore vessel employs a "Freon 502"³ with a capacity of -22°. This figure was based on air temperature, which differs from the measurements made by Japanese industry, which are taken on the freezer coil. The air temperature in the albacore processing was given as -22° in the working hold, and -38° in the holding hold, which translates to a -40 to a -50 coil temperature. Vanderpool noted that a lot of potential sales were lost before it became clear that they had to get down below -22° to inhibit the bacteria problem.

She also emphasized that extreme care in handling was a requisite for the marketing of fresh frozen albacore, since albacore has historically had a poor name on the U.S. mainland as to quality, due to the old way it was handled. The change in technique was illustrated by noting that a vessel that had an 80,000 lb (36,000 kg) capacity when operating for the cannery is totally filled at 40,000 lb (18,000 kg) when operating for fresh frozen. The difference was described as that between packing bricks and packing footballs. The albacore are no longer shoved down and the refrigeration is not turned off. The albacore are laid on a single shroud, they're thoroughly frozen, and then the individual fish are packed. If vessel operators don't meet these standards, the fish are not sold. The need to build a reputation for quality was emphasized, since it was said that if whoever buys doesn't get quality, they won't remember a thousand good fish, they'll only remember that bad one.

The cost per trip was said to be quite variable between vessels and it was pointed out that most of the vessels are not yet outfitted for processing.

³Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Hawaii Sampan

Richard Kinney quipped that since everyone is always talking about how the Japanese catch so much aku hundreds of miles up the island chain, friends and relatives pester him to go catch aku up there. He emphasized that the scientist should not make the mistake that had been made (with much publicity) in the past of underestimating the efficiency and fishing power of the Hawaii sampan. He ridiculed a statement one fishery scientist made to the newspapers years ago that said the local baitboats could not go more than 20 nmi out to sea. To those biologists who say the local fishermen just don't know how to navigate, he wanted them to know that he had taken his sampan from Palau, over 1,400 nmi to Truk in the Caroline Islands. Kinney warned against tinkering with a successful boat design, citing failures which resulted from this in the past. He said that the Hawaii sampan was designed to fish the local waters very efficiently, and not to travel hundreds of miles. He said the range is set by the operation, alternating between nearshore baiting and fishing out to 100 nmi.

FUTURE PROSPECTS

Richard S. Shomura: "Prospects for the Future"

Shomura concluded the formal presentations of the workshop by commenting on the prospects for the future of the aku industry. As had been seen throughout the workshop, the aku story has been pretty grim in Hawaii. The boatowners realize that times are tough for industry and for the future. The workshop objective was to look at the available data and see if there was any hope for salvation. If one can see even a pinpoint of light at the end of the tunnel, to work out a way to achieve that goal of a revitalized fishery on an economically sound basis, then it is worthwhile to take that look.

Shomura proceeded to summarize the previous presentations. The factors show that since 1973 the large, season aku have not appeared in their usual abundance. This absence has been one of the major factors in the decline in the total annual catch of the aku fishery which used to run about 5 million lb (2,300 t) and in recent years has been about 2.5 million lb (1,100 t). The aku fleet has been reduced in numbers and no new vessels have entered the fishery for some time. The boat owners are not making money. This has been attributed to the marked increase in the operating costs, fuel, repairs, and insurance, and although the price of aku has gone up, revenue has not made up for the losses on the other side of the ledger.

The reasons suggested for the decline in catch come from two sides, one is fishing and the other is the environment. Concerning impacts of fishing from outside the region, Kearney acknowledged that while some skipjack tuna do show up from other fisheries as shown by tag recoveries, he did not think the eastern Pacific fishery had a major effect on Hawaii. However, Hudgins had voiced a contrary opinion and Shomura indicated he tended to concur with her. One of the questions is where from outside the

Hawaiian Islands is the impact coming. Boggs pointed out that the offshore ETP and the NWHI are possibilities closer to home. The total catch data needed to be examined carefully, because declines such as those in the ETP pointed out by Kearney may be attributable to the U.S. fleet fishing in the western Pacific. Sibert also noted that with the tag recoveries, it seems unlikely the South Pacific fishery is affecting Hawaii. However, some people have pointed out that there has been very little tagging north of the Equator, such as in the Marshall Islands. Little was said about the western area of the North Pacific skipjack tuna fishery and its interaction with Hawaii's skipjack tuna fishery. Earlier results of the Japanese pole-and-line fishery near Hawaii showed small skipjack tuna in the NWHI and larger skipjack tuna 100 nmi south of Hawaii.

