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A holistic framework for identifying human wellbeing indicators for marine policy



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ABSTRACT

Marine managers increasingly recognize the interconnections between management strategies, ocean health and human wellbeing. While recent trends in marine policy seek to consider the effects of natural resource management on human wellbeing, most resource management agencies have limited indicators of human elements. Part of the difficulty in addressing human wellbeing is that there is no consensus on its definition nor how it can be influenced by marine health. To address this gap, this paper describes a framework that identifies six domains of human wellbeing that are affected by the status of the environment: physical, psychological, cultural, social, economic, and governance. The framework is then applied in two case studies for developing social attributes and indicators from the Pacific Northwest of the United States. The reactions to the framework and examples of using it to inform marine policy are included, demonstrating that it is a broadly useful, scientifically-grounded structure for selecting environmentally related human wellbeing indicators.

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1. Introduction

Since the publication of the Millenium Ecosystem Assessment (MA) in 2005 [37], greater attention has been given to the effect of environmental health on human wellbeing (HWB). This assessment argued that healthy ecosystems support the ability of humans to survive and thrive, and that understanding the interactions between HWB and ecosystem health are critical to promoting a healthy planet. Not only do healthy environments support humans, but the constant search for improved wellbeing influences the way people engage with the environment [14]. Identifying and monitoring the specific linkages between the environment and humans allows for more accurate assessments of socially appropriate environmental management strategies and the impacts of existing strategies on HWB.

The spread of the MA framework has resulted in resource management, ecosystem recovery, and conservation organizations across the globe striving to incorporate HWB into their programs in a variety of ways [9]. For example, the U.S. Environmental

Protection Agency developed the EnviroAtlas to promote planning that takes into consideration the public health impacts of nature [54]. To enhance internal programming, The Nature Conservancy recently developed a human dimensions program to understand HWB within their conservation programs [32]. And regionally, the Puget Sound Partnership, a Washington State agency coordinating the recovery of Puget Sound, included two human-focused goals – human health and human wellbeing – within its suite of six ecosystem recovery goals [40]. The recognition of HWB as a goal for environmental management is an important first step to addressing issues associated with social-ecological systems [17]. In practice, however, there is no framework that explicitly supports the incorporation of understanding about HWB–environmental linkages in marine policy planning and decision-making.

To describe the links between the marine environment and HWB, this paper begins with a general review of the academic research on human wellbeing. Within the social sciences, HWB has been found to be influenced by many aspects of people's everyday lives, including material wellbeing, healthy relationships with family and friends, emotional and physical health, productive work environments, and how people feel about their personal safety [19,42]. Subjective wellbeing, which is defined by each individual, is often measured with life satisfaction or happiness surveys that ask people to rank their personal happiness, values, or preferences

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[19]. Objective wellbeing, which is defined by others, has traditionally been measured by indices such as the Gross Domestic Product (GDP) and the Human Development Index [19]. For the most part, HWB researchers agree that a reliance on either subjective or objective definitions is inadequate and that appropriate definitions and measures of HWB must include both [19].

There is a large body of research covering both subjective and objective determinants of HWB in fields such as psychology, sociology, economics, public health, and anthropology [18,19,22]. Rath and Harter [42], for example, summarized data from 150 countries to describe five universal determinants of wellbeing: career, social, financial, physical and community. They explain that a reliance on any one of these over the others would result in personal dissatisfaction, whereas having a balance of all determines overall HWB. Some countries have specifically set out to measure a broader concept of HWB as an indicator of effective policies. Canada's Index of Wellbeing (CIW), for example, measures eight domains that have been proven to correlate to subjective HWB: community vitality, democratic engagement, education, environment, healthy populations, leisure and culture, living standards, and time use [11]. Bhutan's Gross National Happiness index (GNH) was derived from Canada's index but modified slightly for the Bhutanese context. Its domains are: psychological wellbeing, health, time use, education, cultural diversity and resilience, good governance, community vitality, ecological diversity and resilience, and living standards [52]. The GNH index has since been applied to countries across the globe to provide a different perspective to HWB than the traditional measure of GDP that is focused on economic growth.

