PFRP

Pelagic Fisheries Research Program

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PFRP Research Continues to Diversify

John Sibert

Scientists affiliated with the Pelagic Fisheries Research Program met December 5–7, 2000 in Honolulu to share progress on continuing research projects and introduce plans for new projects initiated in 2000. Scientists from outside the PFRP also presented research results and possible approaches to shared scientific problems.

Principal investigators and their colleagues made 25 presentations on diverse topics ranging from economic analysis of fleet dynamics to biochemical analysis of tuna fat to determine feeding relationships. Many of the new PFRP projects address the fundamental infrastructure on which future analysis of stock status can be based.

Data Studies

Paul Dalzell of the Western Pacific Regional Fishery Management Council presented plans to assemble all of the recreational fishing data available in Hawai'i and to discern trends in catch rates and average sizes over the last 30 years.

Russel Brainard from the NMFS Honolulu Laboratory presented plans to generate databases of oceanographic data from *in situ* measurements and remote sensing that are specifically tailored for use in stock assessment and fisheries management. These data, for the entire Pacific Ocean in the form of printed atlases for the United States EEZ, will be made available dynamically on the world wide web (http://coastwatch.nmfs.hawaii.edu/atlas.html).

William Walsh of the Joint Institute for Marine and Atmospheric Research presented plans to reconcile data on selected incidental catch species in the Hawai'i longline fishery. Data will be gathered from longline logbooks, observers and sales, and studied species will include the blue shark (*Prionace glauca*), blue marlin (*Makaira nigricans*), mahimahi (*Coryphaena hippurus*), opah (*Lampris guttatus*), wahoo (*Acanthocybium solandri*), and pomfrets (several species of the family *tarachthyidae*). Welch's results will produce reliable 10-time series of data that can be incorporated into the first-ever stock assessments for these species.

Spatial Variability and Closures

Large pelagic fish such as tunas, marlins, swordfish and sharks are predators with ranges that encompass the entire Pacific Ocean; issues of spatial variability therefore concern every PFRP project. These fish are highly dispersed in the ocean, with typical population densities of only about one fish per square kilometer integrated over the upper mixed layer. However, they are not distributed uniformly. Tunas in particular have a well-known propensity to coalesce into dense aggregations of various types. Fishermen, of course, are well aware of such aggregations, which is why fisheries are not distributed uniformly.

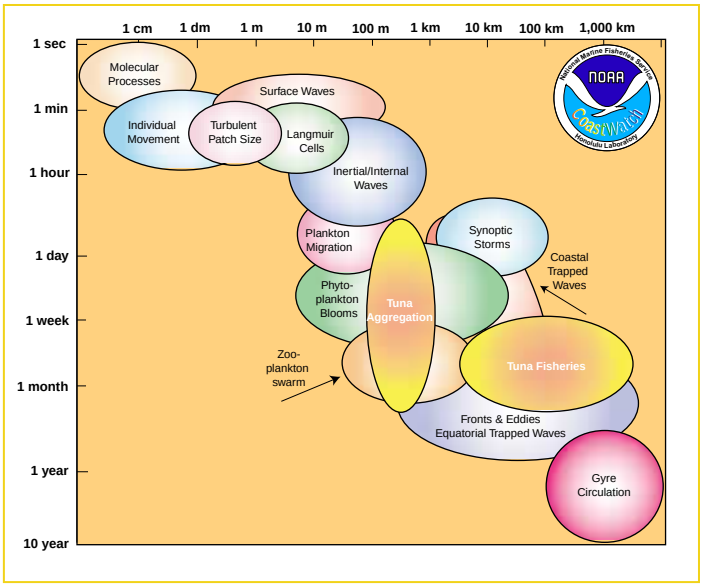

Figure 1. Spatial and temporal scales of various oceanic phenomena (Dickey, T.P., 1991.)

