HUMAN DIMENSIONS OF THE CCIEA

A SUMMARY OF CONCEPTS, METHODS, INDICATORS, AND ASSESSMENTS

Sara Breslow[1], Dan Holland[1], Phil Levin[1], Karma Norman[1], Melissa Poe[1,4], Cindy Thomson[2], Raz Barnea[3], Penny Dalton[4], Nives Dolsak[3], Correigh Greene[1], Kristin Hoelting[5], Stephen Kasperski[6], Rosemary Kosaka[2], Daniel Ladd[7], Aaron Mamula[2] , Stacey Miller[1,] Brit Sojka[4], Cameron Speir[2], Scott Steinbeck[8], and Nick Tolimieri[1]

1. NOAA Fisheries, Northwest Fisheries Science Center
2. NOAA Fisheries, Southwest Fisheries Science Center
3. University of Washington
4. Washington Sea Grant
5. Colorado State University
6. NOAA Fisheries, Alaska Fisheries Science Center
7. University of California, Santa Clara
8. NOAA Fisheries, Northeast Fisheries Science Center

TABLE OF CONTENTS

Overview 4
Executive Summary 4
Detailed Report 6
Introduction: Integrating Human Dimensions into the CCIEA 6
What are "Human Dimensions" and "Human Wellbeing"? 6
What is "Social" in the Socio-Ecological System? 6
Human Wellbeing Connections to Focal Ecological Components 8
Groundfish 8
Marine mammals 9
Seabirds 10
Forage fish 10
Salmon 11
Habitat 12
Conceptual Approaches 12
Cultural Dimensions of Socio-Ecological Systems 13
Economic Frameworks 15
Social Indicators and Human Wellbeing: Concepts and Methods 17
Political Ecology: A Holistic Approach to Socio-Ecological Analysis 22
Social Indicators and Assessments 23
Community Vulnerability Assessments 23
Fishing Diversification 28
Personal Use: Subsistence and Informal Economic Practices Among Commercial Fisheries 31
Effects of Water Supply on Labor Demand and Agricultural Production in California's San Joaquin Valley 34
2012 National Ocean Recreation Expenditure Survey 35
References 36

LIST OF TABLES AND FIGURES

Table HD 1. SWIMM Working group members. 19

Table HD 2. Governmental legislation and policy reviewed for attributes of human wellbeing (n=21) 19

Table HD 3. Applied socio-ecological projects reviewed for attributes of human wellbeing, candidate indicators, and best practices (n=52) 20

Table HD 4. Factor loading results for each of the sociodemographic vulnerability indices 26

Figure HD 1. Conceptual model of the California Current socio-ecological system 8

Figure HD 2. Cultural dimensions of socioecological systems model: key aspects and attributes 14

Figure HD 3. Proposed approach to identifying indicators of human wellbeing for EBM. 19

Figure HD 4. The Wheel of Wellbeing: SWIMM's conceptual model of human wellbeing (in progress). 19

Figure HD 5. Percentage of reviewed US governmental documents and socio-ecological indicator projects that mention each wellbeing attribute (presence/absence). 21

Figure HD6. Selected California Current coastal communities compared relative to one another sociodemographically 21

Figure HD7. Selected California Current coastal communities compared relative to one another on fisheries indices 21

Figure HD8. Trends in average diversification for US West Coast and Alaskan fishing vessels (left panel) and the 2012 West Coast fleets by state (right panel) 21

Figure HD9. Trends in diversification for selected primary West Coast ports in Washington, Oregon, and California. 30

Figure HD10. Catch retained for personal use from 1990-2010 in tons (2000 lbs) 32

Figure HD11. Annual personal catch by species in tons (2000 lbs) for WA tribal fishers, WA non-tribal fishers and CA non-tribal fishers from 1990-2010. 33

OVERVIEW

A conceptual model of the California Current Large Marine Ecosystem (CCLME) socio-ecological system highlights the "social" within the socio-ecological system and demonstrates that any particular management strategy can affect human wellbeing through at least two major pathways: through alterations in environmental conditions, which in turn affect human wellbeing, and through direct effects on human wellbeing. In addition to broad conceptualizations of the coast-wide system in both natural and social terms, and discussions of relevant social science approaches and frameworks, we include 5 major indicator efforts within the CCLME. These indicators cover levels of human coastal community vulnerability, vessel- and port-level fisheries diversification trends and effects, "personal use" of fisheries as a preliminary proxy for possible subsistence practices among commercial operators, the relationship between water supply and agricultural production in Central California, and a survey of marine-oriented recreational expenditures.

EXECUTIVE SUMMARY

In this chapter, we focus on the "human dimensions" of the California Current's coupled socio-ecological systems. Human dimensions include archaeological and historic heritage, contemporary demographic patterns such as population growth and migration, individual and community behaviors, cultural values and cultural trends, social relationships and social movements, political and economic systems, institutions and governance, and perhaps most importantly in this context, the many ways that humans are connected to the environment. This chapter also serves to introduce research relative to human wellbeing and, accordingly, the "social" in the socio-ecological system of the California Current.

Human wellbeing is linked to the California Current, as a large marine ecosystem, in a variety of ways. We provide brief synopses of the multiple and diverse human connections of several focal ecological components to human wellbeing published in social science literatures. Focal components included here are: groundfish, marine mammals, seabirds, forage fish, salmon, and habitat.

Prior to describing our relevant indicators, we include discussions of social science approaches to some of the human dimensions of the California Current Large Marine Ecosystem (CCLME). These approaches include frameworks aimed at capturing some the cultural connections to the CCLME, economic frameworks, social indicators and human well-being frameworks, and political ecology as a holistic approach to human-environment interactions.

In terms of CCLME human dimensions indicators, community vulnerability indices highlight both sociodemographic vulnerability and marine and fisheries-specific vulnerabilities at the community-level. Economic data at the vessel and port level provide an indicator of economic diversification, which in turn demonstrates that fisheries income variability is reduced on average if individuals diversify their income by participating in several different fisheries, though diversification in general is in decline. A personal use indicator provides information on port location and species of interest for subsistence and non-commercial harvests among commercial operators. Notably, an inland CCLME-relevant human dimensions indicator for central California is provided by research on inland agricultural activity and water use. This research indicates that reduced irrigation water supply reduces the demand for farm labor and the production of some crops over the course of a 31-year study period, and that labor demand and crop output may have become more sensitive to changes in water supply. Lastly, data from a recently completed survey will be used in estimates of West Coast consumptive and non-consumptive ocean recreational activities.

The indicators described toward the close of this section are based on available data collected and organized by the Northwest and Southwest Fisheries Science Centers, along with their research partners, and reflect the analytical work currently underway within the human dimensions and economics programs at these science centers. Many of the datasets used in developing these indicators are updated annually and therefore offer time series analysis possibilities within future iterations of the IEA. Finally, the described work of the Social Wellbeing Indicators for Marine Management (SWIMM) project is organized around developing a more refined definition of "human wellbeing" and, accordingly, improving upon and re-evaluating relevant social indicators.

INTRODUCTION: INTEGRATING HUMAN DIMENSIONS INTO THE CCIEA

WHAT ARE "HUMAN DIMENSIONS" AND "HUMAN WELLBEING"?

"Human dimensions" refer to all aspects of human life across time and space, including demography, behavior, cultural values, social relationships, political and economic systems, institutions and governance. In this chapter, we focus on the "human dimensions" of the California Current's coupled socio-ecological systems. A variety of social science disciplines are used to study these different aspects of the human condition, such as anthropology, economics, sociology, political science, psychology, and geography. The contributing authors offer only a subset of social science perspectives on the human dimensions of the CCIEA.

In this chapter we discuss the concept of "human wellbeing." Human wellbeing gained prominence as an area of interest in environmental science, policy, and management via the 2005 Millenium Ecosystem Assessment (MA) and the ecosystem services frameworks. Here, we generally use "human wellbeing" to mean happiness, health, and quality of life, both for individuals and communities. A working group of social scientists advising the Social Wellbeing Indicators for Marine Management (SWIMM) project (described in a section below) developed a more refined definition of "human wellbeing" that draws from multiple literatures and is intended to clarify its meaning in the context of ecosystem-based management:

> *Human wellbeing is a state of being with others and the environment, which arises where human needs are met, where individuals and communities can act meaningfully to pursue their goals, and where individuals and communities can enjoy a satisfactory quality of life.*

WHAT IS "SOCIAL" IN THE SOCIO-ECOLOGICAL SYSTEM?

A socio-ecological systems approach is a holistic view of interacting ecological and social phenomena in their environments, which create important functional connections across spatial and temporal scales (Berkes 2011). The diagram of the CCIEA socio-ecological system illustrates how human wellbeing is related to the marine, coastal, and associated upland environments (Fig. HD1). These relations are dependent on qualities of both the biophysical environment and the human social system. Like the natural environment, human society comprises multiple interrelated components and forces. Human wellbeing in general – including even those aspects related to environmental conditions – is always mediated by broad social forces, local social systems, and human activities.

Broad social forces – such as population growth and settlement patterns, national and global economic and political systems, historical legacies, dominant cultural values, and class systems – constrain or enable local social systems and human activities in ways

that directly or indirectly affect human wellbeing. Likewise, local social systems that vary geographically and across different social groups – such as state and local laws and policies, regional economies, local institutions and social networks, local social hierarchies, diverse cultural values and norms, the built environment, and other particularities – affect human wellbeing directly or indirectly, and constrain or enable human activities related to the natural environment. Such human activities might include, for example, fishing, farming, mining, recreation, environmental research, education, activism, restoration, and resource management. Such activities generate benefits for humans, and they are also how humans affect the natural environment, in this sense often called pressures. However, the ways in which these activities, benefits, and pressures directly or indirectly affect human wellbeing and its myriad dimensions (Fig. HD1) depend on the social attributes and contexts of the humans in question – i.e. the broad social forces and local social systems in which they are embedded.

For example, in order to enjoy the nutritional and cultural wellbeing that comes with harvesting and eating Dungeness crab, a Washington State resident must be able to access the crab fishery, know how to harvest and cook crab, and possess positive cultural values toward harvesting and eating crab, among other qualities. These requirements are mediated through particular governmental, economic, social, and cultural conditions such as state fishing regulations, the affordability of fishing, an accessible launch site, and community-based cultural practices, as well as through environmental conditions such as the quality and availability of crabs themselves. Similarly, human wellbeing derived from working as crew on a trawler, watching seabirds, kayaking, conducting oceanographic research, or any other environment-related activity will be mediated by a complex matrix of social conditions, connections and capabilities.

The Integrated Ecosystem Assessment (IEA) is a tool to track the condition of the ecosystem (including people) under changing environmental conditions and management strategies. There are multiple and interrelated social and natural factors that can affect human wellbeing. Note that with respect to environmental policy and management specifically, any particular strategy can affect human wellbeing through at least two major pathways: 1) policy and management can affect environmental conditions, which in turn affect human wellbeing; and 2) policy and management can directly affect human wellbeing, such as through the nature of the political process, and how management actions affect people's access to resources. The environmental social sciences devote considerable attention to the latter pathway, i.e. how conservation and resource management directly affect people, because this can significantly affect major areas of wellbeing such as sense of control and certainty, social relationships, livelihoods, and equity. It is important to attend to both of these and other pathways to wellbeing – and not only to the connection between the natural environment and wellbeing – in order to

understand the social dynamics and consequences of environmental policy and management.

