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Improving Representation of Human Well-Being and Cultural Importance in Conceptualizing the West Hawai'i Ecosystem

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Ecosystem-based management approaches are increasingly used to address the critical linkages between human and biophysical systems. Yet, many of the social-ecological systems (SES) frameworks typically used in coastal and marine management neither represent the social and ecological aspects of the system in equal breadth or depth, nor do they adequately operationalize the social, or human, dimensions. The National Oceanic and Atmospheric Administration's West Hawai'i Integrated Ecosystem Assessment, a program grounded in ecosystem-based management, recognizes the importance of place-based human dimensions in coastal and marine resource management that speak to a fuller range of social and cultural dimensions of ecosystem-based management. Previous work with stakeholders in West Hawai'i revealed noteworthy SES dynamics and highlighted both the importance and lack of understanding of the links between ecosystem services and human well-being, particularly services that enhance and maintain active cultural connections to a place. While cultural ecosystem services and human well-being are often recognized as important elements of SES, there have been substantial barriers to fully representing them, likely due to perceived difficulties of measuring non-material benefits and values, many of which are socially constructed and subjective. This study examined SES frameworks related to cultural ecosystem services and human well-being to advance the representation and operationalization of these important concepts in coastal and marine management. We describe key insights and questions focused on: (1) points of inclusion for human dimensions in SES models, (2) culturally relevant domains of human well-being and related indicators, (3) the importance of place and its interaction with scale, and finally (4) the tension between a gestalt vs. discrete approach to modeling, assessing, and sustainably managing social-ecological systems.

Keywords: cultural ecosystem services, human well-being, ecosystem-based management, social-ecological system, integrated ecosystem assessment, West Hawai'i, coastal management, marine management

INTRODUCTION

Ecosystem-based management has gained broad recognition as a crucial means to improve conservation and sustainable use of marine systems, through coordinated management of cumulative impacts from multiple sectors (Mcleod et al., 2005; Leslie and Mcleod, 2007). This approach has been embraced by the United States National Oceanic and Atmospheric Administration, the agency responsible for the stewardship of the nation's ocean resources and their diverse habitats. Over the past decade, the conventional focus by the National Marine Fisheries Service (NMFS) on single species fisheries management has broadened to an ecosystem-based approach that includes multiple fisheries and multiple sectors aside from fisheries, such as tourism, coastal development, and marine-related industries (National Marine Fisheries Service, 2016), and interactions between and within biophysical, social, and economic systems (Link, 2010). Ecosystem-based fisheries management (EBFM) adopted by NMFS, thus applies an ecosystem approach to managing fisheries with a focus on multiple biophysical and socioeconomic objectives, with growing concern with procedural equity and the distribution of ecosystem benefits and services (Levin et al., 2018).

The Integrated Ecosystem Assessment (IEA) program was established in 2009 as one tool to help the agency move toward ecosystem-based management. IEAs have focused on large marine ecosystems, with the primary objective to provide a sound scientific basis for ecosystem-based management by synthesizing and providing "[. . .] analysis of information on relevant physical, chemical, ecological, and human processes in relation to specified management objectives" (Levin et al., 2008, 2009). Levin et al. (2016) provides an overview of the progress the IEA program has made toward viewing ecosystems through a coupled social-ecological systems (SES) lens that explicitly includes the "social" elements of SES, or human dimensions (including social, economic, and cultural), in evaluating ecosystem status, risk, and trade-offs of management alternatives to sustain human well-being. IEAs initially followed the established Driver, Pressure, State, Impact, Response (DPSIR) approach to ecosystem assessments (as described by Kristensen, 2004), which largely includes humans only via activities that put negative pressure on the biophysical ecosystem. IEAs then broadened to include benefits to humans via ecosystem services, as a Driver, Pressure, State, Ecosystem service, and Response (EBM-DPSER) model (Kelble et al., 2013). Recent work draws on a more holistic SES approach, conceptualizing the biophysical environment and human dimensions of the system as interconnected, influenced by both biological and social drivers, mediated by habitat and local social systems, affecting ecological integrity and human well-being, and often linked through human activities (Levin et al., 2016; Karnauskas et al., 2017; Ingram et al., 2018).

Developing measurable indicators for the human dimensions of SES has been challenging. Reviews of frameworks designed for broad ecosystem application have noted that most: represent the social and ecological systems in unequal breadth or depth; ambiguously operationalize social concepts (Binder et al., 2013; Hinkel et al., 2015); or draw unevenly from the range of social sciences (Fabinyi et al., 2014). In addition, available social data at the scale of large marine ecosystems is usually limited to information about population demographics, methods and patterns of resource use, and economic performance, which do not adequately capture important linkages between biophysical conditions and cultural benefits of nature (Daniel et al., 2012). This has been a challenge for SES work in general. Kittinger et al. (2012) noted that far more attention has been paid to understanding biophysical dynamics than human dimensions of coral reef management and that there are limited efforts that link social information to biophysical conditions, a concern echoed more broadly by Rissman and Gillon (2017). Our research focuses on the desired outcomes of coastal and marine management related to particular human dimensions of management, namely human well-being and related ecosystem services, to advance their representation and operationalization in SES frameworks for coastal and marine management. Future work will build on these frameworks to identify specific indicators. In addition to contributing to theory and methods, this effort will improve annual Ecosystem Status Reports, which summarize the status and trends of IEA SES components, and will allow better evaluation of the success of management interventions with respect to desired human well-being outcomes.