The closure of all or part of a fishing ground during all or part of a season is a fisheries management tool that has been widely applied recently to United States longline fisheries. Time-area closures are imposed to achieve diverse management goals, such as protection of spawning grounds and reduction of interaction with protected species or recreational fishers.

David Kerstetter, a graduate student at the Virginia Institute of Marine Science, presented plans to compare the efficacy of time-area closures in the Atlantic, Gulf of Mexico and North Pacific. Kerstetter's project will depend heavily on the results of other PFRP projects that focus on the dynamics of fleet movement and validation of longline logbook data.

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The lighter side of a Principal Investigators' meeting: after two solid days of project presentations, PFRP PI's enjoy refreshments and delectables, perhaps debating which species of piscine pelagic was unfortunate enough to be served on the pupu's table.

Spatial Variability and Aggregations

Tuna fisheries depend heavily on exploitation of natural and man-made points of aggregation such as oceanographic fronts, seamounts, logs, and fish aggregation devices (FADs). In 1999, most of the Pacific tuna catch of nearly 2 million metric tons was produced by fisheries that exploit aggregations of tunas around man-made aggregation devices. Most importantly, our ability to estimate population size depends on the relationship between local abundance and the population as a whole.

The proximity of seamounts, offshore weather buoys, inshore FADs, and "koas" makes Hawai'i a natural laboratory for the study of spatial variability of tunas. The general principle that the scale of spatial variability is related to trophic level is one of the great unifying principles of general ecology (see Figure 1).

Kim Holland from the Hawai'i Institute of Marine Biology presented plans for a new project to exploit this natural laboratory. Holland and colleagues Richard Young from the UH Oceanography Department, Richard Brill from NMFS and

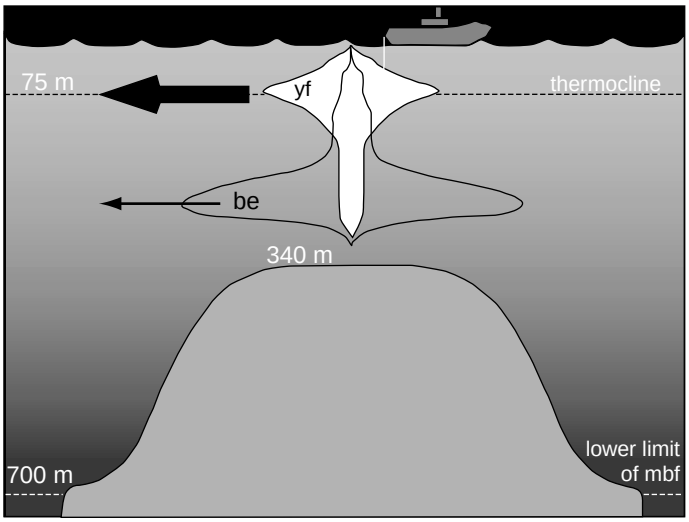

Figure 2. A hypothetical distribution of yellowfin and bigeye tuna at Cross Seamount in Hawai'i, extrapolated from conventional tagging data.

Laurent Dagorn from IRD in France are planning an extensive study of the role of feeding in the mediation of tuna aggregation in Hawai'i.

Other Projects

Other projects discussed at the investigators' meeting included the following.

- Guest speaker Tim Essington from University of Wisconsin-Madison showed how spatial heterogeneity might increase the abundance of both prey and predator in the pelagic ecosystem.
- Sara Iverson from Dalhousie University demonstrated how analysis of fatty acids from tuna tissues might be applied to the study of trophic differences between yellowfin and bigeye at different points of aggregation.
- UH oceanography grad student Matt Parry presented some preliminary work on stable carbon and oxygen isotopes in squids that could be used to elucidate tuna feeding dynamics.
- David Itano of JIMAR and Kim Holland presented results of conventional tagging of yellowfin and bigeye tuna in Hawai'i, and presented a hypothetical scheme for the distribution of these two species at Cross Seamount (see Figure 2).
- Finally, David Welch from the Canadian Department of Fisheries and Oceans outlined plans for a network of automated instruments to monitor movement of acoustically tagged fish on the western continental shelf of North America that could be adapted for use on tunas near Hawai'i.