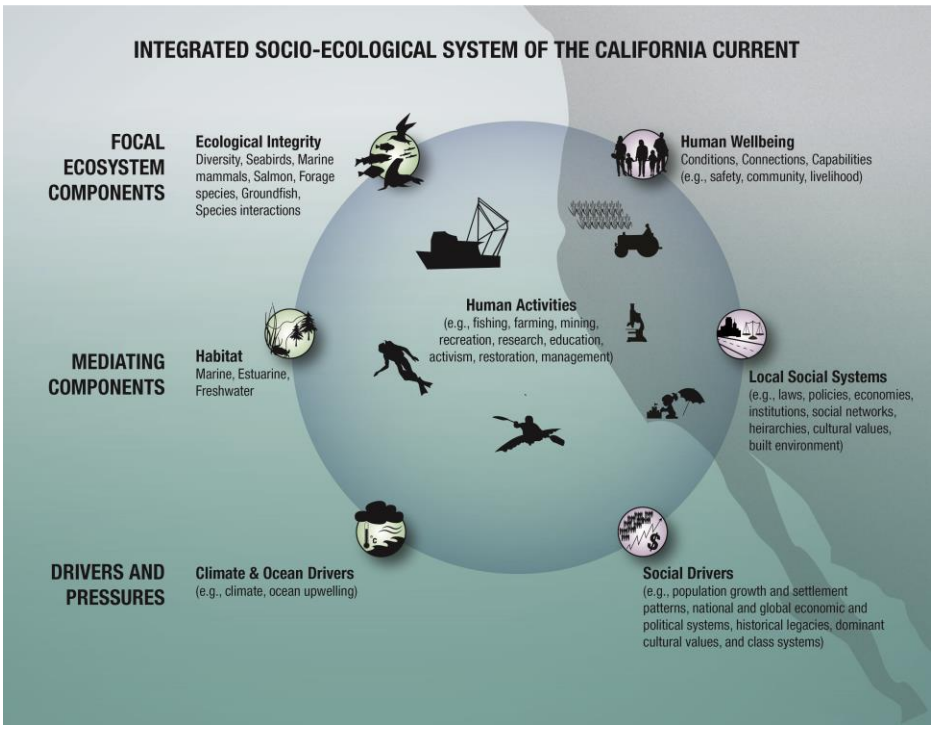


Figure HD1. Conceptual model of the California Current socio-ecological system.

HUMAN WELLBEING CONNECTIONS TO FOCAL ECOLOGICAL COMPONENTS

Each ecological component of the socio-ecological system contributes to human wellbeing in multiple ways. Previous phases of the California Current IEA captured many of the commercial benefits of some focal ecological components (e.g. salmon and groundfish). In this section, we provide brief synopses of the multiple and diverse human connections of each focal ecological component to human wellbeing published in social science literatures. Focal components included here are: groundfish, marine mammals, seabirds, forage fish, salmon, and habitat.

GROUNDFISH

Groundfish are linked with human wellbeing in a number of ways. They provide food for domestic consumption and export, and support a diverse commercial fishery that encompasses the length of the Pacific Coast and involves many species and gear types. Groundfish are also important species for recreational and subsistence fishing. Groundfish

activities contribute to job satisfaction, "quality of life", local ecological knowledge, and also play a role in building community capacity, for example through fishing cooperatives, risk pools, gear innovation, education, and training. Groundfish regulations have affected the spatial distribution as well as volume of groundfish activity, with associated effects on human wellbeing. To rebuild overfished rockfish stocks, the Total Allowable Catch (TAC) in groundfish fisheries has been reduced for both rebuilding and targeted stocks. Other management changes to groundfish fisheries include area closures and gear restrictions to reduce bycatch, heightened monitoring (observer programs, electronic vessel monitoring systems) and – for the trawl sector – an industry-funded buyback, prohibition of bottom trawling in Essential Fish Habitat, and a catch share program that enhances individual accountability for reducing bycatch and individual flexibility to harvest target species. Groundfish fisheries also face issues in common with other fisheries (e.g., graying of the fleet, aging port infrastructure). Groundfish species also indirectly affect human wellbeing through ecological interactions (e.g. as predators, competitors or prey) with culturally and economically important marine species (e.g. forage fish, salmon, seabirds, and marine mammals). Community involvement in restoration (e.g. derelict fishing gear clean-up) and conservation (marine protected areas, or MPAs) also contributes to emerging social networks, and increase engagement with decision-making.

MARINE MAMMALS

Marine mammals have social, cultural, economic, and value to humans. Some marine mammals contribute to sense of place and serve as place-based icons in coastal areas. Marine mammals such as sea otters, pinnipeds and whales are culturally important to many coastal communities' way of life, including as subsistence resources for indigenous communities. Interactions with marine mammals occur at aquaria, zoos, and at sea where marine mammals can be experienced in their natural environment. These activities contribute to employment and income in coastal economies, as well support opportunities for marine science education. Marine mammal education and conservation activities can function to increase public knowledge and build communities with shared values. Several studies document willingness to pay (WTP) for marine mammal viewing and existence. In some cases, marine mammals have led to decreases in human wellbeing through competition and trophic interactions with fisheries, gear and property damage, and loss of catch in commercial and recreational fisheries, and predation on species of concern (e.g. listed salmonids). A wide range of human activities (e.g., fisheries, tourism, shipping, military sonar, seismic surveys associated with offshore oil and gas exploration) is regulated to reduce injury or mortality to marine mammals.

SEABIRDS

Seabirds have social, cultural, and economic value to humans. Some seabirds contribute to sense of place and serve as place-based icons in coastal areas. Interactions with seabirds occur at aquaria, zoos, and in their natural environment along coastal areas or at sea. These activities often contribute to employment and income in coastal economies, as well support opportunities for marine science education. Seabird education and conservation activities can function to increase public knowledge and build communities with shared values. To the north of the California Current, in Canada and Alaska, seabird eggs are harvested for subsistence by some indigenous communities, a practice tied to traditional ecological knowledge. Some migratory birds found seasonally in the California Current are harvested elsewhere on their migratory circuit (e.g. shearwaters by Maori communities). Seabirds can be effective indicators of the condition and health of marine systems, pollution levels, fish stock health and management, contaminants, and climate variability. In some cases, seabirds can influence human wellbeing negatively through competition for resources and trophic interactions with fisheries (in particular, predation on Pacific salmon in the Columbia River basin). Some human activities (e.g., fisheries, tourism) are regulated to reduce injury or mortality to seabirds.

FORAGE FISH

Northern anchovy, Pacific sardine, Pacific herring, and other forage fish have social, cultural, and economic value to humans. Northern anchovy was the second fish species to come under management in the United States. Northern anchovy and Pacific sardine support recreational, subsistence, and live-bait fisheries, and are especially important in the Southern areas of the California Current. Forage fish commercial activities spur many off-the-dock socioeconomic benefits (e.g., supporting local processing, transport and storage industries; creating jobs; and shaping how families structure their time throughout the year). Additionally, the skills, job satisfaction and professional identity of forage fisheries contribute to human wellbeing. Forage fish also contribute to sense of place in some coastal areas where these species have played important roles in shaping community economies and heritage (e.g. “Cannery Row” named for the sardine canning factories in Monterey, California). Forage fish, so-called for their importance as lower trophic level food to higher trophic level species, also have indirect social values owing to their role as food for iconic species such as salmon, seabirds, and marine mammals, which people also value. In addition to food for human consumption, anchovy and sardine are also processed as feed for commercial aquaculture and livestock.

Less commercially important species of forage fish contribute to wellbeing through their role as subsistence food for diverse communities along the Pacific Coast, and as traditional and ceremonial foods for indigenous communities. For example, Pacific herring

is a culturally important forage fish for Northern Pacific Coast indigenous communities, particularly in the Northern Salish Sea and Vancouver Island areas. The whole fish and its eggs (e.g. roe on kelp) are used. Herring figures prominently in the origin stories and oral histories of Northern coastal cultural groups. Knowledge about harvesting techniques, locations and processing comprises part of the cultural legacy of these forage fishes' importance to coastal communities. Systems of rights, ownership, and harvesting patterns have been in place to maintain sustainable traditional harvests. Similarly, eulachon –also referred to as "ooligan"– has historically been used by many Pacific Northwest coastal indigenous communities as food, medicine, material, and trade. The nutritional content of eulachon is high in vitamins A, E, K and fatty acids, as well as calcium, iron and zinc. Eulachon has declined dramatically in the Pacific; the Southern population is listed as a threatened species under the ESA.

SALMON

Salmon play a central role in the social organization, diet, culture, ceremonial and spiritual practice, cultural identity, and economy of coastal indigenous communities of the California Current. Salmon are also important to non-indigenous residents of the larger region as food, regional identity, and an important economic resource. Historically, fluctuating seasonal runs of salmon helped determine the location of Native American villages, where sophisticated salmon harvesting, drying, and storage technologies developed, coupled with complex and cooperative resource ownership and access systems. Contemporarily, wild and hatchery salmon remain an integral part of the fishing economy, and are used for commercial and recreational fisheries and subsistence food throughout the California Current. Marine mammals that people value also prey on salmon; for example, Chinook salmon is a primary prey species for Southern resident killer whales, a culturally iconic marine mammal. Public awareness and concern for salmon protection and recovery (largely owing to reduction in salmon populations resulting from hydropower production, farming, ranching, fishing, logging, and municipal and industrial water use and supporting infrastructure (e.g., dams, water storage and transport systems, hatcheries, among other activities and pressures)) has grown. The growth in concern and awareness is reflected in participation in river restoration, educational programs, and stewardship organizations. Conflicts among competing uses are exacerbated when habitat conditions are particularly limiting (e.g., the current California drought). A large research establishment conducts research relevant to the understanding, management and improvement of salmon fisheries and other natural resources that are socio-ecologically linked to salmon and their habitat, such as agriculture and forestry. The complex challenge of salmon recovery has required new forms of social organization and cooperation, and has also engendered passionate debates among diverse communities in the region who are

grappling with how to ensure that salmon, fishing, and other resource-based livelihoods can survive in an increasingly globalized economy and urbanizing landscape.

HABITAT

Habitats provide the matrix through which ecosystem interactions occur. Human wellbeing is therefore influenced directly and indirectly both by the habitats and the organisms they influence, as well as by their general characteristics that contribute to senses of place (rocky shorelines, intertidal biodiversity, sandy beaches, tide flats, the open ocean, etc.). People benefit from habitat directly and indirectly from the fisheries they support, as well as aesthetic, recreational, cultural, spiritual, and scientific reasons. The CCIEA focuses on four major habitat types: freshwater, estuarine/nearshore, pelagic, and seafloor. Freshwater habitats are crucial not only for their role in provisioning a diversity of species important to human wellbeing (e.g. fish, marine mammals, seabirds), but also for supporting a wide range of benefits to people, including water supply, land for agriculture or development, transportation, recreation, energy generation, cultural resources, and commercial and sport fisheries. Estuary and nearshore habitat directly and indirectly support fisheries and aquaculture, and they also provide a number of other benefits to people as sites for transportation, alternative energy infrastructure, waste disposal and water diversions, and recreation. In the pelagic realm, fisheries and transport are the primary human benefits. Seafloor habitats support important fisheries, providing food, income and recreation for numerous individuals and coastal economies. As well, seafloor habitats are sites for important human activities—undersea cables, oil and gas exploration and infrastructure– to name a few. Habitat is often the focus of management efforts because natural resources are generally associated with specific types of habitat (e.g., designations of essential fish habitat or critical habitat). Conservation or restoration efforts for many species is often directed to necessary habitats needed to support specific life-history stages and is thus a critical component of ecosystem assessments.

