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Title: Cultural Dimensions of Socioecological Systems: Key Connections and Guiding Principles for Conservation in Coastal Environments

Short Running Title: Cultural Dimensions of Coastal Conservation

Authors: Poe, Melissa R. [1]; Norman, Karma C. [2]; Levin, Phillip S.[3]

Affiliations:

1. NOAA Fisheries, Northwest Fisheries Science Center; 2725 Montlake Blvd East, Seattle, WA 98112-2097; melissa.poe@noaa.gov
2. NOAA Fisheries, Northwest Fisheries Science Center; 2725 Montlake Blvd East, Seattle, WA 98112-2097; karma.norman@noaa.gov
3. NOAA Fisheries, Northwest Fisheries Science Center; 2725 Montlake Blvd East, Seattle, WA 98112-2097; phil.levin@noaa.gov

Corresponding Author:
Melissa R Poe, Ph.D.
NOAA Fisheries
Northwest Fisheries Science Center
2725 Montlake Blvd East
Seattle, WA 98112-2097
Ph.: 206-861-7610
Fax.:206.860.3475
melissa.poe@noaa.gov

Abstract: Environments are complex socioecological systems demanding interdisciplinary research and conservation. Despite significant progress in characterizing socioecological complexity, including important inroads for measuring human wellbeing through ecosystem services approaches, cultural interactions with ecosystems remain poorly understood. Inadequate knowledge of cultural dimensions of ecosystems challenges the ability of conservation professionals to include these considerations in their programs. Ecosystem-based conservation without cultural considerations is not only insufficient, it risks producing unaccounted negative impacts to communities and misses an opportunity to build culturally-meaningful alternatives. This mini-review of relevant social science identifies five key cultural dimensions of ecosystems, highlighting examples from coastal North America. These key dimensions are: meanings, values and identities; knowledge and practice; governance and access; livelihoods; and interactions with biophysical environments. We outline guiding principles for addressing these connections in integrated conservation research and application. Finally, we discuss potential methodologies to help improve interdisciplinary assessment and monitoring of cultural dimensions of conservation.

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INTRODUCTION

> "Culture is not an epiphenomenon, to be used if compatible with ecological or economic goals, or bypassed if not. Rather, culture plays a significant role in defining what is ecological and economic for most environmental stakeholders." (Paolisso & Dery 2010: 178)

Environments are fundamental to the sociocultural wellbeing of people and contribute to people's sense of place, wellbeing, relationships, and community resilience (Satterfield et al. 2013). Yet cultural values and their importance to conservation remain poorly understood (Chan et al. 2012; Satz et al. 2013). In this mini-review we synthesize existing social sciences to build an approach for better integrating cultural dimensions into coastal conservation. Using examples from coastal ecosystems in North America, our cultural dimensions of socioecological systems model illustrates five key interrelated cultural aspects: meanings, values and identities; knowledge and practice; governance and access; livelihoods; and cultural interactions with biophysical environments. We conclude by suggesting a set of guiding principles for conservation scientists and practitioners working across socioecological systems.

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Why is it important to consider cultural dimensions in conservation? Implementation of integrated conservation programs without consideration of sociocultural dimensions is insufficient, providing only part of the ecosystem picture (Berkes 2012). Failure to consider cultural dimensions risks creating or reproducing social inequalities (Carothers et al. 2010), diminishing community resilience (Gregory & Trousdale 2009), and stripping away mitigating processes (e.g. customary tenure, social norms, and knowledge systems) (Berkes 2012; Kearney et al. 2007; Ommer et al. 2012). Moreover, omitting important cultural dimensions may create conflict, reduce trust, and hinder collaborative management (Acheson 2006; Kaplan & McCay 2004). Conversely, including sociocultural dimensions in conservation may increase buy-in, reduce conflict and costs associated with negotiation (Evans & Klinger 2008), and yield better alternatives that address concerns of those most affected by environmental and institutional changes (Turner et al. 2008).