Many SES frameworks take an anthropocentric perspective, viewing the ecological system as a provider of ecosystem services that support human well-being (Binder et al., 2013; Kelble et al., 2013; Partelow and Winkler, 2016), and often draw on the four categories of ecosystem services described in the Millennium Ecosystem Assessment (2005). Three of those four categories, provisioning (e.g., food and water), regulating (e.g., climate and flood regulation), and supporting (e.g., nutrient cycling) services, can be quantified through well-established methods and incorporated into these types of assessments and management, while the fourth, cultural ecosystem services (e.g., aesthetic, spiritual, recreational experiences), continues to require significant conceptual, methodological, and empirical attention (Daniel et al., 2012; Hernández-Morcillo et al., 2013; Pascua et al., 2017). Cultural ecosystem services are not limited to indigenous or traditional cultures, but rather refer to the often intangible or non-material benefits derived through people's relationship with an ecosystem, evidenced in their spiritual values, social interactions, and emotional experiences (Millennium Ecosystem Assessment, 2005; Chan et al., 2011; Small et al., 2017). Cultural ecosystem services can contribute to a person's well-being via processes such as fostering and maintaining connections to place, identity, values, or directly enabling cultural practices (Chan et al., 2012; Fish et al., 2016; Poe et al., 2016; Pascua et al., 2017), which in turn can affect how people interact with the ecological system. There have been substantial barriers to operationalizing cultural ecosystem services in ecosystem service frameworks for coastal and marine management. One barrier is the predominant focus on uni-directional flows of ecosystem goods and services, which has become institutionalized in the Open Standards for the Practice of Conservation (The Conservation Measures Partnership, 2013). This approach does

not require examination of the social system (including aspects of resource stewardship and governance), as it presumes that the state of the biophysical system automatically determines the ecosystem services received, rather than feedbacks between SES (Chan et al., 2012). Other barriers are related to the perceived difficulties of measuring non-material benefits that are socially constructed and subjective rather than material components of the ecosystem (Daniel et al., 2012; Fish et al., 2016), and a resistance by decision-makers to drawing on anthropology and related qualitative social sciences to understand non-material cultural dimensions (Bennett, 2019). In response, multiple social science approaches have been identified to help improve the robustness of cultural ecosystem services indicators, although they are not regularly implemented in practice, emphasizing the importance of including multiple social science traditions on transdisciplinary teams for comprehensive SES assessments (Daniel et al., 2012; Fish et al., 2016; Small et al., 2017).

A growing body of literature also has focused more directly on development of human well-being indicators for ecosystem assessment and management (e.g., see Dillard et al., 2013; Wongbusarakum et al., 2014; Breslow et al., 2016). These efforts define human well-being as "people's ability to live a life they value" (Wongbusarakum et al., 2014, p. 4) and as, "a state of being with others and the environment, which arises when human needs are met, when individuals and communities can act meaningfully to pursue their goals, and when individuals and communities enjoy a satisfactory quality of life" (Breslow et al., 2016, p. 251). Attention is paid to a range of well-being domains including livelihoods, health, education, and governance. Common to these efforts is the focus on the meanings people place on their interactions with the environment and society, and their abilities to act and enjoy their lives. Yet, as with ecosystem services assessments, material aspects of well-being are predominantly measured, while non-material elements (such as sense of place, cultural values, and identities) are lacking (Mckinnon et al., 2016), and may require additional social scientific methods to develop appropriate metrics and next-generational conceptual models, especially those designed to examine subjective perceptions of well-being (Breslow et al., 2016, 2017).

Both cultural ecosystem services and human well-being approaches to natural resource management recommend developing place-based indicators tailored to management needs due to the relational nature of environmental spaces, natural resources, cultural practices, and perceived goods and benefits (Dillard et al., 2013; Breslow et al., 2016; Fish et al., 2016; Partelow and Winkler, 2016). Unlike other NMFS IEAs, which span geographic areas as large as the Gulf of Mexico, or the entire west coast from Washington state to Baja California (known as the California Current), the West Hawai'i IEA focuses on a smaller area where there has been a history of marine conservation activity. It encompasses the western coastal and marine ecosystems off Hawai'i Island, with the western boundary dictated by ecology linked to West Hawai'i and land based processes and activities included to the extent they affect marine ecosystems (**Figure 1**). This limited geography makes it conducive for exploring place-based ecosystem assessments. In addition, previous work with stakeholders in West Hawai'i identified cultural ecosystem services as exceptionally vulnerable to ecosystem change and an area that needed to be examined in greater detail to ensure human well-being (Ingram et al., 2018). These conditions also indicate the utility of a biocultural

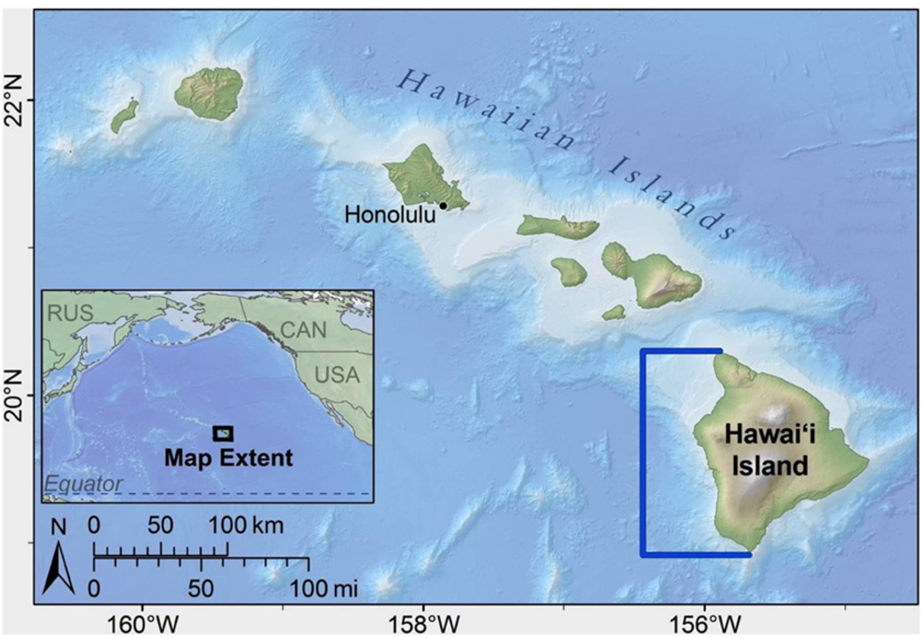

FIGURE 1 | Approximate geographic extent (blue line) of the West Hawai'i Integrated Ecosystem Assessment. Source: Joey Lecky, Pacific Islands Fisheries Science Center, and NMFS.