CONCEPTUAL APPROACHES

A primary challenge in accounting for human dimensions in the CCIEA is that we often lack conceptual and methodological precedents for integrating the social sciences into environmental science frameworks such as the IEA approach. To meet this challenge, we have worked with our natural science colleagues to redraw the CCIEA's overall socio-ecological system conceptual model in order to better account for the complexity of human dimensions. Some aspects of human dimensions are more suited to quantitative approaches than others, and thus, we suggest making a place in IEAs for qualitative

approaches that may be most effective at shedding light on historical, cultural, and political contexts underlying peoples' experiences and values of ecological systems.

A second major challenge to integrating human dimensions into the IEA is that social data are not necessarily already available on the topics or at the resolution necessary to answer questions about the social effects of marine conditions and management strategies. There is a critical need for additional research to produce new, diverse kinds of social science information to inform ecosystem-based management.

In the following section we illustrate a number of diverse potential conceptual approaches for integrating human dimensions into the CCIEA. This is followed by a section summarizing CCIEA-specific social indicators and other types of assessments that have been produced through a number of these approaches. Together these results provide a multifaceted, though still admittedly incomplete, picture of the human dimensions of the California Current.

CULTURAL DIMENSIONS OF SOCIO-ECOLOGICAL SYSTEMS

(author: Melissa Poe, NWFSC)

Environments are complex socio-ecological systems demanding interdisciplinary research and conservation. Despite significant progress in characterizing socio-ecological complexity, cultural values and their importance to conservation remain poorly understood and inadequately accounted for in ecosystem-based management (EBM). In a recent review, Poe et al. (2014) synthesized existing social sciences to build an approach for better integrating cultural dimensions into coastal conservation. They used a focus on cultural dimensions to help identify important interactions between coastal resources and social groups, and as a means to improve socio-ecological analyses and management. Using examples from coastal ecosystems in North America, Poe et al. (2014) described cultural dimensions of a socio-ecological systems model to illustrate five key interrelated cultural aspects: (1) meanings, values, and identities; (2) knowledge and practice; (3) governance and access; (4) livelihoods; and (5) cultural interactions with biophysical environments (see Figure HD2).

It is important to consider cultural dimensions in conservation because implementation of integrated conservation programs without consideration of sociocultural dimensions provides only part of the ecosystem picture (Poe et al. 2014). Coastal environments are fundamental to the sociocultural wellbeing of people and contribute to people's sense of place, wellbeing, relationships, and community resilience. Thus, failure to consider cultural dimensions risks creating or reproducing social inequalities, diminishing community resilience, and stripping away mitigating processes (e.g., customary tenure, social norms, and knowledge systems). Moreover, omitting

important cultural dimensions may create conflict, reduce trust, and hinder collaborative management. Conversely, including sociocultural dimensions in conservation may increase buy-in, reduce conflict and costs associated with negotiation, and yield better alternatives that address concerns of those most affected by environmental and institutional changes. Including meaningful sociocultural components in conservation also fulfills a number of government directives to which natural resource agencies are bound.

Meanings, Values, and Identities

- Define a person or community and constitute a 'way of life'
- Attributed to objects, places, relationships, practices, and processes
- Enlivened through language, relationships, and practices
- Develop through ecosystem interactions
- Form and informed by 'cultural models'
- Dynamic, heterogenous, changing over time and space

Local Ecological Knowledge and Practice

- Cumulative knowledge of the environment and its social and spatial conditions
- Embedded within sociocultural processes
- Continually regenerated through practical engagements with ecosystems

Livelihood Dynamics

- Formal and informal economic activities
- Noncommercial harvests for household use or exchange
- Linked to culture, knowledge, social relations, and traditions
- Job satisfaction, quality of life, and occupational and place identities

Governance and Access

- Mechanisms of control, rules of access, decision-making processes
- Tied to philosophies, norms, relationships, and knowledge systems
- Varied dynamics across spatial and organizational scales
- Entangled with political issues of power and inequalities

Bio-cultural Interactions

- Varied food web effects on sociocultural phenomena
- Cultural keystones species play fundamental roles in social systems and cultural identity
- Culturally-based restoration and management creates 'bio-cultural landscapes'
- Changing enviroments impact cultural connections to ecosystems and cultural wellbeing

Figure HD2. Cultural dimensions of socioecological systems model: key aspects and attributes

Poe et al. (2014) conclude their review by suggesting a set of guiding principles for conservation scientists and practitioners working across socio-ecological systems. These principles are: (1) Recognize the diverse cultural meanings and values embedded in human-environment interactions; (2) Protect access to resources, spaces, and processes upon which cultural wellbeing depends; (3) Involve communities who have cultural

connections to ecosystems in science and management at all stages (from problem framing to assessment, to identifying and implementing solutions, to monitoring); (4) Allow for cross-scale and nested linkages when assessing and managing cultural dimensions of ecosystems; and (5) Recognize the integrated and coupled nature of sociocultural wellbeing and ecosystem health, and design conservation approaches appropriately. Joining sociocultural with ecological and economic considerations of complex socio-ecological systems can be challenging, but is necessary to manage and protect environments for human wellbeing, ecosystem integrity, and viable economies.

ECONOMIC FRAMEWORKS

(author: Dan Holland, NWFSC)

As noted by Lipton et al. (1995, p. 10), the "fundamental distinction between the way economics and other disciplines such as ecology use the term 'value' is the economic emphasis on human preferences." Economics as a discipline is anthropocentric, focusing on human behavior and wellbeing. As such, economic assessments provide a natural complement to ecological perspectives on ecosystem health and function that emphasizes functioning of natural systems and how they are impacted by humans (Holland et al. 2009). Economic analyses can assess tradeoffs between ecosystem protection and associated changes on one or more human activities—in terms of the overall impact on long-run social wellbeing.

Benefits derived from ecosystem services can be direct (e.g., beach use, commercial fish catch), or indirect (e.g., the contribution of submerged aquatic vegetation to the production of fish harvested elsewhere). Services may be traded in traditional markets with observable market prices and values (e.g., commercial fish harvest, electricity from offshore wind turbines), or may be available outside of traditional markets (e.g., recreational fishing, bird watching, coastal viewsheds). People also value things they do not use (non-use values) and may never see – e.g., the continued existence of deep water corals or an endangered seabird. Although economics is often accused of overemphasizing market activities and associated benefits, appropriate economic analysis should provide equal consideration to all short- and long-term sources of human benefit, regardless of their relationships to organized markets. There are a variety of methods that use observations of peoples' activities and choices (revealed preference methods) or surveys (stated preference methods) to determine the value people derive from ecosystem services that are not bought and sold in organized markets (including non-use values).

There are a variety of analytical frameworks used to integrate economic insight into management considerations. One common means of providing economic insight, denoted cost benefit analysis (CBA), involves either comprehensive or partial assessments of the

long-term economic benefits and costs of projects or policies. Multi-attribute utility theory, or MAUT, is a cousin of CBA, in that it is designed to allow assessment policies such as EBM in which multiple attributes are affected. Like CBA, MAUT attempts to estimate a single cardinal "value" whereby policies may be ranked. However, unlike CBA, the "weights" or relative importance given to each policy attribute are not determined by economic value or willingness to pay (WTP) of affected households or individuals but are defined by decision makers, policy experts, or analysts.

In some cases the information necessary to determine the benefits of alternative actions or policies is unavailable but there is still a need to achieve a specified outcome efficiently. Cost-effectiveness analysis (CEA) can help determine the most efficient means of achieving specified management goals in cases where these goals are predetermined by legislation, prior consensus, or other means. CEA can also provide insight on the costs of obtaining various management outcomes.

Yet another economic approach sometimes used to inform management is regional economic modeling, or economic impact analysis (EIA). Unlike CBA or CEA, economic impact analysis measures changes in economic activity or indicators (e.g., regional income, gross value of landings, workers employed, gross expenditures, multipliers) related to monetary flows between economic sectors. In simple terms, EIA tracks monetary payments as they move through a regional economy — measuring the transfer of money from one sector to another. These flows provide insight into the raw quantity of economic activity within a given region and are often of interest to policy makers, but they do not measure changes in economic benefits or costs. A classic illustration of this would be measuring the economic impact of an oil spill with an EIA. Economic activity associated with clean-up activities could easily exceed the economic activity impeded by the oil spill in the short-run but the long-run costs of the oil spill in terms of loss of ecosystem services could be substantial. Of course we would never consider deliberately causing an oil spill to create jobs and income, but this example illustrates that an EIA might suggest that the spill would have positive economic impacts when a CBA would clearly show that human welfare was diminished.

At this time, the Human Dimensions chapter of the IEA and associated analyses do not undertake a comprehensive economic analysis of the net benefits humans derive from the California Current ecosystem or the impacts of human activities and policies on those benefits. Economics is arguably less useful for determining the overall benefits associated with an ecosystem than it is in evaluating how specific types of benefits change over time, or might change as a result of a policy or management action or some external driver such as climate change or an economic shock. At present we provide only a few indicators of economic benefits, such as time series of fishery revenues by community or fishery and metrics such as the fishery income diversification index, which is an indicator of financial

risk for the fishing industry (see below, "Fishing Diversification," and Appendix for details). In the future, additional analyses may be added to quantify and track various types of benefits, but this will likely remain a limited set of analyses targeting specific ecosystem services and economic indicators rather than a comprehensive assessment of benefits derived from the California Current ecosystem.

SOCIAL INDICATORS AND HUMAN WELLBEING: CONCEPTS AND METHODS

(authors: Sara Breslow, Melissa Poe, Karma Norman, Phil Levin, NWFSC; Nives Dolsak, Brit Sojka, Raz Barnea, University of Washington; Penny Dalton, Washington Sea Grant)

The Social Wellbeing Indicators for Marine Management (SWIMM) project is a two-year effort supported by the NWFSC, Washington Sea Grant, and the University of Washington to improve understanding of the human dimensions of ecosystem-based management (EBM). The primary objective is to develop a suite of indicators of human wellbeing for use in NOAA's Integrated Ecosystem Assessment (IEA) of the California Current. The broader objective is to develop a generalizable social science protocol for assessing human wellbeing that can be used in other socio-ecological assessments, such as marine spatial planning and social impact assessment, in other regions of the US, and beyond.

With these multiple expectations, SWIMM aims to develop indicators of human wellbeing that: (1) integrate with the biophysical indicators that have already been developed for the CCIEA; (2) serve the needs of federal marine managers and other environmental decision-makers; (3) resonate with a broad diversity of people on the US West Coast; and (4) can be modified for other contexts. Given its scope, SWIMM is informed by local to international sources.