Including meaningful sociocultural components in conservation also fulfills a number of government directives to which natural resource agencies are bound. For example, the United States Executive Order 12898 "Environmental Justice" establishes the basis for identifying and mitigating the disproportionate impacts on minority and low-income communities by federal actions. Specific to coastal areas, U.S. Executive Order 13547 "Stewardship of the Ocean, Our Coasts, and the Great Lakes" mandates protection of social, cultural, recreational, and historical values. The U.S. Magnuson Stevens Fisheries Conservation and Management Act requires assessment of the impacts of management actions to fisheries dependent communities. Other authorities that call for and rely upon improved understanding of cultural dimensions specifically with indigenous people include: treaties with tribal governments and international laws (e.g., U.N.

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Declaration of the Rights Indigenous People, which recognizes the rights of indigenous people to their cultural and spiritual practices, and access to sacred sites, territories and coastal resources) to which the United States and Canada are signatory parties. Despite these legislative mandates for considering sociocultural dimensions of policy actions, there remain significant shortcomings in the models used to evaluate, monitor, and mitigate the direct, indirect, and cumulative impacts to individuals, families, and communities across appropriate time horizons (e.g. Allen & Gough 2009). Our cultural dimensions of socioecological systems model has the potential to resolve such shortcomings.

We focus on coastal regions of the United States and Canada for two reasons: first, scientists and practitioners at various scales in these geographic contexts have made fewer advances in incorporating cultural dimensions into coastal conservation, and thus may have the most to benefit; second, they encompass the region where we work, suggesting a possible opening for applying the cultural dimensions model to present conservation needs. Still, the cultural dimensions of ecosystems presented here are not unique to North America and we suggest this framework can be used in any geographic context, including both coastal and terrestrial ecosystems.

Joining sociocultural with ecological and economic considerations of complex socioecological systems can be challenging, but is necessary in order to manage and protect environments for human wellbeing, ecosystem integrity, and viable economies (Berkes 2012; Levin et al. 2009). Tackling these challenges requires new tools for understanding the interactions, interdependencies, and scalar dynamics between people and ecosystems (Ommer et al. 2012).

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CULTURAL DIMENSIONS OF COASTAL ECOSYSTEMS

Approaches to investigating coupled social and biophysical complexity are needed for addressing the practical and scientific needs of socioecological systems (Berkes 2012). A focus on cultural dimensions helps identify important interactions between coastal resources and social groups, and improves socioecological analyses and management. Below we develop a cultural dimensions of socioecological systems conceptual model highlighting five fundamental, interactive, and interrelated cultural aspects of ecosystems (fig 1), synthesizing literature from marine social science.

1. ***Cultural connections to ecosystems are rooted in meanings, values, and identity*.**

Meanings, values, and identities are at the root of diverse cultural connections to ecosystems. Meanings, values, and identities develop through interactions with places and resources, which engage cognitive and emotional processes (e.g. knowledge, perceptions, and beliefs) and entail practices based in skills and relationships (Lauer & Aswani 2009). Cultural significance can be attributed to objects, places, relationships, practices, and processes. For example, Field and colleagues (2008) describe how abalone (*Haliotis spp.)* play a central role in the world view of coastal Pomo people of northwestern California. The meanings of abalone flow not only from the animals themselves, but are also produced and enlivened through language, ceremony, relationships, and harvesting; abalone are intricately connected to Pomo way of life.

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Cultural ecosystem meanings and values are often deep-rooted and define a person or community; they are implicit in place-attachments and senses of place (Burley et al. 2007); and often form the basis of community, individual, and professional identities (Clay & Olson 2007; Pollnac & Poggie 2006; Smith 1980). Cultural ecosystem meanings, values, and identities are also heterogeneous. For example, in their study of Mississippi Delta anglers, Toth and Brown (2012) found that ethnicity and gender played a significant role in the diversity of meanings and importance attached to fishing by different groups (e.g. depending on one's socioeconomic position, the importance of recreational fishing varied from relaxation to subsistence, cultural tradition, and social ties). Yet attention to the ways that ethnicity, gender, and other socioeconomic factors impact and shape communities' ties to coastal ecosystems is often missing in fisheries management, as revealed in Hall-Arber's (1996) study on Portuguese and Italian women's experiences in New England.