While the determinants and indices mentioned above are critical for identifying the overall predictors of HWB, they are usually out of the purview of environmental management agencies. Even so, marine managers and policymakers can benefit from an understanding of wellbeing research to identify scientifically-supported indicators of HWB that may be affected by ocean health [38]. Such an understanding can enable the selection of HWB indicators that are likely to play a critical role in the overall social-ecological system, thus saving time, money, and increasing the likelihood for broadly-supported policies. This article responds to the need for better incorporation of HWB considerations in marine policy by creating a broad HWB framework based on current understanding about the complex linkages between human wellbeing and environmental management. An overview of this current understanding is first provided, followed by a description of the HWB framework and examples of how this framework was used to select HWB indicators related to environmental management in two contexts in the U.S. Pacific Northwest. Finally, results from application of the framework and areas for future work are discussed.

2. A human wellbeing framework for environmental management

Similar to the way natural scientists often use a hierarchical framework to describe ecosystem components that represent a biophysical system's overall health (e.g. [27,53]), social scientists can use a hierarchical framework, including domains, attributes and indicators, to organize dimensions of HWB related to environmental health. Domains and attributes are concepts that allow us to understand and broadly categorize information in a way that is useful for a specific purposes, i.e. organizing information to support environmental management decisions. At the highest level, domains describe broad categories of HWB (e.g. psychological health). Within each domain, a set of attributes (e.g. stress reduction) further define the domain. Specific indicators, the

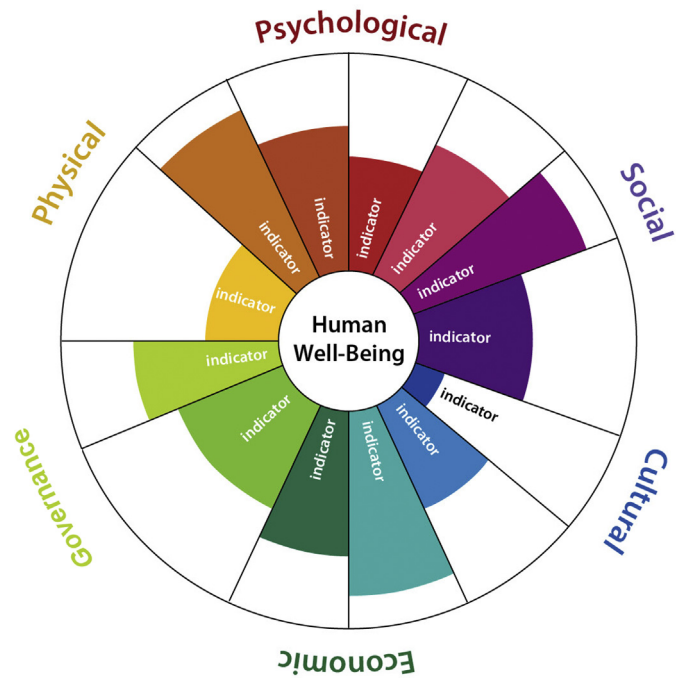


Fig. 1. Visual representation of Human Wellbeing domains for marine policy.

actual measures that communicate information about the status and trends in HWB for a given system (e.g. frequency of experiencing reduced stress after being in nature), are defined for each attribute. While there has been no one agreed upon set of domains and attributes to describe HWB, there is substantial overlap in many efforts to do so, as demonstrated in the similarities among the Rath and Harter [42], CIW and GNH frameworks [25,50]. These efforts informed the development of a framework for HWB related to the marine environment that can support the selection of indicators to be used in ocean management.

The HWB framework presented here highlights six domains of HWB: physical, psychological, cultural, social, economic, and governance (Fig. 1). The domains consider the breadth and complexity of HWB related to environmental health, as informed by literature review and regional input from tribal community members, environmental managers and scientists. These six domains incorporate most of the domains from the non-environmentally specific frameworks of Gallup, the CIW, and the GNH. They also line up with social science disciplines, making them fairly intuitive and thus easily understood by the public, environmental managers, and scientists alike.

Each of the six domains is described below with example attributes and indicators. Similar to biophysical systems, HWB is complex and no single component exists entirely independent of another component. As such, each of the HWB domains has one or many attributes that are related to other domains in multiple ways, making simple, uni-directional relationships between environmental components and a single HWB domain difficult to describe. That said, the proposed HWB framework is intended to encourage consideration of diverse components of HWB by providing a structure for thinking about their relationship to environmental health and management decisions based on the best available social science. The degree of HWB complexity incorporated in any environmental management effort will be determined by the degree to which HWB is affected by, and has the potential to influence, management decisions.