The overall SWIMM approach is modeled after the first two steps – scoping and indicator selection – of the process developed for other IEA indicators (Levin et al. 2009), with modifications based on insights from the social sciences and local stakeholders (Fig. HD3). Theoretical and methodological guidance is provided by an 18-member working group of interdisciplinary and international environmental social scientists who represent a broad range of applied expertise in environmental governance, human wellbeing, social impact assessment, indicator development, ecosystem services valuation, and related fields (

Table HD1). We have developed a conceptual model of human wellbeing (Fig. HD4) for the purposes of ecosystem-based management (EBM) by comparing and compiling priorities for wellbeing found in US Federal environmental policy and legislation, to serve managers' direct needs (Table HD2), and those found in existing socio-ecological indicator projects around the world, to ensure a well-rounded and generalizable definition of

wellbeing (Table HD3). Finally, as a pilot study, we are seeking guidance on local issues, concerns, and definitions of wellbeing, specifically with respect to marine conditions and management, from conversations with stakeholders on the outer coast of Washington State (scoped for August 2014).

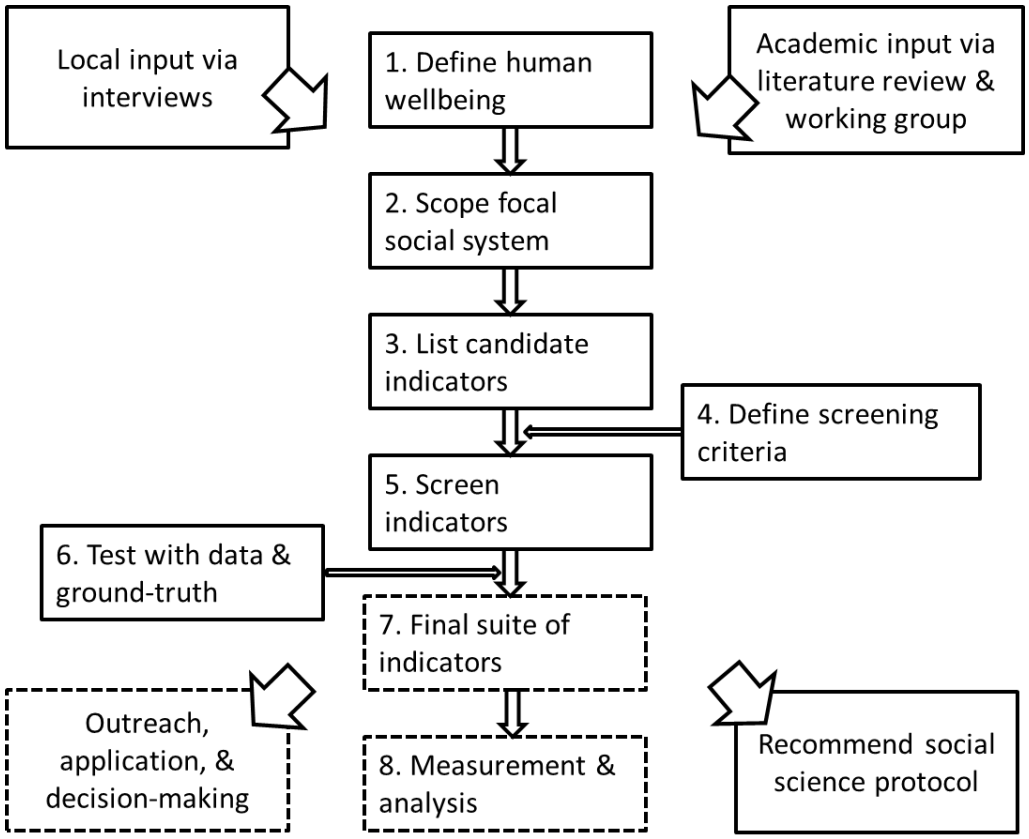


Figure HD3. Proposed approach to identifying indicators of human wellbeing for EBM. Dotted lines represent steps outside the scope of SWIMM.

Table HD1. SWIMM working group members.

Arun Agrawal, University of Michigan
Xavier Basurto, Duke University
Sara Breslow, NRC/NOAA
Courtney Carothers, University of Alaska
Susan Charnley, USFS, Portland
Sarah Coulthard, Northumbria University
Nives Dolsak, University of Washington
Jamie Donatuto, Swinomish Tribe
Carlos Garcia-Quijano, University of Rhode Island
Christina Hicks, Center for Ocean Solutions
Phil Levin, NOAA
Arielle Levine, San Diego State University
Michael Mascia, Conservation International
Karma Norman, NOAA
Melissa Poe, NOAA/Washington Sea Grant
Terre Satterfield, University of British Columbia
Kevin St. Martin, Rutgers University

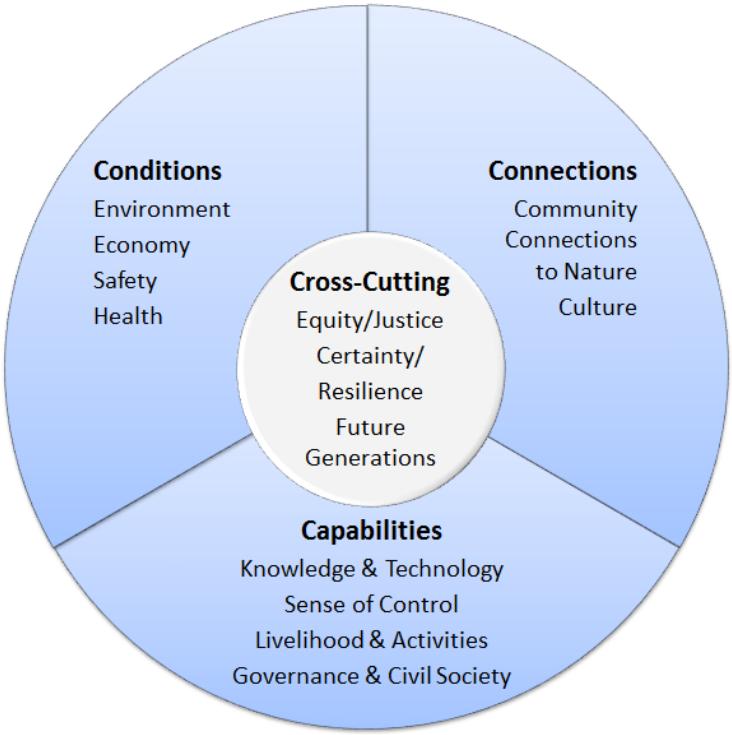


Figure HD4. The Wheel of Wellbeing: SWIMM's conceptual model of human wellbeing (in progress). The wheel and spokes suggest domains of wellbeing that are conceptually distinguishable, but in reality interdependent and dynamic. The central hub indicates domains of wellbeing that are generated by all others and which may be assessed through a cross-cutting analysis. This is a preliminary conceptual model, to be modified as research progresses.

Table HD2. Governmental legislation and policy reviewed for attributes of human wellbeing (n=21). These statutes were selected for their relevance and importance to ocean and coastal management in the United States and Canada. Attributes of wellbeing and supporting language were identified for each.

US Federal Legislation (n=7)

1. Magnuson Stevens Act 2007 - Amended
2. Clean Air Act
3. Federal Water Pollution Control Act (Clean Water Act)
4. National Environmental Policy Act (NEPA)
5. Marine Mammal Protection Act
6. Endangered Species Act
7. Coastal Zone Management Act

US Federal Policy (n=4)

8. National Ocean Policy 2013
9. Ocean Policy Task Force Final Recommendations 2010
10. Executive Order on Government to Government Relations
11. Obama 2013 Ocean Research Priorities Plan Update
12. Executive Order on Environmental Justice

US West Coast Management (n=5)

13. CCIEA Report Summary 2012
14. CCIEA Scenarios 2012
15. CCIEA 2012 Engagement Chapter
16. PFMC 2013 - Pacific Coast Ecosystem Fishery Plan
17. PFMC 2013 - Ecosystem Initiatives Appendix

US State Leg/Policy: WA, OR, CA (n=4)

18. California Ocean Protection Act
19. California Coastal Act
20. Washington Shoreline Management Act
21. Oregon Coastal Management Program

Table HD3. Applied socio-ecological projects reviewed for attributes of human wellbeing, candidate indicators, and best practices (n=52). From a list of 175 candidate projects collected through a literature review and expert consultation, 52 projects were selected for review based on 4 major criteria: 1) inclusion of social and ecological indicators, 2) real-world application, 3) thorough documentation and evaluation, and 4) influential status due to funding level, geographic scope, or presence in the media or literature.

Environmental Management Projects (n = 12)

1. Transboundary Waters Assessment Programme
2. Integrating Watershed & Coastal Areas Management in Caribbean Small Island Developing States
3. Nature Conservation and Human Well-Being in Bhutan
4. Wellbeing in Developing Countries (WeD)/Wellfish
5. Ocean Health Index
6. Millenium Ecosystem Assessment
7. Gulf Ecology Human Wellbeing Index
8. Developing Human Wellbeing Indicators for the Hood Canal Watershed
9. Vital Signs (African Monitoring System)
10. Evaluating Social and Ecological Vulnerability of Coral Reef Fisheries to Climate Change
11. Selecting Indicators to Protect and Sustain Experiences in the Eastern Arctic of Nunavut
12. Socio-economic drivers and indicators for artisan coastal fisheries in Pacific Island Countries & Territories

National Indicator Projects (n = 10)

13. Measures of Australian Progress (MAP)
14. Canadian Index of Wellbeing
15. UK Measuring National Well-being Programme
16. The State of the USA
17. European Social Survey Round 3 Wellbeing Module
18. Commission on the Measurement of Economic Performance and Social Progress
19. Bhutan's Gross National Happiness Project
20. Gallup Healthways Well-Being Index
21. Hong Kong Quality of Life Index
22. Thailand Green & Happiness Index

U.S. Federal Resource Mgmt Projects (n = 10)

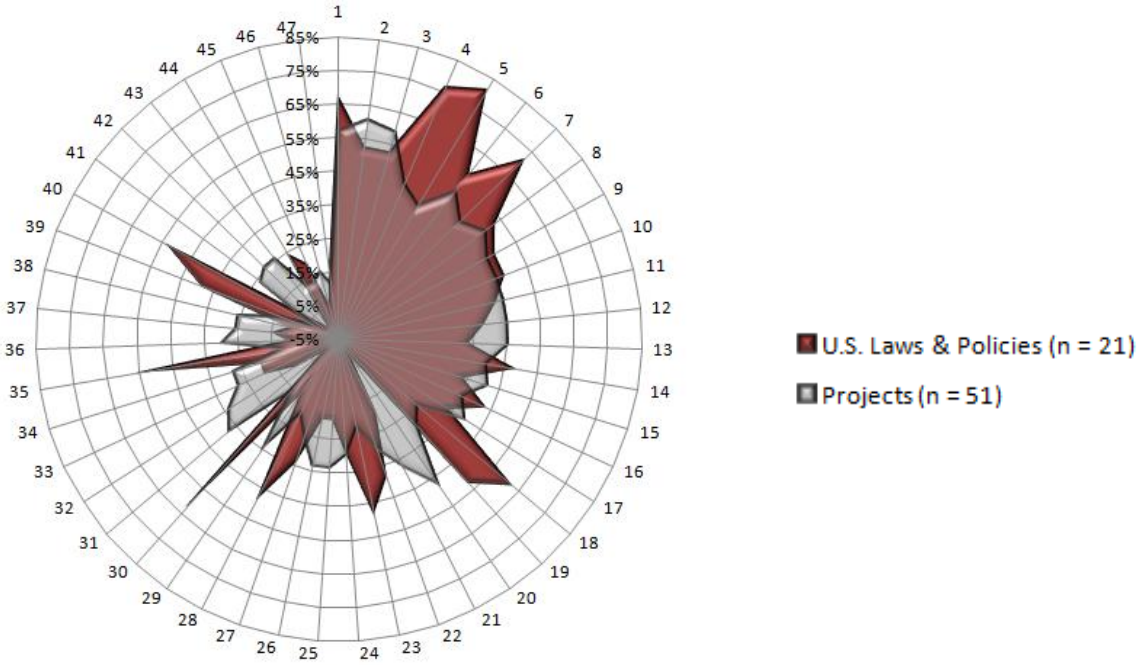
23. Large Marine Ecosystems (U.S. Federal Resource Management; UNEP/RS; GEF)
24. Evaluating Changes in Health and Well-being in Communities Affected by the Deepwater Horizon Disaster
25. Development of Social Indicators of Fishing Community Vulnerability and Resilience in the U.S. Southeast and Northeast Regions
26. Fisheries Social Impact Assessment (Pollnac et al.)
27. Measuring the social and economic performance of catch share programs: definition of metrics and application to the U.S. Northeast Region groundfish fishery
28. Marine and Estuarine Goal Setting for South Florida (MARES) - Noneconomic Indicators
29. Puget Sound Partnership
30. Socioeconomic Profiles of Fishers, their Communities and their Responses to Marine Protective Measures in Puerto Rico
31. Community Profiles for West Coast Fishing Community
32. Improving Community Profiles for the North Pacific Fisheries

