Coastal Resource Use and Food Security in Hawaiian Communities

Kīholo Bay, Hawai'i

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PROJECT OVERVIEW

Understanding the complex ways in which nearshore fisheries ecosystems subsidize human well-being remains a critical knowledge gap in sustainability research. This knowledge gap limits the development of viable options to improve both fisheries ecosystem integrity and social well-being, including sustainable development strategies to improve livelihoods, human health, and welfare (Arrow et al. 2012; UNU-IHDP and UNEP 2012). This gap is becoming increasingly critical as local and global threats such as climate change, overfishing, and land-based pollution impact key life-sustaining ecosystem processes, placing more pressure on vulnerable coastal populations in Hawai'i and beyond (Bohle et al. 1994; Levy et al. 2005)

This project explores the social and ecological factors that mediate the connection between coastal resource use and local food security in several Hawaiian communities. The purpose of this project is to quantify and examine the connections between nearshore marine ecosystems, ecosystem services, and community wellbeing, and explore how these relationships affect local food security from nearshore fisheries. Our specific research questions and hypotheses are listed below. The overarching goal of this research is to inform community and regional-scale efforts to increase resource security and sustainable food systems, and community resiliency to social and environmental change. At the community level, developing baseline information on resource security and provisioning functions of local environments has much potential for developing place-based approaches to increasing local food autonomy and to address the trade-offs necessary to preserve subsistence-oriented local economies and community livelihoods while maintaining ecological resilience. It is our hope that this research is used to help communities and resource managers understand where to make investments to strengthen local food security and which mechanisms may be explored to restore positive feedbacks that connect people to place, engender collaborative stewardship, and develop pathways toward sustainable social and ecological outcomes.

Research Questions and Hypotheses:

(1) How is local food provisioning affected by nearshore marine ecosystem characteristics?
H1: Provisioning ecosystem services are highly influenced by reef fish biomass and habitat complexity.

(2) How do socioeconomic factors, social networks, and resource dependence affect the flow of food provisioning ecosystem services to communities?
H2a: Increased resource dependence and socioeconomic occupational diversity tends to increase subsistence use, local food provisioning and cultural ecosystem services in coastal communities.
H2b: Social networks affect the proportion of catch devoted to different market sectors (e.g. subsistence versus commercial uses) in coastal communities.

(3) How does food provisioning affect specific components of social well-being and aggregate well-being in coastal communities?
H3: Food provisioning and related cultural services support key dimensions of human well-being, but the strength of the relationship will diminish as affluence increases.

To address these research questions, we developed three overarching goals for the project and a set of interdisciplinary methods to generate and analyze empirical data. The first goal was to analyze human use patterns in nearshore fisheries ecosystems. To do this, we partnered with CI HFT personnel and Alan Friedlander's lab at the University of Hawai'i to design a creel and fish flow survey method to deploy at three community sites. This method procures empirical data on temporal patterns of fishing and gathering effort, catch, and gear types and spatial patterns of use.

PROJECT GOALS	***Method***
1) Analyze human use patterns in nearshore fisheries ecosystems	**Creel Survey** *(observational + intercept method)*
2) Quantify and spatially assess "fish flow," or the post-landing disposition and distribution of locally-caught seafood	**Fish Flow survey** *(intercept methods, paired with creel data)*
3) Measure the benefits of local seafood *availability, access and consumption* (i.e. "seafood security") to community well-being	**Household survey** *(interview method from purposively selected sample)*

The second goal was to quantify and spatially represent "fish flow," or the post-landing disposition and distribution of locally-caught seafood (Kittinger 2013). Fish flow research estimates how seafood from nearshore marine ecosystems are used by local fishers and their role in local economies and households. To quantitatively measure fish flow, we developed a fish flow (mahele) intercept survey, which was paired with our creel survey to be deployed at each site.