Sociocultural actors (e.g. fishermen, women who work in processing plants, traditional shellfish harvesters, fisheries biologists, etc.) interact with and experience environments in ways that shape their perceptions, beliefs, and held values toward these environments, constituting what Paolisso (2007) and Blount and Kitner (2007) call "cultural models." Cultural models are often abstract and include philosophical, spiritual, and moral views about environments, and these in turn shape the vision of how resources should be managed (Hall-Arber et al. 2009). Finally, meanings, values, and identities are also dynamic, changing over time and space, as individuals and communities communicate, negotiate, and refine their orientations based on their practices, social relationships, and novel understandings.

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2. *Cultural dimensions of ecosystems are embedded in local ecological knowledge and practice*.

Local resource users maintain substantial knowledge on the environmental, social, and spatial conditions of ecosystems. This cumulative body of knowledge is called local ecological knowledge (LEK), and when LEK is developed and transferred over multiple generations, it is called traditional ecological knowledge (TEK) (Berkes et al. 2000). LEK is not simply a collection of data about the environment, but is embedded within sociocultural processes (Houde 2007). Local knowledges are based in the "sensitivities, orientations, and skills that have developed over one's lifetime through actual engagement in and performance of practical activities" (Lauer & Aswani 2009: 318). As such, knowledge is not simply "passed down" through generations per se, but continually regenerated through practical engagements with ecosystem components, articulated through language, local meanings, methods, and cultural cognitive models. Experientially-derived cognitive models depend on access to opportunities to engage in practices within social groups, and to build, maintain, and share LEK within relevant ecological parameters.

Culturally diverse knowledge systems are increasingly recognized as connected to global biological diversity (Maffi 2005). In many cases, LEK forms the knowledge basis for harvesting techniques and practices that are sustainable and which could contribute to socioecological conservation. For example, Hunn and colleagues (2003) describe a system of glaucous-winged gull (*Larus glaucescens*) egg harvest practiced by the Huna Tlingit in Glacier Bay, Alaska. Through experimentation and ethnoscience on gull breeding and nesting behavior, the Huna Tlingit developed strategies for harvesting without long-term impact on gull reproduction. Common knowledge of gull

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reproduction and egg harvest is codified through language and shared cognitive cultural models that influence behaviors and values (Paolisso and Dery 2010).

Incorporating diverse types of ecological knowledge into conservation and collaborating with alternative knowledge holders can build social and ecological resilience (Bohensky & Maru 2011; Ommer et al. 2012; Turner et al. 2008). Many LEK-based practices also serve to maintain ecosystem processes and functions and enable adaptive management (Berkes et al. 2000). However, there are important power dilemmas to be addressed when LEK, especially among indigenous knowledge holders, is considered. For instance, knowledge may be privileged or sacred; this is, held by select individuals who are endowed with rights to knowledge based in cultural norms and social relations (Nadasy 1999; Shackeroff & Campbell 2007). Additionally, some knowledge is intellectual property whereby open sharing might be unethical or risk appropriation when not transferred and published within locally-defined controls (Maurstad 2002). Another issue that needs to be resolved when integrating LEK/TEK with other knowledge types (e.g. Western scientific) is the deeply contextualized nature of local, and often *in situ,* place-based knowledge that might not align with, and can be relegated by, the principles of "replicability" and "generalizability" of non-local knowledge and science (Agrawal 1995; Bohensky & Maru 2011).

3. ***Cultural dimensions of ecosystems are linked to livelihood dynamics.***

Ecosystems support livelihood activities with cultural implications. Much has been written elsewhere of the economic dimensions of commercial fishing (Pascoe 2006) as well as demographic aspects of fishing-dependent coastal communities (e.g., Norman et al. 2007). Coastal ecosystems also support noncommercial personal use, subsistence

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fishing, and other informal economic activities, which are tied in complex ways to the other cultural dimensions described in this section.

Subsistence fishing and harvesting, for example, is a practice often motivated by food provisioning rather than catching or processing species for sale and income generation (Pollnac et al. 2006). Subsistence fishing might include personal or family-level consumption to meet or supplement household food needs, or procurement for others distributed through sharing, gifting, and bartering (Schumann & Macinko 2007). Subsistence feeds bodily and spiritual nourishment and is often linked to culture, LEK, social relations, and food traditions (Berkes 1990; Schumann & Macinko 2007; Pollnac et al. 2006). Despite high cultural importance, subsistence activities, their enabling conditions, and management impacts are rarely included in North American fisheries management (Berkes 1990).