Indigenous Projects (n = 10)

33. Voices From The Bay: Traditional Ecological Knowledge of Inuit and Cree in the Hudson Bay Bioregion
34. Social Indicators Study of Alaskan Coastal Villages
35. West Coast Vancouver Island Coastal Strategy & Integrated Ocean Management Plan
36. Arctic Social Indicators Project
37. Swinomish Indigenous Health Indicators
38. Te Kupenga Maori Wellbeing Survey
39. Indigenous Relational Wellbeing Index
40. First Nations Health Indicators Toolkit
41. SARD Cultural Indicators of Indigenous Peoples' food and agro-ecological systems
42. UN Permanent Forum on Indigenous Issues

Sustainability Projects (n = 10)

43. Toronto Vital Signs
44. Sustainable Consumption & Production Indicators for Developing Countries
45. SUSTAIN Partnership
46. Sustainable Neighborhoods for Happiness
47. Sustainability Monitor of the Netherlands
48. UNDESA Indicators of Sustainable Development
49. FAO Intl Guidelines on Securing Small-Scale Fisheries
50. Genuine Progress Index (GPI) Atlantic
51. Sustainable Bergslagen Cultural Indicators
52. Measuring Wellbeing: Blythe Valley Case Study



1. Infrastructure/Built Environment/Ports/Housing/Transit
2. Education/Outreach/Building Awareness/Access to Info
3. Material Wellbeing/Wealth/Prosperity/Material Security
4. Public/Political Participation
5. Environmental Quality/Habitat Health
6. Physical Health/Mortality
7. Governance/Management/Public Services
8. Pollution/Waste
9. Resource Availability & Ecosystem Distributions
10. Resource Access & Utility
11. Cultural Values/Traditions/Valued Practices
12. Food/Nutrition/Food Security
13. Civil Society
14. Future Generations' Wellbeing/Sustainability
15. Commerce/Industry/Trade/Revenue
16. Recreation and Tourism
17. Social Justice/Equity
18. Conservation/Stewardship/Environmentalism
19. Transparency in Government
20. Emotion/Attitude/Mental Health
21. Jobs/Employment
22. Access to Nature
23. Archaeological/Historic Heritage
24. Agency/Self-Governance/Sovereignty
25. Subsistence
26. Security/Peace
27. Hazards Preparedness
28. Safety
29. Demographics
30. Diversity/Multiple Users
31. Social Relationships
32. Personal Activities/Time Allocation
33. Non-Consumptive Uses
34. Place Attachment/Sense of Place/Place-Based
35. Science/Research/Production of Knowledge/Technology
36. Livelihoods
37. Local Economies/Corporate Consolidation/Economic Freedom
38. Social Capital
39. Conflict Reduction/Resolution
40. Beauty/Aesthetics
41. Wonder/Spirituality
42. Job Quality
43. Energy Production & Consumption Patterns
44. Community Vibrancy/Integrity/Stability/Adaptability
45. Resilience
46. Identity
47. Certainty/Predictability/Ability to Plan Future

Figure HD5. Percentage of reviewed US governmental documents and socio-ecological indicator projects that mention each wellbeing attribute (presence/absence).

According to lessons learned from more than a century of social indicators use and application, the most effective indicator sets do not attempt to measure all aspects of wellbeing; rather, indicators should be few in number but high in theoretical, applied, and symbolic significance (Cobb and Rixford 1998). Thus, while we have developed a robust model of wellbeing that aims to provide context and raise awareness of the multiple, interrelated dimensions of wellbeing, we are developing indicators for only a subset of its domains. The Working Group identified six priority domains that were (1) foundational to other areas of wellbeing in an EBM context, and (2) most sensitive to EBM decisions. These domains may be related to one or more attributes. While subject to change, the domains we are first focusing on are:

1. Resource access (resource access and utility, resource availability, environmental quality, etc.)
2. Self-determination (sense of control: agency, self-governance, sovereignty, political participation, government transparency, etc.)
3. Social integrity (social relationships, social capital, community integrity, etc.)
4. Job quality (jobs/employment, demographics, livelihoods, personal activities, time allocation, etc.)
5. Food systems (food resources, nutrition, food security, etc.)
6. Intangible connections to nature (sense of place, wonder and spirituality, recreation and tourism, cultural values, knowledge, etc.)

Following the IEA method (Levin et al. 2009), we have begun screening indicators of wellbeing for these domains according to predefined criteria, such as theoretical validity, geographic relevance, management relevance, local significance, and data availability. Candidate indicators are being compiled from 52 existing socio-ecological indicator projects, a literature review and local input. A next step, beyond the scope of SWIMM, will be to test the screened indicators with actual data and ground-truthing. Final indicator sets can then be selected and tailored for specific intended uses and audiences.

POLITICAL ECOLOGY: A HOLISTIC APPROACH TO SOCIO-ECOLOGICAL ANALYSIS

(author: Sara Breslow, NWFSC)

Political ecology is a well-developed field in the environmental social sciences that takes a holistic approach to analyzing the social causes and consequences of environmental problems. Primarily through case studies, political ecology explores the causal linkages among the various components of the socio-ecological system, with a focus on how local socio-ecological dynamics interact with broader political and economic forces. Collectively, these studies reveal regional to global patterns in the human dimensions of ecosystems and

natural resource management. Indicators can inform or complement a political ecology analysis.

A case study of social conflict surrounding salmon habitat restoration and farmland preservation in the Puget Sound basin suggests how political ecology can inform and guide resource management. This study analyzes how "social hierarchies and mistrusts, conflicting senses of place, prevailing cultural narratives, and legal and institutional constraints contribute to the local dispute over habitat restoration." It argues that, "Closer attention to sociocultural factors such as these may help managers identify and implement locally supported recovery opportunities, facilitate cooperation among stakeholders, improve agency approaches, and reframe management agendas to better address collective needs." (Breslow 2014)

SOCIAL INDICATORS AND ASSESSMENTS

COMMUNITY VULNERABILITY ASSESSMENTS

(authors: Karma Norman, Stacey Miller, NWFSC; Stephen Kasperski, AFSC; Kristin Hoelting, Colorado State University)

This section presents a method for using secondary data to assess community-level vulnerability to ecosystem changes, as well as management, policy and other shifts. The method relies primarily on sociodemographic data derived from the U.S. Census alongside commercial fisheries data, but also includes and analyzes data from other available and relevant secondary data sources. The indices which incorporate these data have been developed for and applied to a separate vulnerability assessment process for the coastal communities of the U.S. Southeast and Northeast regions (Jepson and Colburn 2012), building upon prior social indicators work in coastal and fisheries contexts (Cutter 1996, Cobb and Rixford 1998, Pollnac et al. 2006, Jepson and Jacob 2007, Cutter et al. 2008).

The community vulnerability assessment approach is also supported by earlier efforts within fisheries social science, and within the National Marine Fisheries Service (NMFS) in particular, to define and characterize fishing communities both quantitatively and qualitatively (Acheson 1980; McCay and Cieri 2000; Gilden 1999; Norman et al. 2007; Sepez, et al. 2006; Sepez, et al. 2007). Vulnerability indices and vulnerability analyses employed for the coastal communities of the U.S. East Coast have been replicated for the human communities adjacent to and integrated with the CCLME. Similar assessments of fishing reliance and socioeconomic vulnerability are already underway in the Alaska region and, through the development of this work nation-wide, a relatively uniform approach to

coastal community vulnerability will be applied throughout U.S. fisheries management regions and in multiple IEA contexts.

In order to assess and track coastal community vulnerability for the inhabited shoreline areas adjacent to the California Current Large Marine Ecosystem (CCLME), we identified a set of indices that were drawn from extant community-level data and subjected to factor analyses. This process determined which communities are potentially most reliant on fisheries and marine ecosystems, and which among these are the most socioeconomically vulnerable. While this approach has been successfully developed and implemented for coastal communities on the U.S. East Coast (Jacob et al. 2012; Jacob et al. 2010; Colburn and Jepson 2012), the method of measuring and evaluating socioeconomic resilience is still in the early stages of data collection, organization and analysis for the communities of the U.S. West Coast (i.e. the coastal portion of the California Current Large Marine Ecosystem) and Alaska. Several of these indices are developed to account for socioeconomic vulnerability of California Current coastal communities. The socioeconomic vulnerability indices provided below include a *personal disruption index*, a *population composition index* and an index of community *poverty*.

For all three of these aforementioned indices, data are provided by the U.S. Census's American Community Survey (ACS), and were organized for all census-designated place (CDP) level communities in all coastal counties in Washington, Oregon and California. In this way, this vulnerability indicator approach sought to cover the geographic breadth required of the CCLME. Relevant indicator selection considerations for the personal disruptions index were based upon an ongoing national approach along with modified indicator selection criteria described for the natural science components of the IEA (Kershner et al. 2011).