Finally, our third and most challenging goal is to measure the benefits of local seafood *availability, access and consumption* (i.e. "seafood security") to community well-being. In support of this goal, we have developed a comprehensive household survey linking ecosystem services, community well-being and local food security associated with nearshore fisheries.

ACTIVITIES & METHODS

Our research took a community-based, participatory research approach. Participatory action research describes a suite of approaches that involve researchers and community members working collaboratively in the visioning, goal-setting, design, data-gathering and assessment phases of research (Whyte et al. 1989). Participatory approaches differ from traditional research in that local participants are engaged actively in all phases of the research. In contexts where the research is directed towards a community-based planning effort, such approaches can ensure that research products can more directly inform these planning efforts. Such approaches have been

shown to yield valid data that are useful for community planning and management (van Asselt Marjolein and Rijkens-Klomp 2002, Scholz et al. 2004, Aswani and Lauer 2006).

One of our principal goals is to understand local seafood systems and the factors that affect seafood security in local communities. We conceptualize seafood supply systems as being comprised of production, distribution and consumption functions. Distribution functions can be characterized as the proportion of catch directed toward distinct market sectors (Fig. 1); these market sectors include subsistence-consumptive, commercial, barter, and non-market sectors. Distributive patterns in turn affect how production translates into utilization of local food provisioning ecosystem services. Drawing on this conceptual model, we developed household surveys and creel/fish flow surveys to gather data on these processes at the local level, which when paired together with other data (e.g., market surveys and other datasets such as CI HFT's Omnitrack study) will help to assess seafood supply systems in Hawaiian communities.