approach which emphasizes linkages between biophysical and sociocultural components of SES, partners with local communities to identify feedbacks between ecosystems and human well-being, and relies on multiple-knowledge systems to identify management interventions that can meet objectives of stakeholders with diverse priorities and worldviews (Gavin et al., 2015; Sterling et al., 2017a; Gavin et al., 2018). Following this type of approach should lead to indicators that are place-based, culturally grounded, and reflective of both human well-being and the resilience of the associated ecosystem (Sterling et al., 2017b).

West Hawai'i is home to a highly productive and diverse marine ecosystem, supporting an abundance of tropical corals, reef fishes, sea turtles, cetaceans, and manta rays (Gove et al., 2016). The marine resources in the region provide a multitude of ecosystem services valuable to people both locally and globally, such as tourism (the Hawai'i Visitor Bureau reports over 1 million visitors in West Hawai'i annually), aquaculture, protection from wave and storm impacts, fishing, and innumerable cultural practices and activities. West Hawai'i also encompasses a complex social and cultural context, with communities featuring: indigenous Kanaka Maoli (Native Hawaiian) families who may possess profound and diverse indigenous ecological knowledge relative to marine, coastal and terrestrial domains and linkages among them; long-established local communities with families rooted in the plantation and labor histories of different agricultural projects from the late 19th century to the present; relatively recently established families primarily from continental North America and Asia; diasporic communities of Pacific Islanders from elsewhere in the region; and, finally, large numbers of transient tourists and the service providers that cater to them in numerous activities across terrestrial and marine domains. The complexity of the social and ecological context, and the small spatial scale, in West Hawai'i affords a unique opportunity to examine how to better integrate social datasets and place-based human well-being metrics into ecosystem-based management of SES and to improve local management.

MATERIALS AND METHODS

Given our research focus and location, we adopted the biocultural approach described above. Fundamental to this approach is respect for the plurality of priorities, worldviews, and governance systems through which stakeholders interact with resources and their management. Thus, we sought project consultants and community partners to help us better understand: how to appropriately integrate human dimensions into the West Hawai'i IEA project; the most relevant potential human well-being indicators to pursue in more depth; and how management could more effectively develop the links between people and the coastal and marine resources in order to achieve a more sustainable outcome that balances ecological and human well-being.

We applied this approach to three activities: input from specialists; synthesis of relevant literature; and qualitative data collection through group discussions and pilot interviews.

Input From Subject Matter Experts, Resource Managers, and Local Community Leaders

We invited a group of mentors from various backgrounds to help guide the development of our project. These included six subject matter experts, two resource managers, and three local knowledge and community leaders. The subject matter experts were identified based on their experience and knowledge working in the following areas: cultural ecosystem services; sense of place; monitoring human well-being in conservation or natural resource management; and research or collaborative work with communities in Hawai'i or indigenous peoples who rely on marine and coastal resources. The two resource managers have years of experience working in West Hawai'i and are involved in day-to-day efforts bridging research, management, and community needs. The three local knowledge and community leaders were recommended by staff of conservation organizations in West Hawai'i; had a strong connection with West Hawai'i; and worked toward sustainable development, conservation of natural and cultural resources, or natural resource management.

Throughout the project, we sought feedback and advice from the mentor group as a whole or approached individuals as needed for their specific areas of expertise. Subject matter experts helped identify relevant sources of literature for review and provided input on our study design, data collection protocols, and methods. Managers and community leaders identified ways that IEA research can contribute to management and community needs, helped us identify communities that might benefit from this type of work, and helped build relationships with these communities who subsequently continue to partner in the research.

In addition to the project mentors, we involved over a dozen West Hawai'i and Hawai'i State resource managers in multiple ways. We discussed current and future goals of the management agency and identified gaps that should be filled; how our research could be tailored to address the needs of the local management and community in West Hawai'i; challenges management faces when working with the communities; and their advice to our research project. We also attended local meetings to inform participants about the project and discuss relevant marine management issues. These meetings were intended to help build local support for future data collection and collaborative management.

Synthesis of Relevant Literature

We first searched the literature to understand how SES frameworks have been used to examine human well-being and cultural ecosystem services for natural resource and marine management. We focused on studies where social scientific methodologies might improve the representation of these concepts, especially related to measures of non-material elements and types of management interventions that might address them, as well as studies in Hawai'i or the Pacific Islands.

We then selected 11 key references most relevant to the West Hawai'i SES owing to their topical or geographical focus (Millennium Ecosystem Assessment, 2005; Smith and Clay, 2010;

Michalos et al., 2011; Dillard et al., 2013; Smith et al., 2013; Gould et al., 2014; Wongbusarakum et al., 2014; Biedenweg et al., 2016; Breslow et al., 2016; Pascua et al., 2017; Sterling et al., unpublished) and systematically reviewed them with respect to human well-being and cultural ecosystem services definitions and potential indicators. We created an initial list of the domains (broad category), attributes (definitions or descriptions of a category), and potential indicators of human well-being in relation to cultural ecosystem services used in each reference, grouping similar items together. The research team then discussed the terminology, underlying definitions, and examples of indicators in the references, further consolidating the groupings list. When there were differences, we relied heavily on the studies that had been conducted in Hawai'i or the Pacific Islands region (Gould et al., 2014; Pascua et al., 2017; Sterling et al., unpublished) and our own experience for their local relevance. We shared the results of our discussions with our mentors for feedback and discussion during group calls and through one-on-one discussions and revised accordingly.