Commercial fishing activities are also important to sociocultural wellbeing for reasons in addition to generating income and jobs. Some wellbeing measures relate to job satisfaction and quality of life. In Southeast Alaska, Pollnac and Poggie (2006) illustrate the importance of job satisfaction among charter boat operators and fish plant workers. There, variables such as degree of influence over work dynamics and crew social and power dynamics correlated with job satisfaction. Commercial fishing furthermore plays a role in shaping collective place-based and occupationally-based identities. For example, Blount and Kitner's (2007) study of elder African American fishermen who harvested shellfish from coastal Georgia show that fishing is not simply an individual economic strategy, but it also constitutes a "way of life" in these coastal communities.

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4. Cultural dimensions of ecosystems influence and are influenced by governance and access.

Woven throughout this synthesis, and implicit in collaborative conservation, is the recognition that resource management and governance institutions shape and are shaped by cultural dimensions of ecosystems. Mechanisms such as harvest controls (e.g. timing, location, species, quantities, and techniques), formal and customary rules of access to resources, and decision-making processes constitute governance. Marine governance is at once a set of institutional (i.e. political and economic) structures, and also tied to underlying philosophies, social norms, relationships, and knowledge systems embedded in those structures at all scales. Whether through community-based management approaches stemming from local use and tenure norms, or codified in regional conservation efforts, the issue of scale (spatial, temporal, and organizational) has important implications both for socioeconomic analyses of coastal communities, as well as the cultural outcomes of multi-scalar governance (Charles 2012; Sievanen et al. 2013).

The "community level" is a predominant analytical scale for cultural phenomena, and yet the community-scale is frequently a "missing link" in conservation where attention is often paid toward the individual, the market, or the state (Jentoft 2000). It is at the community-scale where, for example, much of the scholarship on fisheries collective action --and its enabling sociocultural conditions-- focuses. These studies explore local structures and processes (e.g. kinship patterns, social relations, customary tenure, and taboos, etc.) that govern fishing effort, crew organization, and resource access rights, often congruent with community-based management of common pool resources

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(Feeney et al. 1990; Ostrom 1990).

So-called "top-down" management --centralized actions originating outside of a local context-- can enable or disrupt cultural processes. In the U.S., federal fisheries management has been structured around the dual goals to conserve fish stocks and make harvesting economically efficient. Although newer ecosystem-based management approaches attempt to shift away from the sustained maximum yield model (Kaplan & Levin 2009), cultural norms and social institutions rarely figure into fisheries management (Jentoft 2000). In a number of cases, management actions have impacted marginalized communities and exacerbated inequalities. For example, Allen and Gough (2006) described how U.S. longline prohibitions enacted in 2001 had disproportionately negative impacts on Vietnamese-American fishing communities in Hawaii with adverse effects on health and wellbeing, livelihoods, and community cohesion. In the Gulf of Alaska, Carothers and colleagues (2010) detailed how policy changes toward a system of market-based fishing rights (e.g. individual fishing quotas for halibut (*Hippoglossus stenolepis* and sablefish *Anoplopoma fimbria*) concentrated access and wealth for fewer quota holders at the demise of small-scale fishermen and rural (mostly indigenous) communities.

Participatory collaborative management can improve the adoption and legitimacy of management actions by communities who are impacted (Hard et al. 2012). Adaptive conservation approaches designed to diversify stakeholder involvement hold promise for increasing equity in management (Kearney et al. 2007). For example, in coastal areas of Northeast United States, Hall-Arber (2007) designed a collaborative project involving community members in all phases to identify and explain regional concerns, including:

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social science needs identification, project management, data collection, results analysis, and project reporting. The process improved mutual understanding between various community stakeholder groups and managers of their unique concerns. Mutual understanding ultimately facilitated more participatory decision-making. Factors such as histories of collective action and other dimensions of social capacity are also important variables in degrees of success (Hanna 1995). Conservation can benefit from locally-adapted ecosystem governance (vis-à-vis institutions, knowledge systems, and social relations) in nested local, regional, and larger-scale ecosystems (Berkes 2012).

5. Cultural dimensions are inherently linked to ecological processes.

Habitat condition, species assemblages, and related ecological processes are essential to people's engagements with coastal ecosystems. In recent years, social scientists have called for more careful integration of ecological data into the study of human-environmental interactions (Charnley & Durham 2010; Nygren & Rikoon 2008).