There was not much said about the immediate impact of Hawaii's domestic fishery on the aku stock. The underlying assumption is that the season skipjack tuna come from outside the Hawaiian Islands. However, this may not be a proven case since everyone knows that skipjack tuna do spawn in Hawaiian waters. This year's 1-2 lb (0.4-0.9 kg) skipjack tuna may be next year's 15 lb (7 kg) skipjack tuna. Do the young reappear here or do they disappear from Hawaii?

These questions are frustrating as to what biology can contribute. The economic issues are also important, such as the change in fuel prices and the impact of the FAD's.

The other area is the environment, although studying it doesn't seem to help us either and everybody agrees that there should be some relationship. There is no question that El Niño is an important phenomenon, but its impact is oceanwide, and there is no obvious relationship between El Niño and Hawaii's decline in skipjack tuna landings. Skillman's environmental data (temperature and salinity) showed a recent trend toward higher salinity waters, suggesting that the Hawaiian Islands are being bathed more by the North Pacific gyre waters than by the more southern waters brought to Hawaii by the California Current Extension which some oceanographers believed was an indicator for the movement of skipjack tuna from the eastern Pacific to Hawaii.

Shomura concurred with the interesting point raised by Kinney which was that the skipjack tuna will not be here if their food is not available in abundance. Shomura thought that a possible environmental influence may be affecting the availability of "bait" (forage). The aku is an extremely unique, highly-tuned fish, and they are able to sense changes in the water very well. Over the years, Hawaii's human population has increased dramatically, especially on Oahu. If one visualizes fish like the aku, what prevents us from suggesting that there may be a plume of water created by humanity on these islands which is uninhabitable by skipjack tuna. In the good old days, you could see aku schools just offshore, just as you still can on many Pacific island atolls. That sort of thing used to happen right off Kewalo Basin, but it happens no longer. Maybe the big aku are just turning their noses and veering 100-150 nmi from Hawaii, outside the range of our aku boats.

The data do not show clearly what has happened to the skipjack tuna. Frank Goto of the United Fishing Agency, Ltd. asked why we aren't doing the research necessary to answer these questions, especially research on the level of years past. The answer lies in the major reductions in force faced since 1970 by the SWFC Honolulu Laboratory. As a result, the Laboratory has restructured its programs, and more attention is mandated to the NWHI. In the 1950's, the Laboratory had a major program working with industry directed toward aku, but today the Laboratory can only monitor the fishery. So there are many things about the current fishery the scientists simply don't know today about how the aku fishery is operating.

With major budget constraints, the SWFC Honolulu Laboratory has not been able to gear up on aku. The Laboratory's programs have very little flexibility now, and much of the funding is being earmarked for specific programs such as monk seals and habitat. However, this should not deter the industry from letting the Laboratory and higher levels know what concerns and needs there are.

What to do, what are the prospects for the future? Hudgins predicted that if nothing is done, the fleet will dwindle down to four to five small vessels landing 2 million lb (900 t) of fresh market tuna. The remainder of the fresh demand would be met by frozen imports, a development which has come up very quickly and very recently and which industry and researchers need to keep on top of.

Pooley had suggested that one major area for changing the bottom line from negative to positive is to increase the number of trips, but this and fishing more efficiently do not solve the problem of the age of the vessels.

Therefore, new investment is the next step, but that will only come about if everyone is convinced that there is money to be made, from the bank which holds the mortgage to the individual boat owner. Perhaps taking exception to Kinney, building the same boat today as is currently operating in the fishery, the same situation would result, with an even bigger mortgage. One new idea is to look at vessels being able to fish to the maximum, and to have a place to direct the surplus from the fresh market. King suggested that a specialty canned product is a possibility, but frozen loins seem extremely unlikely. So new investment will require a vessel that can stay out a longer period with the possibility of a frozen catch. This will require better fuel efficiency, better living accommodations, and refrigerated baitwells.