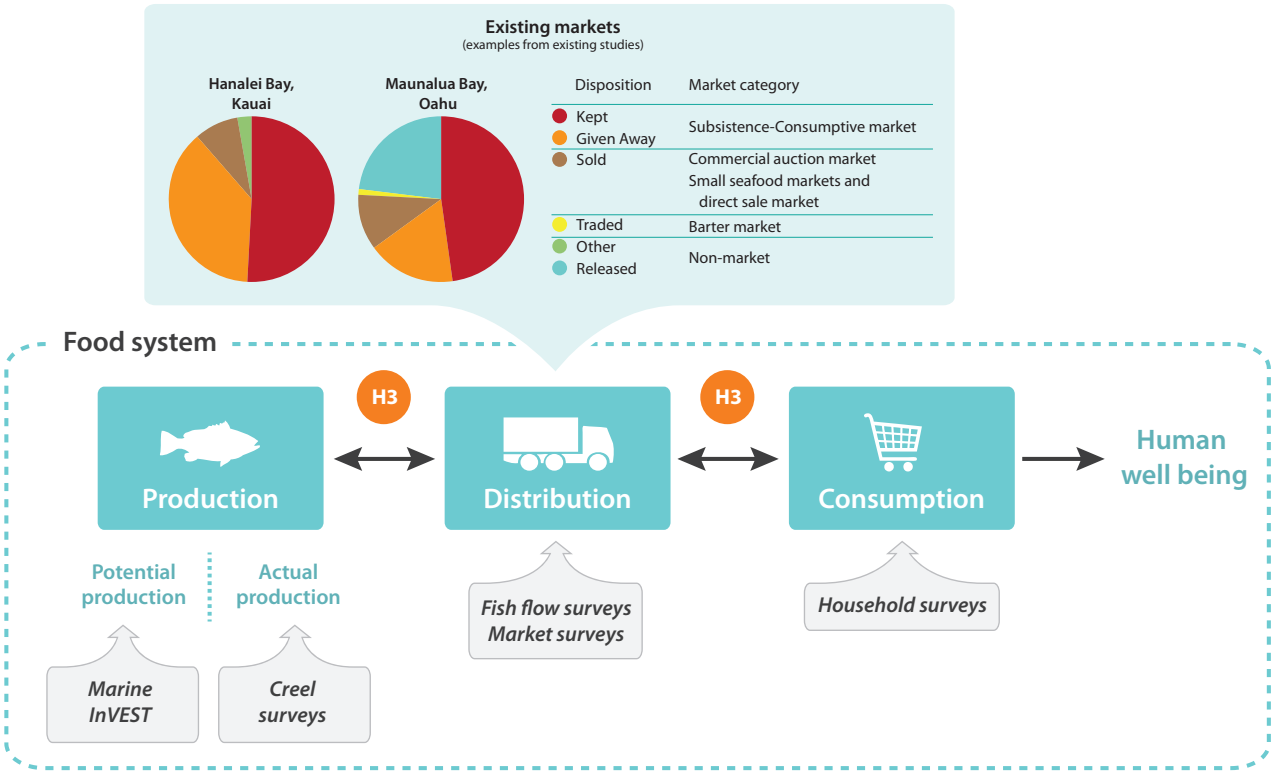


Figure 1. Conceptual model of the seafood supply system, consisting of production, distribution, and consumption processes. Hypothesis 3 (denoted by orange circles) tests the factors that mediate the relationships between these three key components of seafood supply systems. Pilot data of fish flow studies from two participating study sites, including Hanalei, Kauai and Maunalua Bay, Oahu, and the market systems associated with different dispositions of fisheries resources highlight the diversity of market categories which mediate consumption. From Crowder et al. (2012).

In addition to the seafood supply system, social and ecological factors influence fishing behaviors and catch distribution at the community level, and thus mediate the direct (e.g., food provisioning) and indirect (e.g., sociocultural significance) ecosystem services associated with coral reef fisheries (Figure 2). For example, the social capital held and maintained between fishers

and their community can determine specific fishing behaviors. In Hawai'i local fishers are often called upon by community members to provide catch for a social event (e.g. weddings, birthdays), and these requests provide the social motivating factors or triggers for specific behaviors (Severance et al. 2013, McCormack 2013; Hardt and Olayon 2011). The spatial distribution of fishers' social kinship networks also influences the distribution of catch through the community. While most locally caught seafood is consumed in households based in the community, some portion of the catch can also travel considerable distances to family members and friends located further afield (Glazier et al. 2013, Vaughan and Vitousek 2013). Ecological factors also influence the procurement and distribution of ecosystem services from coral reef fisheries. Weather and sea conditions can affect the accessibility of certain habitats, and some predictable seasonal patterns can limit habitat usage (e.g. large winter swells along northern coastlines). Local availability of habitat types, species seasonality, and species abundance (as a result of both natural and human factors) also influence catch type and subsequent post-landings utilization patterns. For these reasons, it is important to understand all the factors that affect seafood supply systems, as determined through fish flow processes at the community level (Figure 2).