The *personal disruptions index* developed by fisheries social scientists in the Southeast and Northeast regions, following prior work on community vulnerability (Cutter 1996, Jacob et al. 2012), provides a means of assessing commercial fishing reliant communities according to one aspect of their relative socioeconomic vulnerability. Relatively frequent personal disruptions within the community are linked to increased overall vulnerability to natural hazards and other events associated with livelihood and social impacts (Cutter et al. 2000, Jacob et al. 2012). The personal disruptions index, employed as a way of measuring socioeconomic vulnerability, includes indicators that account for:

- Percent within the community unemployed
- Percent of the community with no diploma
- Percent of the community living in poverty
- Percent of separated females in the community

As a companion to the personal disruptions index, the *population composition index* quantitatively describes the social make-up of the human communities reliant on the fisheries of the CCMLE. The indices of socioeconomic vulnerability, including the population composition index, rely on community-specific data pulled from annual ACS datasets as maintained by the U.S. Census. American Community Survey data allows for the use of regularly updated data for each of the 2,529 communities within the coastal counties of interest for the CCLME. The population composition index combines ACS data on race, gender and other demographics including:

- Percent of community identifying racially as "white alone"
- Percent of community with female single headed households
- Population age 0-5
- Percent that speak English less than well

In addition to the personal disruptions index and the population composition index, factor analyses on poverty indicators can offer assessments of socioeconomic vulnerability for coastal communities. A *poverty index* developed by fisheries social scientists in the Southeast and Northeast regions, following prior work on community vulnerability to natural hazards (Cutter 1996, Cutter et al. 2000, Jacob et al. 2012), provides a means of assessing relative well-being, vulnerability and resilience potential of fishing reliant communities. The poverty index, employed in measuring socioeconomic vulnerability of coastal communities, includes indicators that account for the:

- Percent within the community receiving assistance
- Percent of families within the community living below the poverty level
- Percent of the community over 65 years old living in poverty
- Percent of the community under 18 years old living in poverty

Data for each socioeconomic vulnerability indicator, based upon the most recent U.S. Census survey of 2010, were subjected to factor analyses in order to provide single factor solutions for each index of socioeconomic vulnerability (Table HD4). Considered together, these indices provide a means of comparing socioeconomic vulnerabilities across the coastal communities of the California Current Large Marine Ecosystem (Figure HD6).

Table HD4. Factor loading results for each of the sociodemographic vulnerability indices. These were factor analyses applied to 2,529 communities in coastal counties in Washington, Oregon and California, including 1,099 for which data indicate commercial and/or recreational fishing activity.

Indices	Factor Loadings	% Variance Explained
Personal Disruption		
% unemployed	0.6097	42.77
% with no diploma	0.7323	
% in poverty	0.7473	
% females separated	0.4944	
Population Composition		
% white alone	-0.7755	49.40
% female single headed households	0.6124	
Population age 0-5	0.6014	
% that speak English less than well	0.7987	
Poverty		
% receiving assistance	0.6132	58.71
% of families below poverty level	0.9226	
% over 65 in poverty	0.6228	
% under 18 in poverty	0.8563	

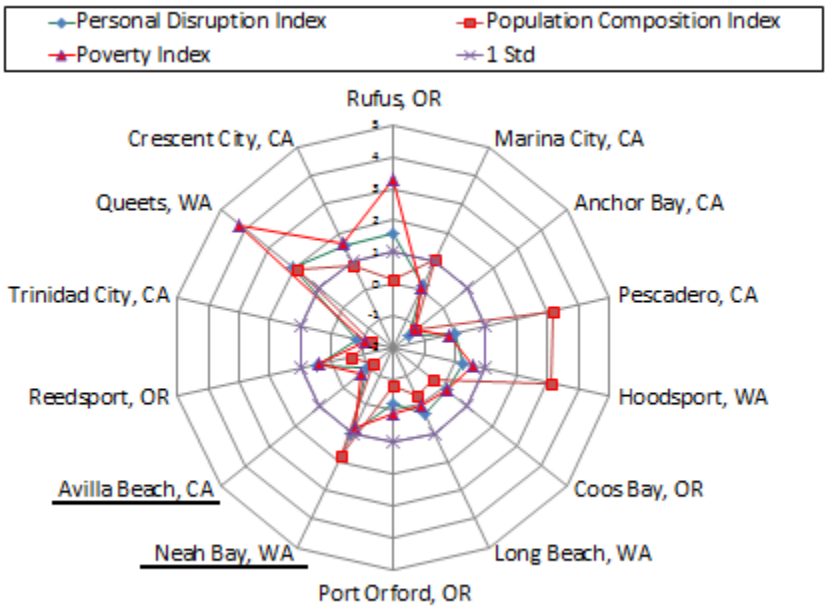


Figure HD6. Selected California Current coastal communities compared relative to one another sociodemographically. The underlined communities of Neah Bay, Washington, and Avilla Beach, California exemplify the kind of contrast that this approach helps to illuminate in the context of the IEA: Neah Bay is at least one standard deviation above the mean for all three indices of socioeconomic vulnerability, whereas Avilla Beach lies below the standard deviation for all three indices.

Similarly, additional indices are used to examine coastal communities with respect to their *reliance* on, and *engagement* with commercial fishing. The commercial fishing reliance index allows for the selection of communities most reliant on commercial fishing and therefore of particular interest to the CCIEA. The indicators included in the commercial *commercial fishing reliance index* are primarily available as annually collected fisheries data maintained by the Pacific Fisheries Information Network (PacFIN), and employment data collected by the U.S. Census' American Community Survey (ACS). The indicators incorporated into the commercial fishing reliance index are the:

- Value of commercial fisheries landings per capita for each community
- Processors with landings per capita for each community
- Percent employed in agriculture, fishing and forestry

The indicators which are included in the *commercial fishing engagement index* are:

- Value of commercial fisheries landings
- Total landings for each community
- Processors with landings

Considered in conjunction with the previously described socioeconomic vulnerability indices, commercial fishing indices allow for selection among those communities that are clearly linked to the CCLME, through data that captures commercial fishing activity, and are also potentially most socioeconomically vulnerable to exogenous shifts and events (Figure HD7).

Figure HD7. Selected California Current coastal communities compared relative to one another on fisheries indices. The underlined communities of Neah Bay, Washington, and Avilla Beach, California again exemplify the kind of contrast that this approach helps to illuminate in the context of the IEA: Neah Bay is at least one standard deviation above the mean for both indices capturing commercial fishing activity, whereas Avilla Beach lies below the standard deviation for both indices.

FISHING DIVERSIFICATION

(authors: Dan Holland, NWFSC; Stephen Kasperski, AFSC)

Catches and prices from many fisheries exhibit high inter-annual variability leading to variability in the income derived by fishery participants. Our analysis indicates that income variability is reduced on average if individuals diversify their income by participating in several different fisheries. The annual variability of aggregate revenues for ports is also reduced by diversification. We utilize the Herfindahl-Hirschman Index (HHI) to measure diversification of West Coast and Alaskan entity's gross revenues across species groups and regions. HHI theoretically ranges from zero when revenues are spread amongst an infinite number of fisheries to 10,000 for an entity that derives all revenue for a single fishery. Thus, the less diversified an entity's revenue sources are, the higher the HHI. We evaluate how diversification measured at the vessel level has changed over time for various fleet groups. We also track diversification of aggregate revenues for various port groups over time. A summary of key results is provided below. A description of the methodology and more detailed reports are provided in Appendix HD-1.

Average fishery revenue diversification of West Coast and Alaskan fishing vessels is variable but shows distinct trends over time (Fig. HD8). The HHI, though erratic, has generally been increasing over time meaning that diversification of fishery income has been declining. The current fleet of vessels on the US West Coast and in Alaska (those that fished in 2012) was the least diverse at any point in the past 30 years in 2011,, but diversification increased slightly in 2012.

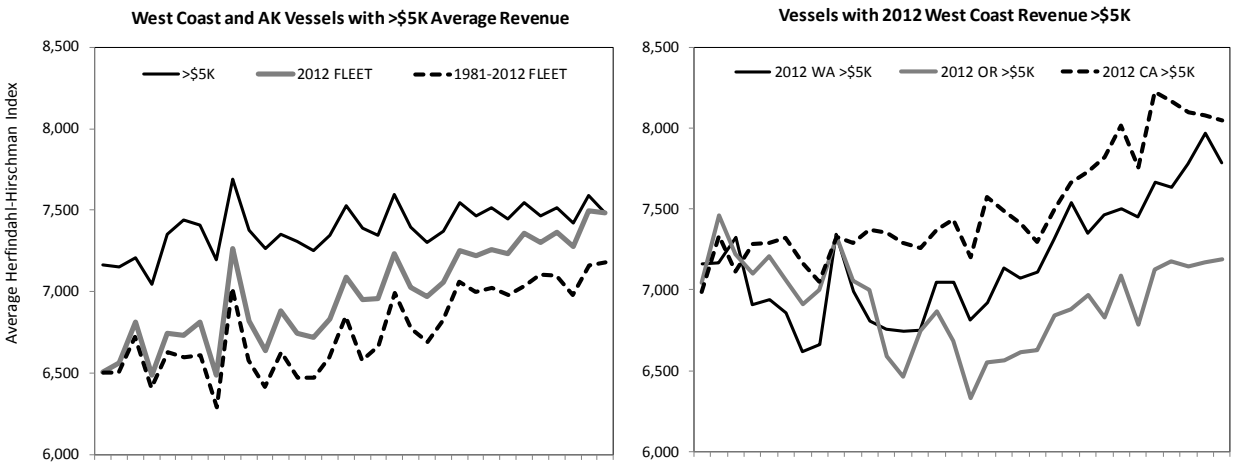


Figure HD8. Trends in average diversification for US West Coast and Alaskan fishing vessels (left panel) and the 2012 West Coast fleets by state (right panel)

Diversification across multiple fisheries can reduce variation in annual revenues and the associated financial risk. It can also increase the minimum annual revenue relative to average revenue, which should reduce the risk of a business failure (Kasperski and Holland, 2013). The ability of fishermen to diversify may be limited (or facilitated) by management approaches and regulatory actions that make it harder (easier) for fishermen to participate in multiple fisheries. There are a number of factors that may limit the feasibility or desirability of greater diversification for individual fishermen. In many cases different fisheries require different gear that must be purchased and there are often costs of acquiring licenses and, increasingly, quota. It may also be the case that a vessel that can participate in several fisheries may be less efficient than more specialized vessels creating a trade-off between risk reduction through diversification and fishing efficiency. The decrease in average diversification is due at least in part to regulations deliberately designed to reduce participation in oversubscribed and often overcapitalized fisheries. Thus, while our results suggest that the observed decrease in diversification of fishing vessels may have increased income variation and financial risk, this does not suggest a decrease in overall economic efficiency.

As is true with individual vessels, the variability of landed value at the port level is reduced with greater diversification of landings. Diversification of landed revenue for some ports has clearly declined (Fig. HD9). Examples include Seattle and most, though not all, of the ports in Southern Oregon and California. A few ports have become more diversified including Bellingham Bay in Washington and Westport, Washington which became less diversified through the mid 1990s but has since reversed that trend. Diversification scores are highly variable year-to-year for some ports, particularly those in Southern Oregon and Northern California that depend heavily on the Dungeness crab fishery which has highly variable landings.