A number of Powerpoint presentations created to illustrate projects at the PI's meeting will be available soon on the PFRP web site (http://www.soest.hawaii.edu/ PFRP/socio/socio.html).

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The Importance of Local Knowledge in Fisheries Management

John Kaneko, Paul Bartram, Marc Miller and Joe Marks

The project "Local Fisheries Knowledge: Its application to the development and management of small-scale pelagic fisheries in the Pacific Islands," was funded by the PFRP to elicit and evaluate local fisheries knowledge held by fishermen on 1) yellowfin and bigeye tuna sought after by Hawai'i's handline and longline fishermen, 2) albacore tuna available to the rapidly growing small-scale fishery in American Samoa, and 3) blue marlin available to Guam's small-boat trolling fleet. This article summarizes the rationale and findings of the Local Fisheries Knowledge project, and discusses "cultural consensus analysis," the process used to obtain and interpret those findings. (Complete findings of the project are presented in SOEST publication 00-06, JIMAR contribution 00-334; a description of the project can be found at the PFRP web site: http://www.soest.hawaii.edu/PFRP/socio/socio.html.)

Local, traditional knowledge of natural resources is becoming widely recognized as a potentially important source of input in the management of pelagic fisheries. However, development of practical applications has been difficult and limited because investigations of this knowledge to date have been largely descriptive and qualitative. The question remains: how can useful local knowledge be elicited, analyzed quantitatively, and used by scientists and managers to enhance the management process?

The PFRP funded this project to explore a quantitative method for evaluating local knowledge about pelagic fisheries that are under the management of the Western Pacific Regional Fisheries Management Council. Cultural Consensus Analysis was applied for the first time to evaluate the knowledge of Hawai'i's handline fishermen about yellowfin tuna; the objective was to elicit fishermen's knowledge with potential importance to fisheries management.[1]

Fisheries Management: Multiple Knowledge Bases

Modern fisheries management is an extremely complex process. Managers are charged with sustaining fishery resources while striving to balance the well-being of fish and fishermen, as well as a growing number of interested parties that hold diverse and often conflicting concepts of resource utilization and management.

Managers look to fisheries scientists for expert assessment of fish populations as well as the social and economic aspects of a managed system. But just as expert scientific opinion is critical to decision-making, so should be an understanding of how fishermen (the managed group) and other stakeholders view the status of the resource.

Over time, long-term resource users such as fishermen develop a set of beliefs or shared views about a resource through observation, first-hand experience, and a sharing of ideas and theories. Experienced fishermen rely on this local knowledge and their own theories to locate and catch more fish, and they tend to share their knowledge selectively. This is not unlike the behavior of fisheries scientists, except scientists apply the scientific method to test and verify theories before publishing.

As a result of extended time on the water, long-term local fishermen may hold beliefs or make observations about the resource that are not familiar to fisheries scientists. A systematic evaluation of this accumulated knowledge may reveal valuable insights about resources, and these insights might help inform and support fisheries research. Fisheries scientists might be informed by local fishermen, share understanding, and exchange and/or confirm theories. Deliberate cooperation might enhance research agendas and data collection, and thereby the quality of management.

Cultural Consensus Analysis

Cultural Consensus Analysis[2] was applied as a quantitative method to evaluate the knowledge of Hawai'i handline fishermen about yellowfin tuna. The objective was to determine how these expert fishermen view the yellowfin tuna resource they exploit both locally and ocean-wide. For comparison, fisheries scientists who help manage Western Pacific pelagic fisheries were also included in the study.

Consensus analysis is derived from test theory that analyzes the responses of a group of experts to a set of resource questions (belief statements or propositions). Consensus is revealed through study of individual responses to the resource questions. The most notable advantage of this method is that it can reveal consensus through individual interviews, without requiring public comment or focus groups, which often politicize the process.