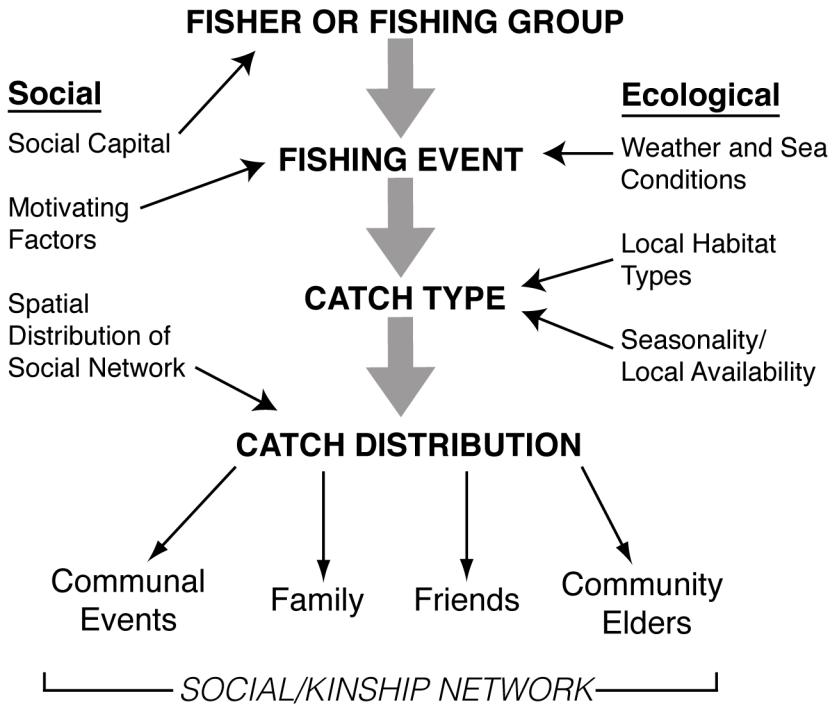


Figure 2: A heuristic model describing the social and ecological factors influencing non-commercial (subsistence/recreational/cultural) fishing behaviors and catch distribution at the community level. Fishing activities and fishers' behaviors are mediated by social factors including social capital, motivating factors and spatial factors, which modulate a series of actions from trip initiation to catch disposition within a social-kinship network. Ecological factors such as weather and sea conditions, seasonality and local availability of habitat types and species also influence catch type and post-landings utilization patterns. From Kittinger (2013).

Over the past year, our research has involved community members, CI HFT, and the project team working collaboratively in the following three communities: 1) Kīholo Bay, Hawai'i Island; 2) Wailuku CMMA, Maui; and 3) Maunalei, Lāna'i (Figure 3). In order to measure the concepts pertinent to the achievement of our goals, we developed two survey instruments. Both the

instrument development and the data collection were undertaken with extensive feedback and effort from the communities involved.

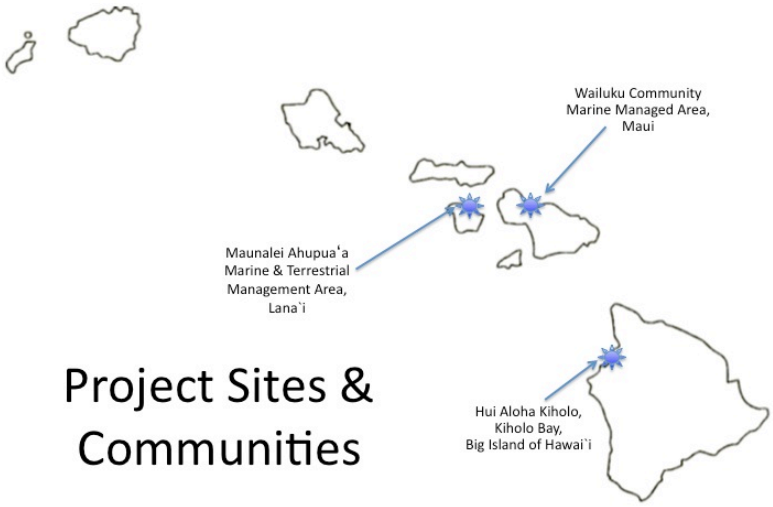


FIGURE 3. PROJECT SITES AND COMMUNITIES.