Ecological integrity is the ability of an ecological system to support and maintain a community of organisms that has a species composition, diversity, and functional organization comparable to ecosystems within a region (Parrish et al. 2003). Evaluating the relationship between ecological integrity and cultural wellbeing requires a detailed examination of cultural interactions with a specific ecosystem component. For example, for a human community that is culturally attached to salmon (*Oncorhynchus sp.*), changes to the trophic structure (or food web) within which salmon is embedded will have specific implications for cultural wellbeing in ways that aggregated ecological integrity measures may not reveal.

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The 'cultural keystone' concept may offer important ways to think about and evaluate the links between ecological integrity and cultural wellbeing. Garibaldi and Turner (2004:4) define cultural keystone species as "the culturally salient species that shape in a major way the cultural identity of a people, as reflected in the fundamental roles these species have in diet, materials, medicine, and/or spiritual practices." These species play a particularly influential role in the social system of a community and its cultural identity; so much so, that loss of access (whether owing to ecological or sociopolitical changes) would have drastic impacts on the community in question (Garibaldi & Turner 2004). Although a "species approach" seemingly departs from an "ecosystems approach" to conservation, focusing on cultural keystone species ironically allows an integrated analysis precisely because it explores the nonlinear and multivariate web of human-environment relationships linked to a foundation species within an ecosystem.

One such cultural keystone species is abalone (*Haliotis kamtschatkana)* for the Gitxaala First Nation community in Northern British Columbia. Abalone's importance is based on long-term harvesting, processing, trade, and ceremonial practices (Menzies 2010). Despite depletion in recent decades and the subsequent closure of the commercial fishery, abalone remain integral to what it means to be Gitxaala. Elders in the community experience grief and loss over the closure, but maintain its importance to younger generations through story, song, and lessons on sustainable harvesting practices in hopes that abalone will recover (Menzies 2010). A second cultural keystone species example, oysters (*Crassostrea virginica*) are highly valued and symbolic to Chesapeake Bay coastal communities (Paolisso & Dery 2010). The cultural importance of oysters motivates community engagement with ecological restoration, with the explicit understanding that oyster restoration supports integrated ecological, economic,

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and cultural benefits (Paolisso & Dery 2010). Understanding and communicating the importance of these biophysical values vis-à-vis their cultural interactions is one pathway to protect them.

Ecological restoration is a more recent example of the ways that humans have historically modified environments toward a desired outcome. In many contexts, ecosystems have been actively managed and altered to various degrees to enhance certain processes, create habitats, and increase productivity of desired species (Lepofsky & Caldwell 2013). Often called "bio-cultural landscapes", some coastal ecosystems have been historically co-produced through biophysical processes and customary landscape management practices. Examples of culturally-modified coastal ecosystems include the construction of rock walls, weirs, terraces, and cleared beaches to support clam gardens and increase marine ecosystem productivity in Northern Coast Salish intertidal areas (Lepofksy & Caldwell 2013). Another example of altered ecosystems includes interventions in ecological food webs through the control of competitors and predators to influence trophic cascades and enhance the availability of important foods resources. For example, Erlandson and colleagues (2005) documented past human predation on sea otters (*Enhydra lutris)* to increase the abundance of abalone, urchins (*Strongylocentrotus* spp.), and kelp (*Macrocystis pyrifera* and *Nereocystis luetkeana)* in Northern California. These examples illustrate ways that humans are important components of ecological processes, just as ecological processes are important to cultural practices, knowledge systems, and ways of life.

Natural oceanographic fluctuations, flooding, and tsunamis as well as anthropogenically caused climate change, ocean acidification, marine biotoxins, and fisheries collapse also have fundamental implications for cultural interactions. Coastal communities

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contending with fluctuating environmental factors have developed strategies to endure and adapt to these changes; however the degree and compounded complexity of more recent changes may become more challenging. For example, Moerlin and Carothers (2012) characterize the observations of and responses to climate change faced by Iñupiaq subsistence fishing communities in Northwestern Alaska. Biophysical changes (e.g. new freeze-thaw ice cycles, increased erosion, and shallower rivers) have meant fewer fish resources and increased difficulty in seasonal access to harvesting and hunting sites, among other impacts. Iñupiaq communities must also contend with an array of social, economic, and political changes with cumulative impacts on wellbeing, including: loss of LEK and traditional technologies owing to modernization, as well as youth out-migration in search of wage-earning jobs owing to high fuel costs, among other political-economic changes. It is ultimately insufficient to study either environmental changes (vis-à-vis changes in biophysical conditions) or human engagements with changing conditions as isolated topics disconnected from one another, or from the myriad stressors affecting both (Moerlin & Carothers 2012).