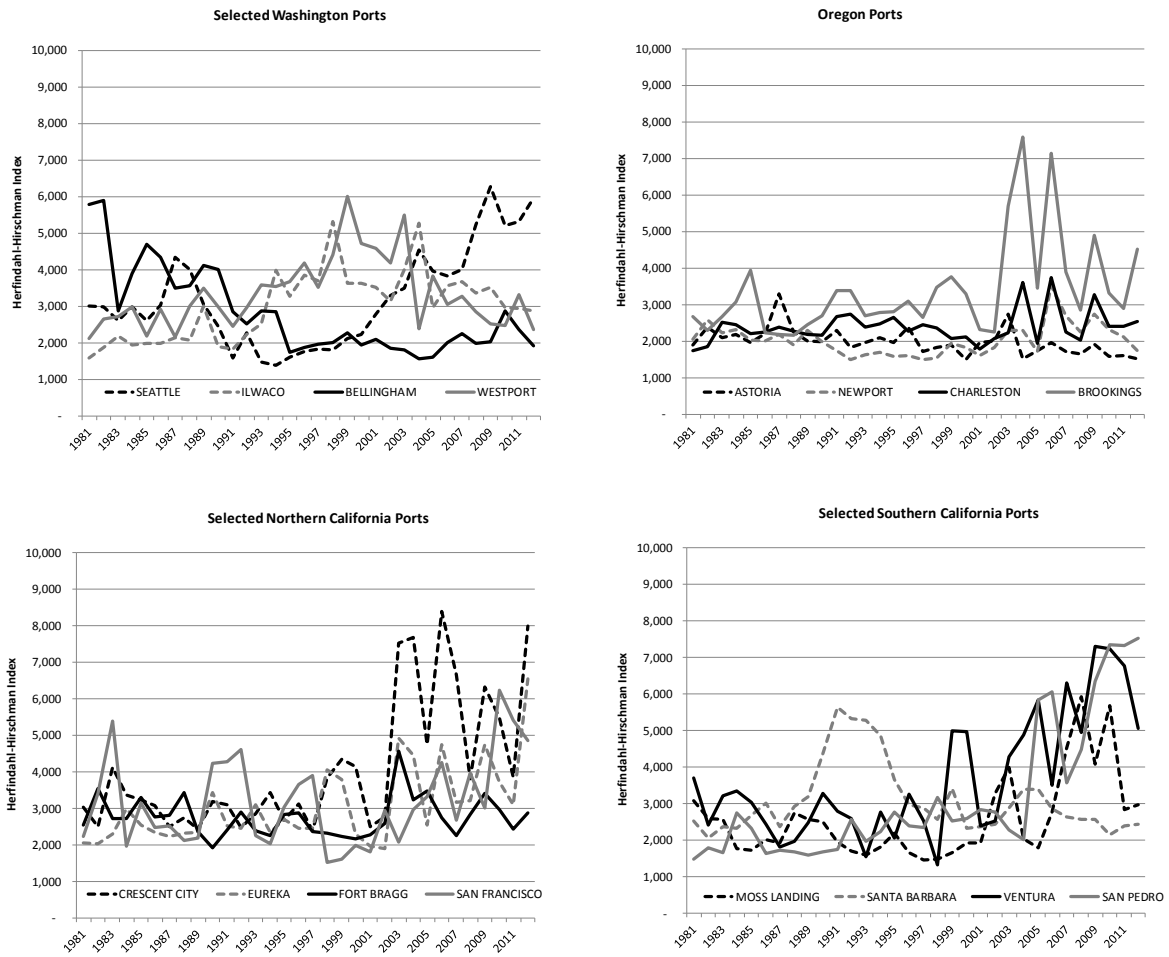


Figure HD9: Trends in diversification for selected primary West Coast ports in Washington, Oregon, and California.

It is not clear that ports could or should increase diversification to reduce variation in landed value, but it does appear that higher levels of diversification can reduce variation in landed value. High variation in overall landed value for several ports is associated with dependence on fisheries like Dungeness crab that have high variation in revenues. This variation could be socially disruptive, but this may be somewhat unavoidable if those ports want to continue to attract the landings from valuable fisheries that have highly volatile annual landings. It should also be noted that the variation in landed value at ports is not necessarily closely correlated with variation in fishing income of fishermen living in those communities since those fishermen may be landing catch in other ports. The link between diversification of individual fishermen and ports and socio-economic wellbeing of communities is one that deserves further research.

PERSONAL USE: SUBSISTENCE AND INFORMAL ECONOMIC PRACTICES AMONG COMMERCIAL FISHERIES

(authors: Melissa Poe, Nick Tolimieri, Phil Levin, Karma Norman, NWFSC)

Between 1990 and 2010, over 17 million kg of fish and shellfish (worth $116.5 million in fishing revenue) were kept by commercial fishing vessels in Washington and California USA for 'personal use', a category used as a proxy for subsistence food use (Pacific Fisheries Information Network, PacFIN). These 17 million kg of personal use constitute a fraction (0.2%) of the total catch (7.4 billion kg) landed during that same period. Although a nominal figure in the overall seafood catch, subsistence practices function to improve human wellbeing and strengthen community resilience by increasing food security. They may also be significant in the everyday lives of fishing communities for their role supporting social networks through seafood gifts and maintenance of food knowledge systems, ceremonial use, and alternatives to crew compensation. Importantly, the presence of subsistence practices among market-based commercial fishing operators reveals a more diverse array of economic systems than previously imagined.

Personal use is a category of fish biomass landed in ports by commercial vessels, which is not used for commercial or research purposes. Rather, personal use applies to the removal of wild ocean seafood species such as salmon, albacore, squid, crab, and more than a hundred other species that are kept for personal subsistence, sharing within communities, and other noncommercial purposes. In effect, personal use is a functional category identifying subsistence harvesting by commercial operators. While the actual volume of subsistence and noncommercial use is likely much larger than reported, the PacFIN personal use category is one of the few databases through which any subsistence and noncommercial fishing practices on the West Coast can be tracked systematically. The only other noncommercial harvest tracked in the rest of Western US is limited to "recreational" fishing (see RecFIN, http://www.recfin.org/). Thus, while these PacFIN data can tell us a limited amount of information about subsistence among commercial operators, they are not a substitute for a potentially much wider and more diverse set of subsistence practices for food security and cultural food systems in the US.

During the study period, rates of subsistence harvest varied across ports in Washington and California, ranging from zero personal use landings in many ports to over 10% of the relative total catch attributed to personal use in other ports, and as much as 33% in one Puget Sound, WA port. Nearly 85% (14.4 million kg) of the personal use removals is from tribal participants in WA (Fig. HD10). Slightly more than 15% of the personal use removals is from nontribal participants from both WA and CA. The majority of personal use, (over 13.8 million kg or 81.3%) was landed in Puget Sound.

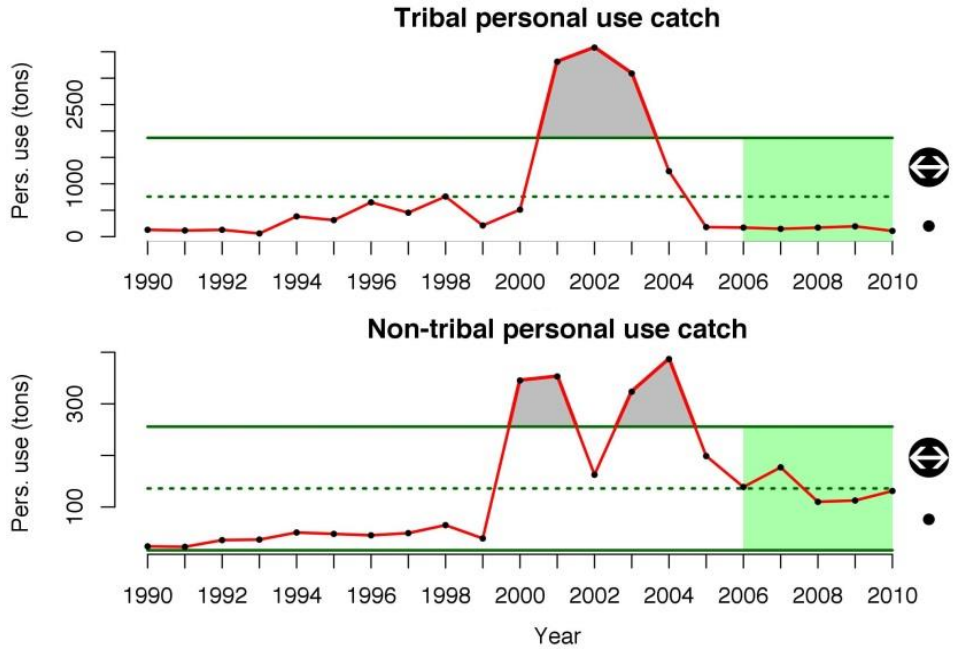


Figure HD10. Catch retained for personal use from 1990-2010 in tons (= 2000 lbs or 907.2 kg). Green horizontal lines show the mean (dotted) and ± 1.0 s.d. (solid line) of the full time series**.** The shaded green area is the last 5 years of the time series, which is analyzed to produce the symbols to the right of the plot. The upper symbol indicates whether the modeled trend over the last 5-years increased (↗), or decreased (↘) by more than 1.0 s.d., or was within one 1.0 s.d. (↔) of the long-term trend. The lower symbol indicates whether the mean of the last 5 years was greater than (+), less than (-), or within (.) one s.d. of the long-term mean. Data courtesy of PacFIN (pacfin.psmfs.org); data not reported from OR.

Ninety-six percent of the retained catch of tribal participants is comprised of salmonids, the other top species retained by tribes for personal use include: geoduck, Dungeness crab, and Pacific halibut (see Fig. HD11). Nontribal participants retain a wider diversity (breadth) of species than their tribal counterparts; top species include: market squid, albacore, Pacific sardine, Dungeness crab, Pacific halibut, bait shrimp, and salmonids. California ports record less personal use overall than Washington ports, but the species breadth in CA is greater (e.g. in CA, 229 species were kept for personal use and in WA, 93 species were kept).