CREEL AND FISH FLOW SURVEY

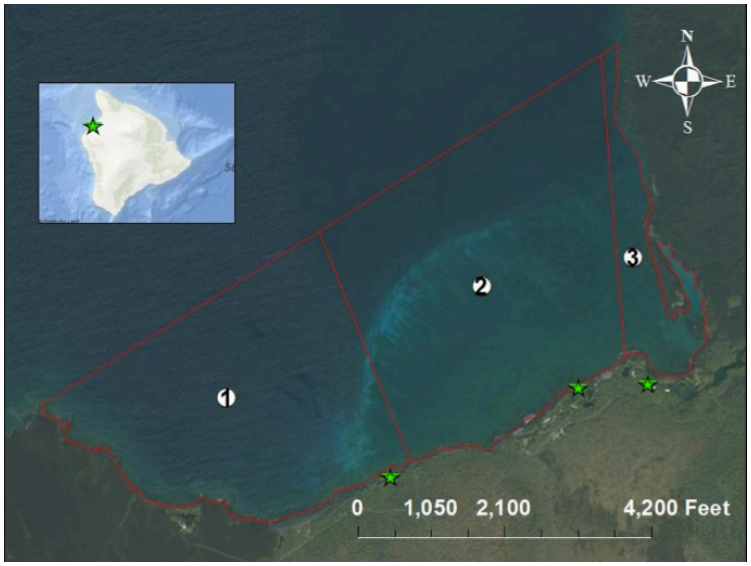
The first instrument we developed consists of 2 components. The *creel*, or *'pakini,'* component uses an observational method to measure spatial and temporal fishing patterns, species, gear types, and (when possible) quantities. Using a high-powered scope and binoculars, community volunteers conducted dawn-to-dusk surveys for 2-3 weekdays and 2-3 weekend days per month (4-6 total man days per month). In other places, volunteers have broken the day into 3 four-hour shifts. We worked collaboratively Alan Friedlander and his team to develop, refine, and implement the pakini survey.

The *fish flow,* or *'mahele,'* component requires that the observer intercept the fishers in order to interview them about their catch information, and location of any recipient(s) of the catch for the day. This latter information, along with GIS technology, is used to create visual representations (maps) of the *reach* of the reef's benefits to the community. Both survey components are compiled into a booklet that contains the observation sheet along with several interview sheets and fish flow sheets (see Appendices B and C for samples). All three communities were trained in the survey instruments in February-March 2012. A brief overview of the status of these surveys follows. Additionally the general creel and fish flow surveys, which were developed collaboratively with Alan Friedlander, CI HFT staff, and community members is attached as Appendices B & C.

Overview of Results from Field Research

Kīholo Bay, Big Island of Hawai'i

Hui Aloha Kīholo, the community-based group that the CI project team has been working with, has been conducting the Creel and Fish Flow surveys since April of 2012. Initially, there were four volunteers helping with the dawn-to-dusk observations and fish flow intercept surveys. As the project evolved, Bart Wilcox was nominated as the primary surveyor. Wilcox has lived and fished in the Kīholo community for his entire life, and is an ideal candidate for his fishing knowledge and rapport with the fishing community in Kīholo. Upon Wilcox's suggestion, the Kīholo Creel/Fish Flow survey efforts were adjusted in late 2012 to begin following a moon cycle, in order to capture a more comprehensive assessment of fishing effort. Ultimately this will yield 2 years of creel and fish flow data, one in a stratified randomized block design, and one following a traditional Hawaiian moon calendar schedule, with 2 of 6 observation days still using a random schedule.



Survey zones for creel/fish flow surveys in Kīholo Bay

Kīholo Creel/Fish Flow At-A-Glance:

- 63 observation days between 4/11/2012 – 2/12/2013
- To date: 218 observations, 1254.25 observed fisher-hours
- 106 fish flow (intercept) surveys (48.6% interception rate)
- 866.5 pounds of catch recorded

A more in-depth analysis of the findings from research at Kīholo can be found in Appendix A, "Coastal resource use and food security in Kīholo."

Wailuku, Maui

Community members from the Wailuku Community Marine Managed Area (CMMA) began collecting data in June of 2012. However, due to shortages and turnover of staff, they focused primarily on collecting observational creel data (no intercepts surveys, which resulted in little catch data or fish flow data). As of March 4th, 2013, Wailuku CMMA hired a new staff member, Alton Wilhelm, to assist with data collection. However, as of the end of our contract, no Fish Flow data (or "intercept" data) has been collected in Wailuku.

Survey zones for creel/fish flow surveys in Wailuku Harbor.