Qualitative Data Collection

To learn from stakeholders and community members from West Hawai'i how to better incorporate human well-being aspects in coastal and marine management, we held an informal session at the Symposium on West Hawai'i's Marine Ecosystem in Kona, Hawai'i on December 6, 2017 and piloted a series of semi-structured informal interviews with community members.

The symposium was a free, 2-day event to which scientists, resource managers, and community members were invited to learn about ongoing research related to the regional marine environment. Our session was held over a 1½ h working lunch and was attended by approximately 25 individuals, primarily community members and resource managers. We began with a discussion of the ways in which human well-being is starting to be considered in ecosystem management and other IEAs, including the predominant depiction of human well-being as an outcome of ecosystem services. To begin to identify locally important connections between the marine ecosystem and human well-being, we then asked participants to reflect on the question "How does the marine ecosystem contribute to the things that matter most to the people in West Hawai'i?" We discussed this topic as a group and participants submitted specific written responses anonymously. The session revealed the importance of thinking about place-based conservation at a finer scale within West Hawai'i, described in the Section "Results."

Using discussion from the session as guidance, we focused our project on learning from communities that have organized around the ideas of place and conservation. We created a set of considerations to help identify candidate places and communities as project partners (**Table 1**). Rather than viewing these considerations as a checklist, we used them to reflect on benefits or challenges that potential communities might experience if they decided to work with us, as well as what our work would contribute to the communities. This process informed who we approached to be involved in the project and how we thought about desired outcomes.

TABLE 1 | Considerations for Identifying Place(s) and Community(ies) that can help ensure research process and outcomes have greatest benefit to all involved.

Cultural[1] conditions
1. Well-defined or clearly perceived boundaries of place by the community
2. Existing or reviving cultural and/or traditional practices or culturally valued locations
3. Support of community groups and agencies to continue the above practices and locations
Community conditions
1. High level of social cohesion and collaboration within the community
2. Diverse perspectives and opinions being well represented
3. Perception of community participation to other nearby communities
4. Level of transferability and useful lessons to others (researchers, managers, community members)
Research conditions
1. Possibility to build on existing relationships and strengthen trust between researchers and community
2. Availability of local champions (i.e., mentors or partners who work closely with the community and researchers)
3. Absence (or degree) of research/survey fatigue among community members
4. Availability of literature and secondary data from same or similar locations to use, learn from and replicate
5. Community *wants* this type of research, and can directly benefit from collaborating with researchers
6. Community *needs* this type of research for planning, community development, etc.
7. Existing foundational research and management in the place and with the community
8. Potential for future study
Governance/management conditions
1. Level of readiness of community members and leaders to work with resource management entities
2. Historical or on-going collaborative management efforts and successes
3. Management interest in conservation of particular place (e.g., aligns with management goals, ecologically or species-specifically significant)
4. Potential future management activities

[1]*Cultural conditions can refer to any community's traditions, practices, and important locations. They are not limited to Native Hawaiian culture but could include plantation culture, surfing culture, or fishing culture, for example.*

We also used the consolidated list that resulted from our synthesis of relevant literature as the basis for an interview guide. We reviewed in detail and pretested the interview guide with several project mentors, other researchers who conduct similar work with communities in Hawai'i, and community members. From April 23, 2018 to May 30, 2018 we conducted seven in-person semi-structured pilot interviews with leaders of communities in West Hawai'i that were working in conservation and place-based management. We asked about their relationship with their community(ies) within West Hawai'i, how they connect with the coastal and marine environment, their perception of the status of ecosystem, predictions they have for the future of their connections with the coastal and marine environment, and their thoughts on ways that science and marine management can help their community(ies) achieve its goals. Questions were open-ended and designed to gain a better understanding of the relevancy of each domain. Our consolidated list was used to prompt follow-up discussion, allowing us to

compare topics that they brought up themselves vs. following a rubric. Interviews lasted from approximately 1.25–2.50 h and were audio-taped.

Preliminary analysis of pilot interviews was conducted by one of the authors using NVivo 12 Plus (QSR International Pty Ltd.), primarily to check the relevance of the interview guide and domains and attributes used as prompts. When a larger number of interviews have been completed, we will complete a full analysis of interview transcriptions and notes.

Combined findings broaden our conceptual framework for thinking about the role of social dimensions in the IEA. Future work will continue interviews with a more diverse range of participants to gain a better perspective of how the coastal and marine ecosystem influences and contributes to human well-being, and to identify specific indicators of cultural ecosystem services and human well-being for West Hawai'i.

RESULTS

We present results in four main areas that improve frameworks to integrate the human dimensions of marine management into SES models for decision making: (1) insights on how to improve the representation of human dimensions within SES conceptual frameworks; (2) potential additional social indicators that might be included in West Hawai'i SES models; (3) the importance of place in relation to cultural ecosystem services and human well-being; and (4) depicting reciprocal and holistic aspects of SES models.

Representation of Human Dimensions in SES Conceptual Frameworks

We identified three areas where human dimensions, and in particular cultural ecosystem services and human well-being, were often underrepresented in the conceptual models used in coastal and marine and management: explicitly including the social system within analyses of the SES state; the interaction between biophysical and social conditions and ecosystem services; and the intentional use of socially oriented strategies to affect human behavior.

Many representations of SES in coastal and marine management use the term "ecosystem state" but measure only biological and physical ecosystem components. As previously mentioned, this approach assumes that with certain ecosystem states, an automatic flow of ecosystem services will result in human well-being. In this conceptualization, desired conditions (ecological health and human well-being) manifest at different points, where biophysical health is a relatively well-described and measured ecosystem state, and since human well-being depends on biophysical health, it is rarely measured as a separate outcome. IEA-focused models more clearly and intentionally ascribe human well-being at the same level of importance as ecological components (e.g., Levin et al., 2016). Thus, depending on the model, metrics of human well-being may be viewed as representing the state of the social system within an SES, or the state of the social system may be attributed to affecting human well-being outcomes.