2.1. Domain: physical health

Physical health, often referred to as human health, is probably the easiest domain to understand and measure. Physical health related to ocean health includes attributes that are usually measured within western medicine and public health sectors, such as diet, exercise, exposure to toxins, and disease and illness rates. Example indicators of these attributes would include consumption rates of local salmon for the Pacific Northwest [39], ingestion of toxics through food [12], or reported participation in outdoor exercise [31]. Although the brain is part of the body, psychological and physical health were purposefully separated to highlight their respective importance to HWB, mirroring the efforts of more general HWB frameworks (i.e., GNH).

2.2. Domain: psychological health

The psychological health domain includes emotional, spiritual and cognitive health. The emotional attribute of this domain includes the experience of positive emotions, depression, or anxiety, which are known to be positively and negatively influenced by exposure to natural environments or simply the knowledge that those environments exist (also called existence value) [2,58,59,35]). In one study, for example, [60] people identified feeling more happy, calm, or excited following different types of outdoor recreation opportunities. Spirituality is also a critical aspect to mental health [47] and for some is deeply tied to nature [51]. Similarly, cognitive restoration and the ability to stay focused and process complex problems are known to be enhanced by interaction with the natural world [7,29]. Indicators relevant to this domain include self-reported experiences of happiness, gratitude, restoration, and peacefulness as a result of experiencing nature [58–60]. They might also include objective measures such as incidence of depression and anxiety or the capacity of short-term and working-memory [7].

2.3. Domain: cultural

Culture is commonly defined as a system of shared beliefs, values, customs, behaviors and artifacts that humans create and pass on to future generations [28]. While cultural attributes related to natural resources are most commonly associated with indigenous groups, this is not exclusive as all human populations have cultural components that depend on natural resources to some degree (e.g. fisheries and mining) [3]. Additionally, as with all the domains, cultural attributes and indicators are likely to overlap with those from psychological, social and physical domains. Example attributes of culture related to the marine environment include traditional resource stewardship practices, food collection and preparation, language, and natural resource-based legends [8,20]. Example indicators for cultural health include the number of heritage sites maintained by heritage organizations [57], artisanal fishing opportunities [26], or participation in opening day salmon traditions [34].

2.4. Domain: social

Research on HWB has found that social interactions are among the primary determinants of overall wellbeing [42]. Social health is most often encapsulated in the concept of social capital, and includes the attributes of strong families and friendships, and community cohesion [30]. The marine environment provides a variety of opportunities for people to develop social ties while engaging in outdoor activities, environmental stewardship, or passing down trades [15,49,54]. While there are few specific examples of indicators of social health related to the environment,

they could include things such as self-reported participation in outdoor activities with family members, the number of generations of family who engage in marine outdoor activities together, the frequency of social events held in the marine environment, or the frequency of participating in dinner parties highlighting locally-collected food.

2.5. Domain: economic

Economic health is traditionally the most commonly measured domain of HWB [19]. Attributes include income, income distribution, purchasing power, community development, and access to meaningful jobs and income. Indicators related to the maintenance of marine-based economies include the annual number of resource-based jobs available at a communally-defined family wage, percentage of marine-based jobs that are entry-level, and the net income from salmon hatcheries to a native community [9,16]. The tourism industry can also be included in the economic domain; relevant indicators might include travel cost per outdoor activity or annual revenue from tourist activities [23,55].

2.6. Domain: governance

Governance refers not to specific laws or politicians, but to the way that power and decision-making is structured within society [33]. Several studies have explored how people's experience with environmental governance influences their overall satisfaction and sense of empowerment, and thus HWB (e.g. [13,6]). Common attributes from these studies include trust in decision-making processes, social justice, transparency, legitimacy, democracy, and leadership. Indicators for governance include self-reported trust in government as well as objective measures of opportunities for the public to participate in decision-making and the outcomes of public policy differentially affecting diverse demographic groups [41].

3. Methods

To test the utility of the framework to guide selection of contextually relevant HWB indicators, the framework was applied at two different scales in the Pacific Northwest of the United States: The Quinault Indian Nation, a tribal community on the Olympic coast of Washington State with strong ties to native salmon, and Hood Canal, an iconic watershed in Puget Sound, Washington. In both contexts, resource management groups solicited a set of HWB indicators to support the development and assessment of marine management policies that would respond to both the social and ecological needs of the region. In the case of the tribal community, the indicators were focused on salmon habitat restoration. In the case of the watershed, the indicators were general indicators related to watershed health. Following is a description of the two regions with further detail on the methods for developing HWB attributes and indicators.