To evaluate how fishermen view a resource, a set of statements about their beliefs is prepared to elicit what the respondents "believe" to be true or false, as opposed to what they "know" to be true or false. Fishermen formulate beliefs easily based on observation and experience, while scientists formulate theories and analyses through application of the scientific method. However, in the culture of science, expert opinion or conventional wisdom is based on probabilities of something being true. In this way, scientific knowledge and local knowledge are both expressions of what each expert group believes to be true.

Consensus analysis can determine the answers to a set of questions about resources without knowing the answers in advance.

[1]*Local Fisheries Knowledge: The Application of Cultural Consensus Analysis to the Management and Development of Small-scale Pelagic Fisheries.* 2000. Project Final Report. J. Kaneko, P. Bartram, M. Miller and J. Marks. SOEST 00-06. JIMAR Contribution 00-334. 34 pp.

[2]A detailed description of the methodology can be found in the PFRP Final Project Report: *Local Fisheries Knowledge.*

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The method does not determine a consensus based on a simple majority of responses from the group. Instead, it evaluates the competence of each response and applies a weighted value to it, only then identifying the consensus of the group. Competence in this context is not a judgement of correctness, but a judgment instead of how well the individual's response reflects the consensus. To clarify this point: Christopher Columbus was correct in his belief that the world was round, but as none of his peers held this belief as well, Columbus would have had a very low competency score.

Consensus analysis allows managers to answer three basic questions:

- Is there a consensus amongst groups of experts regarding a body of knowledge, or is there a diversity of beliefs and opinions?
- If different groups share a consensus belief about a resource, what is this belief?
- If there is a consensus, are there particular issues on which individuals or subgroups tend to disagree?

In any given locale, experienced resident fishermen usually have the most detailed knowledge of near-shore fisheries, which can be a vital complement to the geographically broader knowledge of pelagic research scientists and fisheries managers. Shown here are ikashibi fishermen unloading tuna at the Suisan Fish Market in Hilo (left) and at Kewalo Basin in Honolulu (right) (Ikashibi is derived from the Japanese words "ika," for squid, and "shibi," for yellowfin). During the summer yellowfin run, Hawai'i handliners fish around the islands at night, drifting with the current; they can catch large yellowfin and albacore, as well as the occasional swordfish. Their experience in this fishery makes them expert in nocturnal near-shore aggregations and behavior of tuna and other fishes around the Big Island and O'ahu. ***(Ed.: Big Island refers to the island of Hawai'i, Hawai'i to the entire state.)***

Experiential vs. Scientific Consensus

To determine consensuses regarding the Hawai'i handline fishery on management issues such as species populations and biology, overfishing, catch competition, and fish aggregators, the research team drafted a list of pertinent belief statements, and two groups were interviewed: expert handline fishermen with at least 15 years in the Big Island yellowfin fishery, and pelagic fisheries scientists in Hawai'i researching yellowfin tuna.

The analysis of responses demonstrated that, in general, fisheries scientists and Big Island handline fishermen share a consensus view of the yellowfin fishery in Hawai'i. Figure 1 is a similarity matrix used to plot each expert in relationship to the others in the group; it indicates how well individual experts agreed with each other. Note that the pattern of distribution indicates that the experts are "on the same page," or share a consensus view. Closer inspection reveals that the scientists tend to fall on the periphery of the cluster of fishermen. The reason for the clustering may be explained by reviewing the list of yellowfin belief statements, and closely examining the key beliefs that tend to separate scientists and fishermen.