When viewed through an ecosystem services lens, explicitly considering the state of the social system (e.g., food production and market structure, cultural norms, household characteristics, resource governance system, etc.) led us to think about the ways that social conditions can interact with biophysical conditions to access the benefits of ecosystem services, which are rarely discussed in the literature. For example, even with a service as straightforward as food provisioning, the presence of abundant fish stocks may be necessary, but not sufficient, to ensure food security. Social conditions, such as availability of fishing gear, food distribution networks, access to fishing grounds, and adaptive capacity of fishers may affect the extent to which fish are actually received as food throughout a community (Senapati and Gupta, 2017). In this conceptualization, the interaction between the state of the social system and ecological (biophysical) system determine the degree to which ecosystem services and related well-being are experienced. Given that many cultural ecosystem services are non-material and to a certain degree produced by society, we believe that the interaction between social and biophysical conditions/states will have especially important effects on cultural ecosystem services, and their equitable distribution, and should be examined in more detail.

Given the importance of social conditions on resultant ecosystem services, and therefore human well-being, we also noted that the representation of "ecosystem-based management" in models often did not explicitly discuss socially oriented strategies and outcomes, but rather focused on nature-oriented outcomes. In practice, managers often state, "We don't manage fish, we manage people," yet most models did not appear to have a clear way to represent management actions designed to affect the state of the social system that then cascade to effects on the biophysical system, although some ecosystem cascade models are including these reverse cascades (e.g., Spangenberg et al., 2014). Efforts such as campaigns to motivate participation in beach cleanups, inspire participation in voluntary data initiatives such as the saltwater angler registry, or adopt fishing practices that reduce harmful interactions with protected species instead are often presented broadly as education and outreach initiatives, even though the underlying intent may be to affect people's collective behavior. Explicitly identifying these initiatives as efforts to achieve a change in social conditions would bring attention to potential for social science disciplines such as social psychology or psychological anthropology to improve the effectiveness of these types of activities. These disciplines can improve understanding of the target audience's attitudes, knowledge, beliefs, and motivations to design and monitor campaigns that are more likely to result in the desired behavior, and related desired ecosystem results.

Human Well-Being Domains, Attributes, and Potential Indicators for West Hawai'i

Our review of relevant literature and discussions with mentors resulted in a consolidated list of human well-being domains, attributes, and potential indicators related to cultural ecosystem services tailored to West Hawai'i (**Table 2**). Here, domains represent the broad conceptual areas related to human

TABLE 2 | Human well-being domains, example attributes, and potential indicators for cultural ecosystem services in West Hawai'i.

Domains	Attributes	Potential indicators of cultural ecosystem services
Heritage	Multi-generational interactions/connections with natural resources Archeological and historic sites Cultural resources Acceptable historical change	Transmission of knowledge or practices around deified ancestral guardians (e.g., *'aumākua*); use or transmission of stories and verbal histories (e.g., *mo'olelo*); birth place and family burial sites; ceremonial practices, practices of respect, and other practices related to connection with place and resources
Spirituality	Interacting with the landscape to perpetuate spiritual beliefs and practices (e.g., divine power)	Formal ceremonial practices (e.g., *oli*, *pule*, other cultural protocols used to acknowledge relation to place); perpetuation of songs, chants, dances, and prayers of about place; protocols for place-specific gathering and harvesting practices
	Presence and recognition of plants, animals, and elements that represent/symbolize deities	Creation and use of ceremonial garlands (e.g., *lei*); ceremonial offerings such as fresh water, rain, salt, and turmeric
	Presence and recognition of familial guardians/ancestors; resources themselves recognized as kin	Recognition of deified ancestral guardians that are cared for by and take care of specific families (e.g., *'aumākua*)
Sense of place and identity	Sense of self, community, and/or home related to the coastal and marine environment	Activities on the landscape; heritage, social, and emotional connections to places
	Presence of historical place-based names which describe the past and present of the coastal and marine environment	Place names; landscape terms; species names; environmental process names (e.g., rain names, wind names); transmission of existing or creation of new cultural proverbs to describe these observations
	Engagement of families in coastal and marine resource based activities	Existence and availability of activities such as fishing or harvesting for livelihood or enjoyment
	Presence on and interaction with lands that will remain secure (formally or informally) for future generations	Presence by lease, physical access, ownership, and/or occupation; customary rights and tenure
Education	Local knowledge about the coastal and marine environment	Language and/or culture encoded knowledge of seasonal patterns such as timing and intensity of rain and other meteorological phenomena or plant/animal behavior and reproductive cycles; place-specific practices associated with storied landscapes
	Knowledge transmission (place-based, observational, formal, informal, etc.)	Scientific research, experiential, land-based education, learning from elders, culture-based education (e.g., gathering salt from natural pools and making salt in raised ponds)
	Presence of environmental signs or indicators (e.g., bioindicators) and the ability to recognize them	Species or environmental processes that signal the cycles of another plant/animal species (e.g., types of rainbows to signal events)
Social relations	Perpetuation of practices/skills that allow individuals to provide for and share with their families and community	Goods for household, sharing, and income; jobs that require knowledge of traditional practices or the discipline required; formal and informal apprenticeships; place-based fishing/gathering practices; community fishing endeavors; acknowledgment of young leaders
	Presence of strong social ties or networks; sense of community; trust in neighbors	Network of people to share with and receive from; gifting/exchanging of goods; joint family endeavors; communal child care; community spaces
Stewardship	Ability to care for resources and environment	Contributions of time, labor, and/or monetary support toward maintenance of public or private lands or specific sites; restoration and maintenance of sacred sites (e.g., *wahi pana*), civic activities around public spaces
	Customary rights and responsibilities are locally known, practiced, and respected	Recognition and use of access restrictions, gathering rights, and easements related to traditional ownership or harvesting practices (e.g., *kapu*)
Existence	Aesthetics	Recognition and practices around the appropriate maintenance of specific sacred sites; pride in community parks and coastal areas; beach clean up activities
	Inspiration	Broadly circulating public discourse about collective responsibilities (e.g., caring for place or *malama 'aina*)
	Creativity	Local artistic or creative practices; moralization; poster competitions in schools
Governance and management	Political participation and equity	Participation in marine management decision-making processes and leadership; stakeholder processes; exercising rights/interest in politics; management reflects local and traditional values
	Effectiveness of management	Perceptions of management, permits, and regulation; adequate funding and staff capacity for achieving management objectives; partners and collaboration
Health	Physical and nutritional health Mental and emotional health	Outdoor activities that promote health and strength of body and mind
Safety and security	Security and safety related to real or perceived environmental risks	Protection from threats of natural disasters such as hurricanes, tsunamis, earthquakes, etc. (e.g., level of social preparedness for natural disasters; access to social nets; availability and application of traditional knowledge to mitigate environmental risks)