Wailuku Fishing Effort/Flow At-A-Glance:

- 48 observation days between 6/5/2012 – 9/20/2013
- To date: 298 observations, 24.5 recorded fisher-hours (more observed, but not recorded)
- No catch or fish flow (intercept) surveys (as of 3/1/13)

Maunalei, Lānaʻi

As of the end of the contract, Lānaʻi had not yet begun collecting either Fishing Effort or Fish Flow data. A number of setbacks have precluded the beginning of data collection, including shortage of staff and a deliberate community engagement strategy designed to make the project develop from the bottom-up with the support of local fishers. We have worked with the Maunalei Ahupuaʻa Marine & Terrestrial Management Area, the primary community organization that we have worked with and trained on the Creel/Fish Flow instrument. They organized a lawaiʻa ohana fishing camps for young fishers and kūpuna (16-18 November 2012), which we attended and which have been helpful in getting to know the community.

HOUSEHOLD SURVEY ON COMMUNITY WELL-BEING

We also developed a household survey instrument in support of our third—and most challenging—goal for the project, which seeks to quantitatively assess household food security and well-being associated with nearshore fisheries. This survey will be delivered using a more extensive interview format (~1 hour), with a sample purposively selected from self-identified members of the community.

We drew on a growing literature to develop a Hawai'i-specific framework for well-being, which is defined as the following four components: 1) Personal health and wellness, 2) Household economics, 3) Cultural integrity, and 4) Social capital (Figure 4). Our wellbeing framework draws on the components of well-being in the Millennium Ecosystem Assessment (MEA 2005), and Hawaii-specific conceptions of well-being, drawing on Davianna McGregor's work on Native Hawaiian conceptions of wellbeing (McGregor et al. 1998, 2003).

We developed comprehensive literature reviews for each component of well-being, and engaged key partners to help operationalize these components into a survey form to be deployed at the household level in the CI HFT communities. For social capital, for example, we employed a summer intern at the Center for Ocean Solutions, who completed a full literature review on social capital and helped us develop this section of the survey (Appendix F), based on a full accounting of the literature (Appendix G). Similarly, we worked with Kirsten Oleson (Univ. of Hawai'i NREM Dept) and her graduate student Jade Delevaux on refining the survey.

We used the Food and Agriculture Organization's (FAO) definition of *food security* as a basis for defining *"seafood security"* (FAO 2006), and developing metrics for measuring food security at the local level. The FAO's definition posits four dimensions of food security, of which the three primary components comprise: (1) physical availability of sufficient quantities of seafood; (2) economic and physical access to seafood; and (3) consumption or utilization of seafood for basic nutrition and sustenance (Table 1; Figure 4). These three components must also be stable over time, meaning a population, household or individual must have access to adequate food at all times. Stability means that to be food secure, communities should not risk losing access to food as a consequence of sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e.g. seasonal food insecurity). The concept of stability can be thus be characterized an o*verarching* component of food security. Another overarching component of food security include the cultural dimensions of seafood. Cultural dimensions vary by geography, history, and other social factors, but are critically important aspects of fisheries in many coastal communities in Hawai'i and beyond. Our thinking on these concepts is captured in a draft white paper that we developed with CI HFT on "Seafood Security and Sustainability in Hawaiian Communities." (Kittinger and Philibotte, in prep). This draft further defines the concept of seafood security, outlines key drivers of seafood insecurity, and advances metrics for measuring seafood security at the community level, based on a review of the literature and practices used in other geographies.

Table 1. Key components of seafood security. From Kittinger and Philibotte (in prep).