The Japanese have a major fishery dedicated to bait. They age and harden up their bait and have made major advances in baitwells technology so that their pole-and-line vessels can go major distances, such as to French Polynesia.

Another aspect is to increase fishing efficiency by improving scouting. Even during the peak of the season, during the years when there was plenty of aku, fishermen would see an average of eight schools of aku a day, and on average only four schools would respond. If you are in the

wrong place, you'll just see a few sooty tern scouting around for their next meal. People have looked at satellites to improve the situation. The military technology is not currently available but what is needed is a way to track bird flocks, at least until we can accurately predict where the fish are by salinity, temperature, and currents.

So in the short term, placing transmitters on birds may be a way of tracking the bird flocks. Bird biologists have done this. The idea is to have land-based receiver stations communicating with the aku boats. The boats need to be on the fishing grounds at the break of day. That's when the action is best, that is, when there is the greatest interaction between prey and predators. So being on the ground more than 1 day and following the bird flocks are ways to improve the efficiency of the fishing.

Bait fish has been a perennial problem, even though the fleet has been reduced in half.

Shomura concluded by asking not to discount the possibility of a small purse seiner being the most efficient, although that may be a question for the economists.

PANEL DISCUSSION: Future Prospects

Richard S. Shomura chaired the panel discussion. He asked the panelists to give some perspective on what they feel the future role of universities, the State, and the Federal Government should be.

Frank Goto, United Fishing Agency, Ltd.

Goto began by noting that the auction house's main forte is not aku, but mostly bottom fish and longline-caught tuna, the large tunas such as yellowfin and bigeye. However, Goto had been involved with a fairly small group of aku fishermen for quite a number of years and has lived through their frustrations. There have been some very, very high hopes in years past as you can see from the FV Anela, which unfortunately is tied up because of economic reasons. Goto said that what has to be said has been said by the speakers, and he wouldn't want to belabor the point.

Wadsworth Yee, Western Pacific Regional Fishery Management Council

Yee began by explaining that he would not be speaking on behalf of the Western Pacific Regional Fisheries Management Council (WPREMC) of which he is Chairman but as an interested observer, a businessman, a banker, and an insurance man. Yee thought the ideas for rejuvenating the aku industry were excellent but they were more for the long term. However, with prices the way there are this year, Yee indicated today is when the aku fishermen are in panic. With the cannery closed, the market bad, the fish not around, how do the aku fishermen survive is one of the main purposes of this conference.

Yee suggested that for the aku industry to survive, all the boat owners and operators have to get together and work together. One of the

most difficult things to do is getting boat people to work together. But if you want to see this industry survive and you want to survive and continue making a living, every boat owner has to get together, pool ideas, and combine their resources. Yee mentioned insurance pools as an example of such cooperation. Another potential area for working together would be in getting an oil company to bid to fuel all the aku boats as a fleet.

Yee also suggested looking at other areas of marketing. Although the sashimi, the fresh aku, market is excellent, people view the prices as very high. Perhaps with lower prices, more people will eat aku and this will distribute the surplus and get rid of more fish in the future. Yee noticed that when he used to go to parties, every place anyone used to go, everyone served sashimi because it was within economic reach. Today it's too expensive. So maybe somewhere down the line, there has to be some moderation so that the consumption will pick up in Hawaii which is a fresh, quality seafood eating community. And the tourists like it too. The more haoles (Caucasians) eat it, the more business for the aku industry. This is the short range thing that the industry can benefit from immediately.

Yee also mentioned the hui (investment group) of which Goto is a part and their attempt to reopen the cannery. If they can get one or two lines of the cannery in operation, then they can take care of the excess catch of the local aku fleet. Whether that is feasible or not, Yee didn't know. Financial costs are tough, and even large businesses have high insurance costs. Yee spoke in favor of the tort reform legislation which had been introduced in the Hawaii Legislature in 1986.

Yee urged the boat owners to all work together, put their heads together, and to sit down, and work with people like Frank Goto and John Robey, with the biologists, the Federal Government, and the State. He suggested that the government could help investigate flash freezing and other techniques which industry could not afford to front itself. He emphasized the effectiveness of an active constituency in getting what it wants from government and recommended active political pressure to achieve these goals.