well-being. Each domain has associated attributes that further describe its aspects and characteristics. Potential indicators are variables associated with the attributes. Some indicators are effective for multiple associated attributes. Later, metrics can be developed to measure the state of selected indicators to assess changes or evaluate trade-offs related to potential management actions. Many Native Hawaiian examples are included because the cultural ecosystem services work in this region has focused on Native Hawaiian culture (see Gould et al., 2014; Pascua et al., 2017); however, most of the domains and attributes can be applied to any of the communities in West Hawai'i described in the introduction.

The definitions of cultural ecosystem services and human well-being emphasize the relationships and meanings derived from interactions with the environment. As described in Satterfield et al. (2013), studies often emphasize the tangible, or material, aspects of the interactions as suggested indicators. These may or may not reflect relationships that are not generally perceived as tangible, but which nevertheless play materially impactful (causal) roles in environmental and ecological states and outcomes. We modified items in our consolidated list to reflect this relational aspect. For example, in the 11 key references we synthesized, recreation is typically listed as a cultural ecosystem service and component of human well-being, with potential metrics including number of visitors, related-jobs, and income generated through recreational activities. Yet, we saw recreation reflected in multiple well-being domains, such as physical health related to outdoor activities, mental and psychological health from regaining life balance and shared activities with families and friends, or landscape-based activities that are related to sense of place. We viewed the aspects of the activity related to cultural benefits, rather than the activity itself *per se*, as a better gauge of the cultural ecosystem service it provided. As we move to the full data collecting stage of the project (completing interviews with community members), we will listen for specific examples that will help us better represent the meanings related to the biophysical components of the landscape and activities in which people engage. For example, rather than merely counting kayak trips, we will also inquire into motivations and experiential benefits of kayaking to those engaged in the activity.

This focus on meanings, relationships, and importance of activities also underscores the usefulness of a bigger toolkit drawn from many social science disciplines to identify appropriate metrics for non-material contributions of ecosystems to human well-being. Primary data collection would be necessary for crucial indicators of the cultural ecosystem service aspects of well-being, such as range of emotional connections to places, amount of pride in community parks, or perceived degrees of protection from environmental risks. While these concepts refer to experiential phenomena, psychometric scales can be created to systematically evaluate the degree to which populations experience them. Additionally, place-based stories, ethnographic narrative, and qualitative analyses can provide in-depth understanding of the meaning of well-being and relationships between social and ecological systems (Vaughan, 2018).

Importance of Place in Relation to Cultural Ecosystem Services and Human Well-Being

As previously mentioned, participants in our informal session at the Symposium on West Hawai'i's Marine Ecosystem emphasized the importance of investigating place at a finer spatial scale. They were uncomfortable treating all of West Hawai'i as one community, noting that specific geographies within West Hawai'i will lead to different types of interactions between communities and marine resources. For example, the extent of coral cover or the influence of submarine groundwater on coral reefs near a community's shoreline result in different ecological characteristics that are conducive to different types of activities and resultant meanings. Attending to place was not only a large part of the session dialogue, it was also reflected in a word cloud created from the written responses to the discussion question (**Figure 2**). These observations led us to focus our research on better understanding reciprocal relationships in a place-based conservation context. The importance of place was also evident throughout the pilot interviews. As suggested in our consolidated list of potential indicators, characteristics of place were reflected in the way people talked about potential indicators. This highlights the importance of not only taking a place-based approach to ensure relevancy of results, but also the way that the geography and ecology of the place itself factor into specific elements of well-being.

There was an assumption by many that because the West Hawai'i IEA is at a smaller scale than other IEAs (e.g., only one part of one state), it would be simpler to identify indicators of social phenomena such as human well-being. Yet, although relatively small in spatial scope when compared to other IEA regions in the United States, West Hawai'i is comprised of multiple unique places which may require site-specific indicators. The West Hawai'i IEA is improved by working closely with these unique communities to identify site-specific management needs. We observed that analogous to the way coastlines exhibit fractal characteristics, with similar spatial patterns revealed at different scales, stakeholder engagement exhibits similar fractal qualities. That is, stakeholder engagement to identify social indicators is equally complex at multi-state levels, vs. local place-based levels. However, the composition of stakeholders will change based on the management questions, which also vary by scale.

Reciprocal and Holistic Social-Ecological Systems Models

In addition to identifying the importance of place, participants in the symposium session also expressed concern with conceptualizing human well-being as an outcome of ecosystem services, as is often depicted in SES models. They explained that viewing human well-being in this way does not adequately convey the reciprocal connections between people and the land and ocean. As one participant described, "...if place is healthy we are healthy. We make place – place makes us. It is in us – our food, livelihood, identity, purpose in life." Reciprocity was also evident throughout the interviews as the natural way that people

FIGURE 2 | Word cloud of compiled responses from all participant responses to the question "How does the marine ecosystem contribute to the things that matter most to the people in West Hawai'i?" All responses included are verbatim. Word size relates to frequency of word use.

talked about their relationships with the environment and/or how they connect with the environment.