TOWARD A SET OF GUIDING PRINCIPLES FOR INCORPORATING CULTURAL CONSIDERATIONS INTO CONSERVATION

Conservation is already complex, involving significant investments in human and economic capital to support science needs, design and implement plans, and monitor outcomes. These efforts are important and have improved in recent decades by incorporating new methodologies and new constituents. Still, adaptive conservation for socioecological systems requires more robust integration of the sociocultural

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phenomena of ecosystems. Interdisciplinary approaches still frequently lack adequate social science for integrated ecosystem science, shared learning, and improved solutions (Armitage et al 2008; Berkes 2012; Haapasari et al. 2012). The cultural dimensions presented above are used to develop a set of guiding principles that will allow conservation programs to undertake this task (fig. 2). Alongside other principles of socioecological systems (see Foley et al. 2010 on ecological principles in marine ecosystems, and Costanza et al. 1991 for principles of ecological economics) these culturally-oriented principles aim to guide and improve conservation outcomes.

Guiding principles of a cultural dimensions approach to conservation

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.
5. Recognize the integrated and coupled nature of sociocultural wellbeing and ecosystem health; and design conservation approaches appropriately.

There is a growing call for tools to assess cultural values and services provided by ecosystems. Attempts to define and measure these values are often plagued by three shortcomings: an oversimplification of “culture” as a static “thing” that an individual or

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group possesses rather than a set of processes, relationships, and practices shared by a collective group; classification schemes and evidentiary norms defined by "experts" and not by members of a community whose cultural values are being assessed; and adoption of methods, metrics, and scales to measure cultural values that are not effective at capturing or explaining hard-to-articulate and other non-negotiable values (Chan et al. 2012; Satterfield et al. 2013). Turner and colleagues (2008) provide guidance on how to avoid or correct these pitfalls. First, focus on what matters to communities whose cultural connections to ecosystems might be impacted, using proven techniques for eliciting values (e.g. open-narrative interviewing); second, use meaningful ways to describe what matters (e.g. story-telling); third, make a place for invisible and hard-to-measure concerns in decision-making even if they don't fit the status quo metrics; fourth, select appropriate historical baselines to assess and monitor conditions (realizing that impacts may have initiated in the past with significant cumulative effects for current or future community members); and finally, create alternatives through value-focused and iterative processes.

Socioecological scientists from all disciplines want reliable and valid information. Methods for producing and interpreting science should not be restricted to one approach *a priori;* rather socioecological complexity requires properly-suited interdisciplinary models and methodological flexibility (Berkes 2012; Hall-Arber et al. 2009). Systematic qualitative and quantitative methods have been used to examine cultural dimensions of coastal ecosystems (Satterfield et al. 2013). Since cultural dimensions are often interwoven and may be difficult or unwise to disentangle, interpretive and inductive empirical methods may be among the most helpful explanatory models. Approaches such as ethnography (rapid and long term),

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interviewing, survey, focus groups, oral history, and discourse analysis succeed in sociocultural investigation, as demonstrated in many of the cases previewed above. Additionally, the use of locally-defined parameters and participatory mapping have proven useful in resolving seemingly intractable challenges of including cultural considerations in conservation (Satterfield et al. 2013).