John Robey, Tuna Boat Owners Co-op, Inc.

Robey began by thanking Shomura for holding the workshop and thanking all who participated. He said his biggest disappointment was that there were not more industry representatives at the workshop. Industry has the tendency to say "Well, why should we go, we hear the same old thing." Robey said he appreciated the scientists admitting what they did not know. However, he thought that what the fishing industry needed to ask is "Why don't you know?"

Robey related an experience of his in the U.S. Air Force where a test rocket failed and everyone was dejected except for one high-powered colonel who pointed out that now they knew what didn't work. The workshop was like this. Unfortunately, in many cases the problem can't even be identified, let alone answered. But Robey said he had sensed a positive attitude towards the aku industry here and an effort and willingness to help.

Robey concurred that the industry had a big problem and doesn't know what to do about it. The industry is frustrated. There are some things that can be done locally that may be able to help but nothing can be done without fish. And as Yee suggested, there could also be more marketing. Yet the really frustrating thing that the local industry experiences is that when a market is developed, when everybody gets geared up for it, the fish disappear. And even though there is a cooperative, there is severe competition here.

As for the scientific community, Robey said he would like to see more effort expended toward knowing what the aku resource is. The aku industry's interests may seem very parochial, but that is their livelihood. Robey asked the scientific community to help tell industry where the aku are. He pointed out that many of the industry's problems would disappear if there were sufficient aku on the grounds. Robey also pointed out that there may be problems with the current catch reporting system and the scientists should look at that issue carefully, in cooperation with the aku industry. Robey said that it could be a good source of data that should be utilized.

When faced with the possibility of surpluses, Robey also asked how refrigeration can be used, what is the best method to preserve or make use of this excess fish, which is the basic economic problem. There is some conjecture that the cannery is the answer, but Robey was not sure. The cannery is just another method for holding excess fish for later distribution. Alternative techniques, including freezing, might also be fruitful.

Robey pointed to the recent imports of fresh frozen aku from Japan. The question is: Is there any impact? The inference from the workshop discussion was there was no impact. However, Robey thought there had been a considerable impact in that some of his customers, because of the high price of local aku and the lack of fish, have been buying frozen fish, and because of that frozen fish his customers have been able, in a sense, to stay in business. Is that helping or hurting the local aku industry? Robey suggested that it's at the point where the scientific community can help. How do the Japanese freeze their fish? How are they processing their skipjack tuna? Robey said that he had heard of flash freezing to -75°, of filleting the skipjack tuna in its frozen state, and of refreezing fillets. These were issues which needed to be sorted out, but a small organization like the aku industry couldn't handle them alone.

Robey emphasized that the biggest problem now is the lack of fish. "It's amazing how much of our problems would go away if we could suddenly have fish." The fishermen would accept the ups and downs of availability of aku as long as they were sure there still is a resource out there and it is still exploitable. He concurred with Pooley's recitation of the cost problems facing the aku industry and argued that new boats with new technology were required. There was a substantial local market, largely because of Hawaii's unique ethnicity. He agreed with Hudgins' estimate of a 3-5 million lb (1,400-2,300 t) local market but he said this would

require new investment and State or Federal help in confirming whether the aku resource would be there to legitimize new investment.

Robey concluded that the industry is hurting very badly and needs whatever assistance it could get.

DISCUSSION SUMMARY: Future Prospects

The workshop concluded with responses from the audience to the final panel.

Aku Markets

An aku fisherman and boat owner initiated the discussion by disagreeing strongly with the idea that lowering the price of fish could serve to increase the market for fresh aku in Hawaii. He said that local outlets could absorb only so much and that whereas a price drop might speed sales for a short time, it would not increase the volume sold after a couple of days. He stated that a viable price for aku was \$1 per lb (\$2.20 per kg) and that without this price, the aku fleet would not survive. In contrast to what others had said, he emphasized that the problem of getting a decent price was the major problem facing the industry. He explained that there are three bona fide outlets to which the aku fleet can sell, and although competition has always tended to drive down the prices paid by these legitimate dealers, the problem has become much worse in recent times because some of the owners and captains are selling aku directly from the boats. This so-called "bootleg" market drives the price down much farther than the usual competition.