Seafood Security Component	Definition
Physical availability	Physical availability or supply of sufficient quantities of seafood of appropriate quality. Availability is determined by social factors, including domestic production or imports, as determined by the level of seafood production and net trade, and ecological factors, including condition of fisheries resources and habitats.
Economic and physical access	Access by individuals to adequate resources for acquiring seafood for a nutritious diet. Physical access entitlements are defined as the set of rights over which individuals can establish and maintain access given the legal, political, economic and social arrangements of the community in which they live (including traditional rights such as access to common resources). Economic access is affected by incomes, expenditures, markets and prices, and food policy systems.
Consumption and utilization	Sufficient consumption and utilization of seafood through adequate dietary intake, as an important source of protein, essential fatty acids, and micro-nutrients, contributing to a state of nutritional wellbeing where all physiological needs are met. Consumption and utilization is mediated by eating practices, food preparation, diversity of the diet and intra- and inter-household distribution of seafood. Combined with good biological utilization of food consumed, this determines the *nutritional status* of individuals, households, and communities.

Using the white paper as a conceptual basis and a suite of well-being surveys we gathered from various sources, we developed the following conceptual framework and key indicators for dimensions of food security and community well-being.

INDEPENDENT VARIABLES Seafood Security	**DEPENDENT VARIABLES** Components of Social Wellbeing			
1. ***Availability*** (Utilization of resources) 2. ***Access*** to local fisheries 3. ***Utilization*** (Consumption of seafood)	**A) Cultural identity and integrity:** • Cultural integrity (gap score) • Place attach-ment	**B) Social capital and relations:** • Strength of social bonds • Number of social bonds • Social/ political engage-ment	**C) Household economics:** • Sources of income • Income/ occupational diversity • Levels of subsistence	**D) Personal health and wellness:** • Medical conditions • Health status • Exercise/ Dietary habits

A detailed outline of the variables, including the survey questions that will be used to measure each, can be found in Appendices D, E, and F.

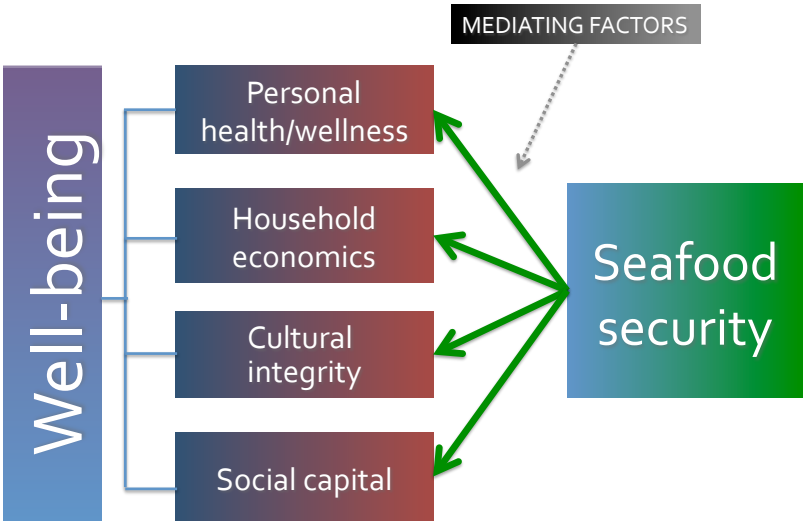


Figure 4. Household Survey Variable Framework, conceptualizing the relationship between components of human wellbeing and local seafood security. Mediating factors such as demographic, socioeconomic, and governance conditions affect the relationship between local food security and community well-being.

Current Status of Household Survey

Hui Aloha Kīholo, the Kīholo community group helping with the Fishing Effort/Flow data collection, has also been highly involved in the development of the Household survey. Although they are eager to begin, progress has been slow as the research team and community leaders are working deliberately to make sure the survey is culturally appropriate for the Kīholo community and generates the right information to inform stewardship efforts at Kīholo. Over the past several months we have been working with Kīholo community members, balancing two primary concerns, which include (1) developing a survey instrument that effectively measures our variables; and (2) developing the survey instrument in a way that engages productively the community members at Kīholo. In recent weeks, we have come to a consensus on many of the questions and are in the process of revising the survey in a way that accommodates both parties.

