Purpose of the project and indicative results.
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 Hawaii’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 Hawaii’s handline fishermen about yellowfin tuna; the objective was to elicit fishermen’s knowledge with potential importance to fisheries management.¹

Modern fisheries management is an extremely complex process. Managers are charged with sustaining fishery resources while striving to balance the wellbeing 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 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.

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

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 (see kaneko_fig1.pdf) 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.

Evaluation of the individual belief statements (see Table 1 at end of article) reveals that some of the scientists and fishermen disagreed on a few key beliefs about overfishing in the yellowfin fishery.
- 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 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 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.

About the authors:
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.
Table 1. Hawai‘i yellowfin fishery belief statements and consensus view.

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

<table>
<thead>
<tr>
<th>Belief statement about the yellowfin resource</th>
<th>Consensus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Yellowfin caught in Hawai‘i are a mix of resident and migratory fish.</td>
<td><strong>True</strong></td>
</tr>
<tr>
<td>2. Yellowfin are caught in Hawai‘i mostly in the summer because they migrate to other areas during the winter.</td>
<td><strong>True</strong></td>
</tr>
<tr>
<td>3. Most of the yellowfin catch in Hawai‘i is concentrated around the 1,000-fathom contour.</td>
<td><strong>True</strong></td>
</tr>
<tr>
<td>4. The abundance of yellowfin in Hawai‘i depends on how much fishing occurs in and around the 200-mile zone.</td>
<td>True</td>
</tr>
<tr>
<td>5. The abundance of yellowfin in Hawai‘i depends on how much fishing is done before the fish migrate near Hawai‘i.</td>
<td><strong>True</strong></td>
</tr>
<tr>
<td>6. The abundance of yellowfin in Hawai‘i depends on the availability of food (prey) in Hawai‘i waters.</td>
<td><strong>True</strong></td>
</tr>
<tr>
<td>7. The cycles of high and low tuna abundance in Hawai‘i depend on variation in ocean temperature and currents.</td>
<td><strong>True</strong></td>
</tr>
<tr>
<td>8. Variation in tuna (and marlin) abundance in Hawai‘i depends on variation in fish abundance ocean-wide.</td>
<td>True</td>
</tr>
<tr>
<td>9. Yellowfin catch is strongly affected by the full moon.</td>
<td>True</td>
</tr>
<tr>
<td>10. FADs divert tuna away from natural ahi koa.</td>
<td><strong>True</strong></td>
</tr>
<tr>
<td>11. The overall abundance of tuna around Hawai‘i is the same with or without FADs.</td>
<td><strong>True</strong></td>
</tr>
<tr>
<td>12. Tuna abundance around natural ahi koa has declined because of overfishing.</td>
<td><strong>True</strong></td>
</tr>
<tr>
<td>13. The yellowfin resource in Hawai‘i is being overfished (i.e. present yields are not sustainable).</td>
<td>True</td>
</tr>
<tr>
<td>14. The yellowfin resource in the Central and Western Pacific is being overfished (i.e. present yields are not sustainable).</td>
<td><strong>True</strong></td>
</tr>
<tr>
<td>15. Yellowfin caught in Hawai‘i are getting smaller.</td>
<td>True</td>
</tr>
<tr>
<td>16. The yellowfin resource in Hawai‘i is not as abundant as 10 years ago.</td>
<td><strong>True</strong></td>
</tr>
<tr>
<td>17. Heavy fishing by existing Hawai‘i boats alone</td>
<td>True</td>
</tr>
</tbody>
</table>
could deplete tuna abundance in Hawai‘i
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  False
   20    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  False
   20    11

20. Heavy fishing in any one area can cause localized depletion over the long term.
   True  False
   10    21