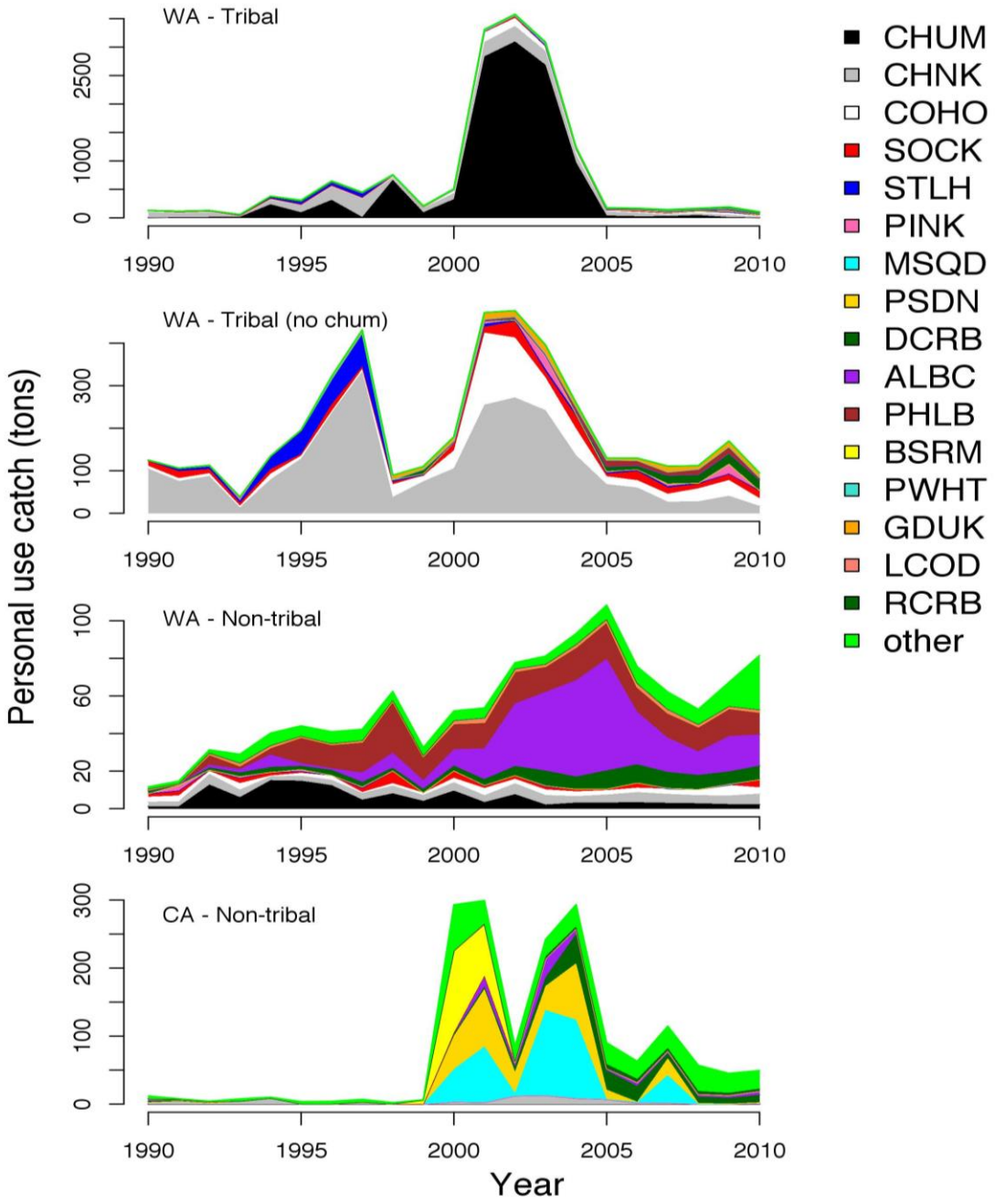


Figure HD11. Annual personal catch by species in tons (= 2000 lbs or 907.2 kg) for WA tribal fishers, WA non-tribal fishers and CA non-tribal fishers from 1990-2010. CHUM = chum salmon, CHNK = Chinook salmon, COHO = coho salmon, SOCK = sockeye salmon, STLH = steelhead, PINK = pink salmon, MSQD = market squid, PSDN = pacific sardine, DCRB = Dungeness crab, ALBC = albacore, PHLB = Pacific halibut, BSRM = unidentified bait shrimp, PWHT = Pacific whiting (hake), GDUK = geoduck, LCOD = lingcod, RCRB = rock crab. Data courtesy of PacFIN (pacfin.psmfs.org).

EFFECTS OF WATER SUPPLY ON LABOR DEMAND AND AGRICULTURAL PRODUCTION IN CALIFORNIA'S SAN JOAQUIN VALLEY

(authors: Cameron Spier, Aaron Mamula, SWFSC; Daniel Ladd, University of California-Santa Cruz)

The San Francisco Bay Delta is the central feature of California's water supply system and is the source of irrigation for about 3.75 million acres of highly productive farmland. The Delta also provides critical habitat for salmonids like Chinook salmon (*Oncorhynchus tshawytscha*) and Steelhead trout (*O. Mykiss*), listed under state and federal Endangered Species Acts. Management of water exports from the Delta is a key issue facing ecosystem restoration efforts. Increased emphasis on instream flow and episodes of drought mean that irrigation water deliveries may be periodically reduced in the future. In this study, we estimate the effects of annual changes in the quantity of water delivered to farms in the San Joaquin Valley on agricultural labor and crop production. Two water projects export water from the Delta to farms in the San Joaquin Valley: the State Water Project (SWP) and the U.S. Bureau of Reclamation's Central Valley Project (CVP).

We construct a statistical model of agricultural production in the San Joaquin Valley of California. The model uses data from 1981 through 2011 to determine how water deliveries from the CVP and SWP to farmers in the San Joaquin Valley are correlated with farm employment and production of certain crops. Our study area consists of six counties in the southern San Joaquin Valley: Stanislaus, Merced, Fresno, Kings, Tulare, and Kern. This region represents some of the most productive farmland in the United States, with all six counties ranking among the top nine in terms of market value of agricultural products sold.

The model consists of 8 equations – an agricultural labor demand equation and supply equations for 7 crop groups (Field Crops, Cotton, Tree Fruits, Grapes and Berries, Nut Orchard Crops, Vegetables, and Processing Tomatoes). To measure agricultural labor in each of the six counties, we use data on farm employment from the U.S. Bureau of Economic Analysis. To measure agricultural production and crop prices, we use data from California County Agricultural Commissioner's Reports. Data on water deliveries are from the U.S. Bureau of Reclamation and California Department of Water Resources.

Preliminary results indicate that farm employment is affected by annual water supply. These effects are relatively small but statistically significant and imply that a 10 percent change in water deliveries results in a less than 2 percent change in employment. Lower water deliveries are also associated with lower production of cotton, field crops, processing tomatoes, and vegetables. Our results also indicate that, over the 31 years of the data, labor demand and crop output may have become more sensitive to changes in the supply of water from the CVP and SWP.

2012 NATIONAL OCEAN RECREATION EXPENDITURE SURVEY

(authors: Rosemary Kosaka, Cindy Thomson, SWFSC; Scott Steinbeck, NEFSC)

In 2012, the National Ocean Recreation Survey was implemented to increase our understanding of national and regional participation in ocean recreation activities. The survey collected participation and expenditure information associated with recreational activities that occur at, in, or in view of oceans, bays, estuaries, coastal wetlands, saltwater bayous, and other seawater areas. These include:

- Recreational finfishing
- Recreational shellfishing
- Hunting waterfowl or other animals
- Viewing or photographing ocean features (e.g., waves) or wildlife (e.g., whales)
- Beachcombing, tidepooling, or collecting items
- Water contact sports such as swimming, surfing, and diving
- Boating and associated activities such as cruises, kayaking, and water skiing
- Outdoor activities not involving water contact such as walking and horseback riding

The survey period was one year, divided into six two-month waves to capture the seasonal variability in recreational activities. On the West Coast, randomly selected households in California, Oregon, and Washington participated in at least one of the six survey waves, with respondents in each wave asked questions about their activities in the previous two months.

Additionally, information was collected regarding how hypothetical changes in air temperature might influence respondents' recreational choices. Using the temperature estimate provided by each survey participant for the day(s) of their most recent ocean activity, they were asked whether they would participate in that same activity, switch to a different ocean activity, or switch to a non-ocean activity if the temperature was 5, 10, or 15°F higher or lower than what they actually experienced. The responses to these questions may contribute to our understanding of how temperature changes may influence the choice between different ocean activities (for example, from boating to swimming if temperatures were to increase) or non-ocean activities (for example, from ocean swimming to pool swimming if temperatures were to decrease).

This data collection was a cross-regional effort between the Office of Science & Technology, Southwest Fisheries Science Center, and the Northeast Fisheries Science Center. Additional partners included the Gulf States Marine Fisheries Commission, ECS (formerly OAK Management), and GfK (formerly Knowledge Networks). Data analysis is underway.

REFERENCES

Acheson, J. M. A. W. Acheson, J. R. Bort, and J. Lello. 1980. The Fishing Ports of Maine and New Hampshire: 1978. Maine Sea Grant College Program Publications.

Berkes, F. 2011. Restoring Unity, in World Fisheries: A Social-Ecological Analysis (eds R. E. Ommer, R. I. Perry, K. Cochrane and P. Cury), Wiley-Blackwell, Oxford, UK. doi: 10.1002/9781444392241.ch2.

Breslow, S. J. 2014. A Complex Tool for a Complex Problem: Political Ecology in the Service of Ecosystem Recovery, Coastal Management **42**:308-331.

Cobb, C. and C. Rixford. 1998. Lessons Learned from the History of Social Indicators. Redefining Progress, San Francisco, CA.

Cutter, S. L. 1996. Vulnerability to Environmental Hazards. Progress in Human Geography **20**:529-539.

Cutter, S. L., J. T. Mitchell, and M. S. Scott. 2000. Revealing the vulnerability of people and places: a case study of Georgetown County, South Carolina. Annals of the Association of American Geographers **90**:713-737.

Cutter, S. L., L. Barnes, M. Berry, C. Burton, E. Evans, E. Tate, and J. Webb. 2008. A Place-Based Model for Understanding Community Resilience to Natural Disasters. Global Environmental Change **18**:598-606.

de Groot, R., Wilson, M., and R. Boumans. 2002. "A typology for the classification, description and valuation of ecosystem functions, goods and services". Ecological Economics **41**: 393–408.

Gilden, J. (ed.). 1999. Oregon's Changing Coastal Fishing Communities. Corvallis, OR: Oregon Sea Grant College Program, Oregon State University. ORESU-)-99-001, 73 p.

Holland, D.S., J. Sanchirico, R.J. Johnston and D. Joglekar. 2009. *Economic Analysis for Ecosystem Based Management: Applications to Marine and Coastal Environments.* Washington, DC: RFF Press.

Jacob, S., P. Weeks, B. G. Blount, and M. Jepson. 2012. Development and Evaluation of Social Indicators of Vulnerability and Resiliency for Fishing Communities in the Gulf of Mexico. Marine Policy **26**:16-22.

Jepson, M. and S. Jacob. 2007. Social Indicators and Measurements of Vulnerability for Gulf Coast Fishing Communities. National Association for the Practice of Anthropology (NAPA) Bulletin **28**:57-67.

Kasperski, S. and D.S. Holland. 2013. Income Diversification and Risk for Fishermen. Proc. Nat. Acad. Sci. **100**:2076-2081. doi: 10.1073/pnas.1212278110

Kershner, J., J. F. Samhouri, C. A. James, and P. S. Levin. 2011. Selecting Indicator Portfolios for Marine Species and Food Webs: A Puget Sound Case Study. PLoS ONE **6**:e25248

Levin, P. S., M. J. Fogarty, S. A. Murawski, and D. Fluharty. 2009. "Integrated Ecosystem Assessments: Developing the Scientific Basis for Ecosystem-Based Management of the Ocean." PLoS Biology **7**: e14.

Millennium Ecosystem Assessment (MA). 2005. Ecosystems and Human Well-Being: Synthesis Island Press: Washington.

McCay, Bonnie and Marie Cieri. 2000. Fishing Ports of the Mid-Atlantic. A Report to the Mid-Atlantic Fishery Management Council, Dover, Delaware.

Norman, K., J. Sepez, H. Lazrus, N. Milne, C. Package, S. Russell, K. Grant, R. Petersen, J. Primo, M. Styles, B. Tilt, and I. Vaccaro. 2007. Community Profiles for West Coast and North Pacific Fisheries - Washington, Oregon, California, and other U.S. States. NMFS-NWFSC-85.

Poe, M. R., K. C. Norman, and P. S. Levin. 2014. Cultural Dimensions of Socioecological Systems: Key Connections and Guiding Principles for Conservation in Coastal Environments. Conservation Letters **7**:166-175.

Pollnac, R. B., S. Abbott-Jamieson, C. Smith, M. L. Miller, P. M. Clay, and B. Oles. 2006. Toward a Model for Fisheries Social Impact Assessment. Marine Fisheries Review **68**:1-18.

Sepez, J., K. Norman, A. Poole, and B. Tilt. 2006 Fish Scales: Scale, and Method in Social Science Research for North Pacific and West Coast Fishing Communities. Human Organization **65**:280-293.

Sepez, J., K. Norman and R. Felthoven. 2007. A Quantitative Model for Ranking and Selecting Communities Most Involved in Commercial Fisheries. National Association for the Practice of Anthropology (NAPA) Bulletin **28**: 43-56.