- For question 12, 13 out of 24 fishermen believed that tuna abundance around *ahi koa* has declined because of overfishing, while 4 out of 7 scientists did not. This question also demonstrates how consensus is determined based on the competency of the respondents. Although only 16 out of 31 individuals believed that this statement was true, the probability of this being the consensus is greater than 0.99.
- For question 18, 19 out of 24 fishermen believed that heavy fishing at offshore seamounts and FADs will cause a decline in future abundance of large tuna in Hawai'i, while 6 out of 7 scientists did not believe this. This supports the need for studies on the significance of seamounts and FADs to the recruitment of large tuna accessible to Hawai'i's handline and longline fleets.
- For question 14, 20 out of 24 fishermen believed that yellowfin tuna in the Central and Western Pacific are currently being overfished, while 6 out of 7 scientists did not.
- For question 19, 17 out of 24 fishermen believed that heavy fishing of large tuna and marlin in Hawai'i will cause a decline in future abundance of these fish. In contrast, 4 out of 7 scientists believed that because Hawai'i's tuna catch is a relatively small portion of the Pacific tuna catch, landings in Hawai'i will not likely affect future availability because of recruitment from the oceanic population.

Management Implications

The Big Island handline fishery traditionally has targeted yellowfin tuna, and much of the fishing activity revolved around natural fish aggregators known as *ahi koa*. Knowledge of *ahi koa* is of great interest, in that this knowledge has been developed and shared among local fishermen for many years (even generations). This knowledge is important in the context of managing Hawai'i's pelagic fishing fleets that target yellowfin, as well as managing potential gear interactions between longline, handline and troll fishermen.

The investigation of local knowledge about yellowfin tuna provided an opportunity to apply consensus analysis to determine if two important expert groups share a common view of the resource. In general, both fishermen and pelagic fisheries scientists share a common base of knowledge or beliefs about yellowfin. In

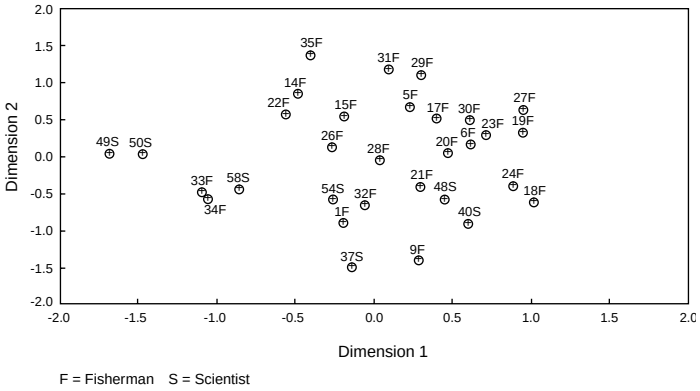

Figure 1. Similarity Matrix of Hawai'i handline fishermen and fisheries scientists.

a sense, both groups are on the same page with regard to how they view the yellowfin resource.

Nevertheless, there are several issues on which these two groups tend to disagree, and consideration of the issues revealed that the probable source of disagreement is contrasting perspectives. Fishermen for the most part possess a detailed knowledge of the yellowfin resource within the range of their vessels. Island handline fishermen tended to have a local perspective about pelagic resources with a strong experience-based consensus. This group does not share the same stock-wide perspective that tends to form the research-based consensus of pelagic fisheries scientists.

The scientists tended to share an oceanic perspective on the yellowfin tuna population with less emphasis on the local nearshore fishery. This explains why fishermen and scientists could disagree on such major issues as local overfishing and overfishing by existing fleets in the Pacific outside of the range of handliners.

Both groups believe that yellowfin caught in Hawai'i are a mixture of resident and wide-ranging fish. A mixed population

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Table 1. Hawai'i yellowfin fishery belief statements and consensus view.