Discussions about reciprocal relationships between people and the marine ecosystem led us to think critically about the linear or cascading models of ecosystem services that portray people primarily as negative stressors. Some SES models add people as beneficiaries of positive ecosystem goods and services to represent reciprocity (e.g., Kittinger et al., 2012; **Figure 3A**), however, this relationship only represents one dimension of reciprocity. Similar to other studies (e.g., Rissman and Gillon, 2017; Vaughan et al., 2017; Winter et al., 2018), participants in our research instead described a system where people could be both environmental stressors and stewards, and experience both benefits and risks from the ecosystems (**Figure 3B**). Examples of ecosystem risks in West Hawai'i include king tides, storm surges, vog (air pollution from volcanic gasses), and lava flows.

In addition, our work illuminated a tension between scientific models that parse out elements of the system and the more multivariate dynamics of human domains within the system. Interviewees rarely described a single human well-being domain when discussing interactions with the ecosystem, even when prompted with a question designed to relate to a single domain or attribute. While modelers tend to refer to considerations of a holistic system in terms of identifying all the discrete elements within the system, interviewees described a more gestalt experience where the elements were experienced as broadly interactive, as in **Figure 3B**, making them difficult to separate.

DISCUSSION

As natural resource managers increasingly move toward ecosystem-based approaches and SES frameworks, metrics of human well-being and cultural ecosystem services will be necessary to determine success of management interventions. Yet, there have been considerable challenges in including and

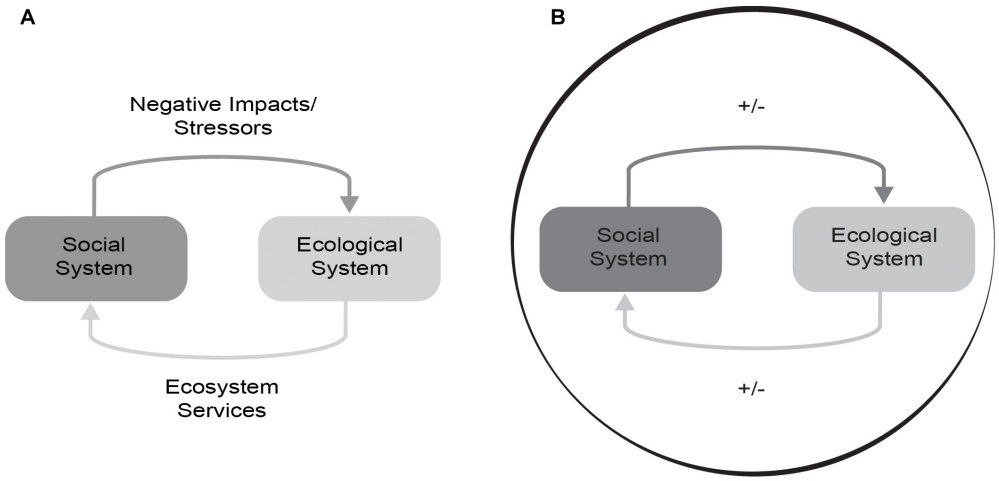

FIGURE 3 | (A) One-dimensional depiction of reciprocity within a social-ecological system, with the social system exerting pressure on the ecological system (biophysical components) and receiving benefits through ecosystem services (based on Kittinger et al., 2012). **(B)** Emergent stakeholder perception of reciprocity, where the social system and ecological system experience both positive and negative interactions with each other, and people generally experience the system as a whole.

operationalizing these concepts in SES models for coastal and marine management. This study contributes key insights and questions focused on: (1) points of inclusion for human dimensions in SES models, (2) culturally relevant domains of human well-being and related indicators, (3) the importance of place and its interaction with scale, and finally (4) the tension between a gestalt vs. discrete approach to modeling, assessing, and sustainably managing SES.

Our examination of SES frameworks identified several points where attention to human dimensions are typically under-represented. First, it is unclear when and how human well-being should be considered a social system state. On the one hand, human well-being may be considered the desired outcome of a management action, and therefore representative of the state of the social system. On the other hand, the state of the social system may be seen as interacting with the state of the biophysical system in delivering ecosystem services that affect human well-being. The conceptualization chosen has implications for identifying and monitoring indicators, as well as planning and implementing management interventions. Spangenberg et al. (2014) and Schleyer et al. (2017) discuss ecosystem services as anthropogenically defined and produced, where the actual benefits received depend on the social and ecological interactions. It may be important to consider the reflexive influence of human well-being conditions (as one aspect of the state of the social system), or to view ecosystem cascade models as representing multiple time steps related to state of the social system. Assuming that the presence of biophysical conditions will result in ecosystem services without considering these social interactions not only misses opportunities for potential social interventions, it also ignores the social processes that, in many situations, may be necessary to ensure fair and equitable distribution of these services. Including these interactions in SES conceptual models may help identify other socially directed management strategies necessary to ensure sustainable and equitable receipt of ecosystem services, and related human well-being outcomes.

In addition, SES frameworks would benefit from more clearly including socially oriented strategies and outcomes. For much of natural resource management, including marine management, socially directed management strategies are often not explicitly designed to target behavioral change and positively affect biophysical conditions, but are instead limited to education and outreach to build awareness. Lack of exposure to social science disciplines may cause managers to overlook other promising and creative approaches to encourage conservation behaviors. For example, the discipline of conservation marketing is now being recognized as a key area of social science contribution to conservation practice (Bennett et al., 2017). This discipline applies conservation psychology and traditional marketing techniques to increase participation in pro-environmental behaviors and reduce activities that negatively affect the environment. Explicitly recognizing when social interventions are intended to change behavior, and understanding their socio-cultural values and relationships with the natural resources, can help identify additional resources, strategies and partnerships that may result in more effective management.