SYNERGISTIC ACTIVITIES

NSF Grant Proposals: Understanding the role of nearshore marine ecosystems in food security and community wellbeing

We developed two large-scale grant proposals that we submitted to the National Science Foundation's *Coupled Human Natural Systems* and *Coastal SEES* programs in late 2012 and early 2013, respectively. These proposals received positive reviews from NSF, but were not funded. However, the proposals were very beneficial in that the process of developing these proposals allowed us to: (1) put in place a well-equipped interdisciplinary team for science and research in support of CI HFT communities and overarching programmatic goals and objectives on local seafood security in Hawaii; (2) allowed us to summarize the literature and develop our own conceptual framework for measuring local food security and the ecological and social factors affecting seafood security in Hawaiian communities; and (3) allowed us to forge meaningful partnerships with key organizations and community leaders in support of science and research on this topic. We intend to revise these proposals for resubmission, with hopes of future funding success at NSF and beyond.

"*Seafood Security and Sustainability in the Hawaiian Islands*," 21st Annual Hawai'i Conservation Conference: Living Today, Sustaining Tomorrow: Connecting People, Places and Planet, 16-18 July 2013, Honolulu, HI

We also worked with CI HFT to organize a forum and panel at the 2013 Hawaii Conservation Conference, focusing on "*Seafood Security and Sustainability in the Hawaiian Islands."* This panel will review the key factors and current issues surrounding seafood security from hook to mouth, starting with local fishing community members, and ending with a local chef. The goal of this symposium is to generate discussion and awareness of the importance of local fisheries in island food security. We are paired with a related panel on agricultural systems and food security, and are working with HCC organizers on an inclusive pau hana event to engage key community members on seafood security in Hawai'i.

CONCLUSIONS & NEXT STEPS

As we conclude a year of collaborative research and participatory community engagement, we look forward to continuing this research with CI HFT and its partners. Each site has unique opportunities and challenges that will need to be taken into consideration in the continuing future. Next steps will vary by site and are outlined as follows:

Kīholo Bay, Big Island of Hawai`i

Hui Aloha Kīholo has been the most involved and enthusiastic of all three communities since the commencement of the project. Data collection for the Creel and Fish Flow components is ongoing and will continue until the project is complete. We conducted a preliminary analysis of data and have worked up a more complete analysis (see Appendix A). We look forward to finalizing the Year 1 analysis, working with Alan Friedlander's team to supply information in support of the July Lawai'a Ohana camp at Kīholo, and for a science publication to follow thereafter. Hui Aloha Kīholo is particularly interested in telling the *story* of their beloved bay, in the hopes that it will inspire a younger generation of stewards. For this reason, they are eager to begin the Household surveys in order to coalesce the knowledge of Kīholo's kūpuna and fishers.

Wailuku, Maui

Wailuku CMMA is planning on beginning Fish Flow surveys in June of 2013, building off recent efforts to implement the creel survey. Based on how their surveyor is received by the fishing community there, we plan on also implementing the Household survey soon thereafter; however, currently the focus is getting capacity at the local level to successfully collect creel and fish flow data. This urbanized site presents some challenges, and as the Wailuku CMMA organization grows, so too will the capacity to engage in research activities to support their stewardship program.

Maunalei, Lāna'i

Maunalei Ahupua`a Marine and Terrestrial Managed Area continues to seek a staff person to carry out the survey efforts, but heretofore has been focused on permaculture issues in the adjacent watershed, which has been successful. They have been unable to staff the creel/fish flow efforts since the purchase of Lāna'i, which has affected the labor market on the island. However, we will continue to work with and learn from them going forward.

APPENDICES

a. Coastal resource use and food security in Kīholo (includes results of Creel/Fish Flow surveys and Fish Flow maps)
b. Creel Observational and Intercept Survey
c. Fish Flow Survey
d. Household Survey on Community Food Security & WellBeing
e. Cultural Integrity Gap Score Analysis
f. Social Network Analysis: Background and Survey Instrument
g. Annotated Bibliography on Social Network Analysis

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