	Belief statement about the yellowfin resource	Consensus	
1.	Yellowfin caught in Hawai'i are a mix of resident and migratory fish.	**True*** 26	False 5
2.	Yellowfin are caught in Hawai'i mostly in the summer because they migrate to other areas during the winter.	**True** 31	False 0
3.	Most of the yellowfin catch in Hawai'i is concentrated around the 1,000-fathom contour.	**True** 18	False 13
4.	The abundance of yellowfin in Hawai'i depends on how much fishing occurs in and around the 200-mile zone.	True 9	**False** 22
5.	The abundance of yellowfin in Hawai'i depends on how much fishing is done before the fish migrate near Hawai'i.	**True** 30	False 1
6.	The abundance of yellowfin in Hawai'i depends on the availability of food (prey) in Hawai'i waters.	**True** 31	False 0
7.	The cycles of high and low tuna abundance in Hawai'i depend on variation in ocean temperature and currents.	**True** 31	False 0
8.	Variation in tuna (and marlin) abundance in Hawai'i depends on variation in fish abundance ocean-wide.	**True** 27	False 4
9.	Yellowfin catch is strongly affected by the full moon.	**True** 25	False 6
10.	FADs divert tuna away from natural *ahi koa*.	**True** 25	False 6
11.	The overall abundance of tuna around Hawai'i is the same with or without FADs.	**True** 25	False 6
12.	Tuna abundance around natural *ahi koa* has declined because of overfishing.	**True** 16	False 15
13.	The yellowfin resource in Hawai'i is being overfished (i.e. present yields are not sustainable).	True 11	**False** 20
14.	The yellowfin resource in the Central and Western Pacific is being overfished (i.e. present yields are not sustainable).	**True** 21	False 10
15.	Yellowfin caught in Hawai'i are getting smaller.	**True** 23	False 8
16.	The yellowfin resource in Hawai'i is not as abundant as 10 years ago.	**True** 25	False 6
17.	Heavy fishing by existing Hawai'i boats alone could deplete tuna abundance in Hawai'i	True 7	**False** 24
18.	Heavy fishing on small tuna at seamounts, weather buoys and FADs will cause a decline in future abundance of large tuna in Hawai'i.	**True** 20	False 11
19.	Heavy fishing on large tuna and marlins in Hawai'i will cause a decline in the future abundance of these fish in Hawai'i.	**True** 20	False 11
20.	Heavy fishing in any one area can cause localized depletion over the long term.	True 10	**False** 21

*The bolded answer represents the consensus. Probability is greater than 0.99.

assumes the existence of a resident yellowfin subpopulation. The resource information and research needed to manage resident yellowfin subpopulations is likely to differ from information needed to manage wide-ranging yellowfin populations.

These findings should be of interest to fishery managers faced with conservation decisions, as well as to scientists and fishermen during formulation of a research agenda to support fisheries management objectives.

Conclusion

Interviews of yellowfin fishermen from the Big Island were the first to apply cultural consensus analysis to local fisheries knowledge, so this initial effort can be viewed as a beginning, rather than an end. However, the findings identify a basic difference in perspective between Hawai'i handline fishermen and pelagic fisheries scientists, and help to explain why they differed so strongly on certain key resource issues. At first, this may appear to be a trivial finding, but in reality, many of the critical management issues facing the Hawai'i yellowfin tuna fishery require a knowledge of nearshore tuna movements and aggregations, rather than knowledge of stock-wide issues in international waters. The consensus that yellowfin tuna caught in Hawai'i's handline fishery are a mixture of resident and wide-ranging fish indicates a need to include both nearshore (local) and oceanic perspectives when developing or refining research agendas and management policies.

This effort also identified an information gap and attendant need to disseminate large-scale fisheries information to local fishermen. Efforts to share scientific assessments of tuna population are important. Ideally this information would be summarized and then presented in a format easily accessible to fishermen. By sharing this information, the information gap and difference in perspectives between handline fishermen and scientists might be reduced.

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John Kaneko, Project Director for PacMar, Inc. a Hawai'i-based international development consulting company, and Paul Bartram, a Honolulu-based fisheries development and management consultant, served as Co-PI's for the project. They managed the team effort, identified management issues, formulated questions, conducted interviews and prepared the final report. Marc Miller is a cultural anthropologist at the University of Washington School of Marine Affairs; he guided adaptation of cultural consensus analysis for the project, and analyzed responses from participating fishermen. Joe Marks is a commercial fisherman and international fisheries consultant based in Kona; he identified and facilitated interviews with handliners and other expert fishermen.

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