In addition to broad SES frameworks, our consolidated list of human well-being domains, attributes, and potential indicators can help managers identify areas requiring actions to improve elements of well-being related to cultural ecosystem services. To effectively measure the effects on non-material aspects of these concepts, primary data may need to be collected, using social science methodologies. Researchers outline a number of techniques which draw from the full range of social science disciplines and practice areas, including topics as diverse as ethnography, economic

valuation, deliberative governance, and participatory mapping (Daniel et al., 2012; Fish et al., 2016; Small et al., 2017). This range indicates the importance of including a diversity of social scientists from multiple backgrounds as part of an IEA team.

When we started this project, there was an assumption that the smaller scale of the West Hawai'i IEA, relative to other NMFS IEAs, would simplify stakeholder engagement. Yet, we observed that engagement with communities revealed fractal-like characteristics. Large ecosystem scale science and management (e.g., at state or large marine ecosystem levels) is understood as complex, yet smaller geographies (e.g., local and place-based systems) are no less complex, socially and ecologically. Instead, different management questions may be relevant. Small et al. (2017) describe how levels of social organization, from individual, to groups, to communities, to society, affect the values attributed to ecosystem services. They also identify different socioeconomic and environmental drivers of change that act at different spatial and temporal scales and recommend taking a multi-scalar approach. Following such an approach may help identify the types of management questions that can be reasonably addressed at different scales, as well as the range of stakeholders who can be practically engaged. Insights from the local place-based scale of research we explored in this project are necessary to inform management at the site level, but may require additional science investments to carry out across a larger-scale IEA. To make comparisons across sites possible, we recommend following the advice of Breslow et al. (2016), in selecting a set of core metrics alongside site-specific metrics. The core metrics allow transferability and comparison across regions, while site-specific metrics ensure relevant place-based indicators are present at the management table.

Finally, our project is ultimately focused on eliciting specific social metrics of human well-being and cultural ecosystem services, which we believe must be included in scientific models if we are to more effectively and comprehensively assess SES. However, we also identified discrepancies in the way these models tend to portray the relationship between the social and ecological components of the system and the way they are experienced by community members. First, many models portray a one-dimensional view of reciprocity between human communities and marine ecosystems, which focus on benefits to people and may miss important considerations of vulnerability (Binder et al., 2013). In addition, people living in these systems do not experience them piecemeal, but rather as a whole. Viewing/experiencing the environment through this reciprocal, holistic lens is not unique to traditional and indigenous societies, although it been most well studied in these contexts (c.f., traditional ecological knowledge research, Berkes et al., 2000). However, reciprocal and holistic concepts are rarely integrated into modern resource management despite being central cultural models among many contemporary communities. This mismatch is particularly challenging for place-based management, where managers want and value local community input, but management tools may not seem relevant to community experiences and needs. Yet, without uncovering all components of the system, crucial considerations related to cultural ecosystem services and human well-being run the risk of being overlooked by management. Guidance from the fields of community-based management, co-management, and stakeholder engagement (for example, see Wondolleck and Yaffee, 2000, 2017; NOAA Office for Coastal Management, 2015; Hawai'i Sea Grant, 2018) may be useful in bridging the needs of scientific modelers for discrete and simple components and the holistic, boundary-collapsing gestalt of living in a place.

There were a number of limitations to this first stage of our research. First, while we focused on frameworks typically used in marine and natural resource management, we recognize that there is a large body of research around human well-being in other contexts from economic growth to international development (for review, see Dodge et al., 2012; Biedenweg et al., 2016). Our work focused specifically on the linkages between human well-being and coastal and marine resource management. Given that we identified limitations in how these concepts have been applied in practice, it would be useful to re-examine some of the questions raised by our study through the lens of well-being used in other contexts, including drawing from disciplines such as public health, psychology, and economics as we refine our research. For example, recreation as a domain of well-being may be unique to natural resource management, whereas our interpretation of recreation as an activity that influences well-being may be more similar to broader literature under which recreation may impact human well-being domains such as physical and mental health. Second, our focus on the linkages between cultural ecosystem services and well-being does not include aspects of well-being related to the other main categories of ecosystem services, which need to be included to fully assess well-being in a SES. Many of those linkages are already accounted for in current conceptual models of the West Hawai'i ecosystem (Ingram et al., 2018), however, it is possible that examining cultural ecosystem services separately from the other ecosystem services may affect the relative importance placed on different types of services. Finally, we did not yet assess the status of potential indicators of well-being to determine those most sensitive to management actions. This will be a necessary future step to identify a set of meaningful and manageable set of metrics to monitor.

Despite these limitations, our work enhances recent efforts to improve the representation of the human dimensions of SES. By advancing our thinking about the broad frameworks used to represent cultural ecosystem services and human well-being into SES models, we are improving the ability to achieve NMFS guiding principles related to ecosystem-based management, especially related to appropriate social indicators. Future work will apply these insights with partner communities to identify more specific indicators. We hope that our findings not only improve the ability of future models to assess status and trends of the full range of SES components, but also to holistically integrate human experiences into the management of marine ecosystems, large and small.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the University of Hawai'i Institutional Review Board (IRB) with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The project has exempt status for Human Subjects Research from the University of Hawai'i Committee on Human Studies (CHS) under the exempt project 19449, Socioeconomics of Western Pacific Fisheries.

AUTHOR CONTRIBUTIONS

KL and SW conceived the project, wrote the funding proposals, and developed and coordinated the project design and activities. RI was responsible for day-to-day project management, contributed significantly to project design, and conducted the literature review and interviews. KL and RI co-led the symposium session. AM and MP served as project mentors and helped shape the direction of the project. KL led the writing of the manuscript. All authors contributed significantly to the writing of the manuscript.

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