CONCLUSION

In this paper we take on the challenge of conceptualizing the cultural dimensions of human wellbeing in socioecological systems. We present a cultural dimensions approach to ecosystems, highlighting a range of interrelated domains through which people interact culturally with coastal ecosystems. The model focuses attention on: cultural meanings, values, and identities; knowledge and practice; governance and access; livelihoods; and biophysical environments. Identifying and acknowledging cultural dimensions is the first step toward incorporating these principles into adaptive conservation. Once identified through appropriate methodologies, locally-meaningful approaches and indicators can be designed to evaluate the state of cultural wellbeing associated with different ecosystems and address the conditions which threaten or enable these conditions to thrive. The guiding principles outlined in this paper refocus applied integrated ecosystem science by considering a wider range of topics and methods for socioecological systems. It is important that the range of cultural dimensions, particularly those that remain absent but no less significant, is considered by scientists and practitioners in conservation decision-making. This task may take time, but it is crucial in order to build culturally-meaningful alternatives, to expand participation in conservation, and more broadly-speaking, to better understand and

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manage environments for both human and ecosystem health and wellbeing. Better understanding of the holistic and myriad human connections to diverse ecosystems ultimately improves conservation.

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Figure 1. Cultural Dimensions of Socioecological Systems Model: key aspects and attributes

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

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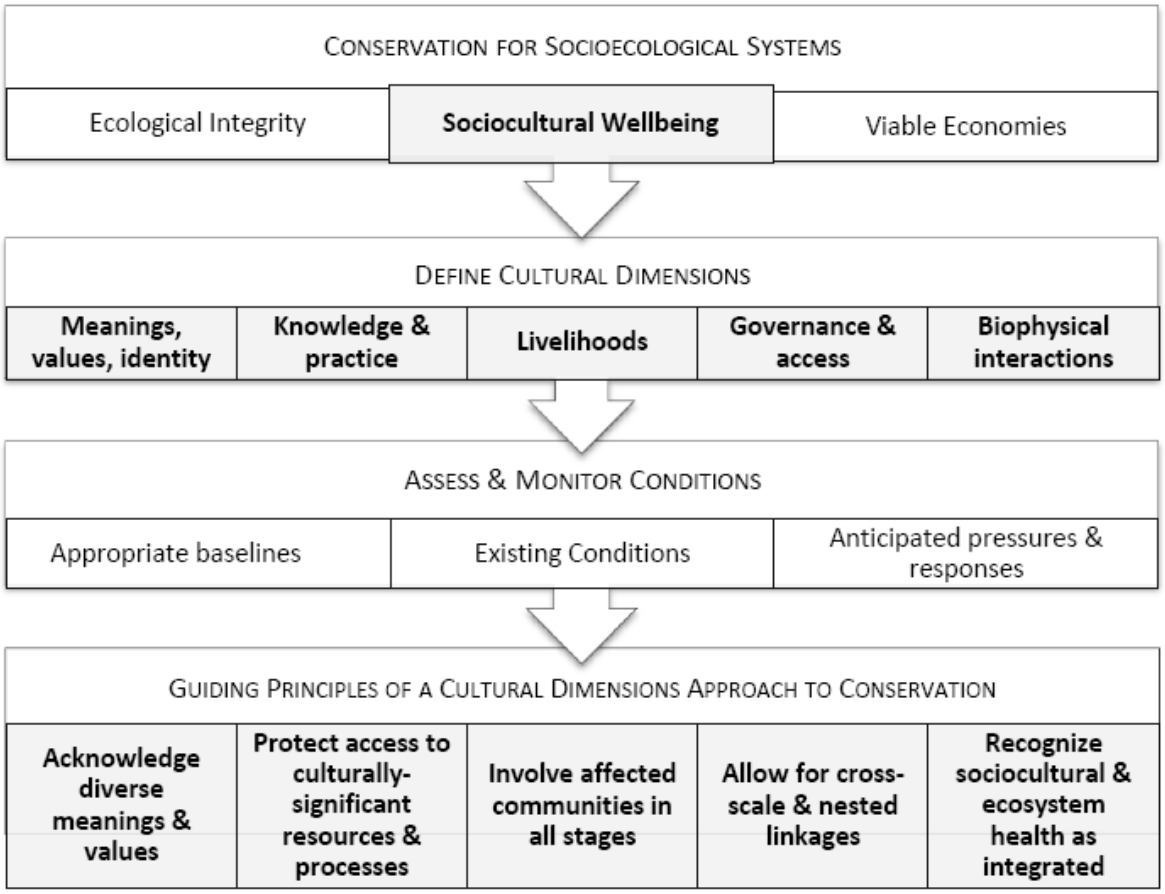
Figure 2. Incorporating Cultural Dimensions into Socioecological Conservation



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