The boat owner appealed to those in control of the three legitimate outlets to get together and refuse to buy from those boats that are bootlegging aku. He said that getting cooperation was very difficult, that the buyers are more competitive than cooperative, but that without such cooperation, they would never be able to maintain a decent price to keep the fishermen in business. He also complained that the retail prices don't reflect the price drops that occur when the fish are plentiful; in other words, the dealers are well organized and maintain a decent retail price but the fishermen are maneuvered into accepting very low prices because they are not organized, not talking to each other, and they are letting bootleg sales drive down the wholesale price.

One person in the audience mentioned that the trolling boats are much more numerous these days and getting quite good at catching aku. These boats catch 600-700 lb (approximately 300 kg) of aku, fishing right alongside the aku boats and they can legally sell this fish. The opinion was expressed that they may be doing better than the baitboats and competing legitimately for the aku market. It was implied that some of the problems attributed to "bootleg" sales might actually be due to the marketing of troll-caught aku.

Government Role

Next, one of the local fishing industry members emphasizing the conflict he felt between his respect for local officials and his frustration, expressed his opinion that the local people who hold prominent positions as government fisheries scientists are not doing enough for the fishermen. He said he believed that the meeting was just an academic excuse for not having done more to help the fishermen, and that these State and Federal officials know that the industry is dying. He asked the panel members if they felt the same way.

Goto responded by saying that the issue is that we live in a democracy which expects certain things from its public officials. He said that new laws, do-gooders, and environmentalists, all have some control over what government officials can do for the fishermen. Therefore, the government officials have to be careful. He pointed out that in the "good old days," a lot could have been done in the "smoke filled room" but with sunshine laws, those days are over. And whether that was good or bad, he couldn't say. He had often been very frustrated but that the rules had to be lived with, and these constraints made it take longer to do what had to be done. He agreed that the system could be very frustrating and that he was perturbed by it.

Yee agreed with Goto that the government system is frustrating, and he said that as Chairman of the WPRFMC, he had been very frustrated with the marine biologists because, in fisheries, it is often not possible for them to give exact answers. He acknowledged that the scientists must be very careful, because if they are wrong, they could be taken to task or sued. He said he would support the recommendations of the scientists if they could tell him what was happening in a fishery in positive, meaningful terms, because the resource must be conserved. However, he said that if the scientists could not tell him that, even though he had a government role in fishery management, he strongly favored the interests of the fishermen, to the extent that he had been accused of conflicts of interest. He said he believed in supporting the fishermen because they were having hard times, they had a lot invested, and they deserve a chance to continue making a living.

Robey said that he was glad the era of the smoke-filled room was over. He regretted that the industry was spilling its guts in public instead of getting organized together to solve some of the problems that don't require input from fishery scientists. He agreed that industry members needed to communicate and cooperate and he said that they should stop pointing fingers and look in their own backyards.

Shomura responded to the criticism directed towards government officials by saying that it was fair enough to complain when the system becomes frustrating and he agreed with Goto that things are a lot more complicated than they were in the past. However, he said it was wrong to think that he didn't have the industry's well-being in mind. Shomura said if he were to completely support some of the fishermen who would like him to stand up and say that the scientists don't know what is going on, and

support an unregulated fishery, that he and they knew that some fisheries, such as the lobster fishery, would be run into the ground. There were differences in opinion, even within the industry, about what was best for the fishery.

Sakuda said that the State agencies are in the position of having to juggle between satisfying the concerns of commercial, recreational, and environmental interests, which is not a simple thing to do. He said there are many legislative actions that concern the industry that the State agencies are involved in which could use the support of the local industry.

The local fishing industry member responded to these comments by saying that he didn't think the aku fishermen should look to the State and Federal agencies for help with insurance and other problems like that. He said it was clear that the industry would have to take care of itself, and it could not cry for government help to solve their problems.

The meeting ended with a few comments on cooperation. It was said that the previous discussion made it sound as though the fishermen were not very cooperative but that actually, during these hard times, the fishermen have been more cooperative than ever before because they are going through a common hardship. One aku boat owner said that it was not the fishermen who were uncooperative, but the boat owners, and without a unified policy among the three major dealers with regard to marketing, the industry would continue it's decline and the fleet would continue losing boats. On that note, the workshop was adjourned.

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