3.1. Salmon in the Quinault Indian Nation

The Quinault Indian Nation (QIN) is one of six tribes descended from the Coast Salish tradition on the Olympic Peninsula in the Pacific Northwest of the United States (James and Chubby 2002). The tribe owns 84,271 hectares of conifer forest and 23 miles of coastline, including first and second growth rainforest and three important salmon-bearing rivers. The QIN, as with all tribes from Salish descendants, have a deep connection to salmon for all aspects of their wellbeing. The health of salmon populations, however, has been declining over time due to several factors, including

overharvesting, timber extraction, and floodplain conversions. In response, the QIN has developed hatchery programs to help offset declines in natural stocks. They have also built engineered log jams to create more diverse habitat within the river and are considering modifying timber harvest regimes. Each of these environmental management strategies differentially influences human wellbeing, however, and understanding the tradeoffs is critical for selecting those that are least likely to result in behaviors that negatively impact salmon abundance and are most likely to promote HWB. Decreasing timber harvest, for example, might be an effective approach to reducing harvest pressures on salmon habitat, but it could decrease income from timber and thus increase reliance on salmon harvests for economic wellbeing. Additionally, hatchery fish might have less cultural relevance than non-hatchery fish, thus decreasing the contribution of salmon to cultural wellbeing. These are important conversations to have to ensure that policies have the greatest potential for long-term success.

3.2. The Hood Canal watershed

The Hood Canal is a glacier-carved 60-mile long fjord home to two tribes, portions of three counties, and more than a dozen small communities [10]. The region is rural, with both full-time residents and a vibrant recreational community. Residents are multi-ethnic, providing a different level of complexity for testing the framework. It is an ideal place for shellfish farming and is home to several species of salmon that provide commercial and recreational fishing opportunities.

Over the past twenty-five years, the Hood Canal Coordinating Council (HCCC), a council of county and tribal government representatives, has explored the ecological and human dimensions of watershed planning in the region [43]. Through participatory stakeholder processes, they identified the importance of timber, fishing and shellfishing industries for commercial, recreational and cultural activities. They also identified that human behaviors, such as timber harvesting, agriculture and infrastructure development, have influenced the health of these systems and their ability to contribute to human wellbeing. Because the HCCC had been tasked with protecting both the ecological system and the rural communities that depend on it, Council members were interested in identifying key HWB indicators that could be monitored over time to keep a pulse on human impacts of marine management and to inform difficult decision-making about where to invest limited resources toward maximizing ecological health and human wellbeing.

3.3. Defining HWB Attributes and Indicators for the case studies

3.3.1. Defining attributes

Because HWB literature recommends that metrics be both objective and subjective [19,46], data were collected using participatory methods to subjectively identify attributes and indicators in addition to a review of existing data sets that objectively identified HWB indicators. In both the tribal and the watershed contexts, qualitative data was gathered from open-ended interviews first. The primary interview question in both contexts was “How does salmon/the watershed contribute to your wellbeing?” In the watershed, interviews were conducted by the primary author of this manuscript. Nineteen interviewees participated, mostly in their middle ages and 58% of whom were female [5]. In the tribal community, interviews were conducted by a graduate student and a tribal community liaison. The 32 participants ranged from high school students through elders, 38% of whom were women (Amberson 2013). Participants were selected using snowball sampling procedures [4]; the first respondents were recommended as important stakeholders by the relevant

management agencies and subsequent respondents were identified by asking prior respondents to recommend local residents with perspectives that were likely to be different from their own.

The primary content of interviews consisted of values associated with salmon or the watershed and aspects of salmon or the watershed that contributed to the individual's wellbeing. All interviews were coded into one of the six HWB domains by two independent coders. Differences in domain assignment were discussed between the two coders until they reached agreement. The first coder then independently coded the items within each domain, creating a codebook that identified attributes that organized the concepts within each domain. The second coder used the codebook to code the same items. Again, the two coders reviewed their results, modifying any disagreement in the wording and assignment of attributes through iterative conversations. In the watershed, these domains and attributes confirmed by qualitatively comparing them to existing documents and literature from the region [5], while the tribal community data was confirmed with a tribal cultural liaison who had done extensive work on the tribe's relationship to natural resources [1].

3.3.2. Developing indicators

There were two methods to identify indicators for each of the attributes. For the tribal community, representative indicators were suggested by two social scientists familiar with regional tribal contexts and then validated for their appropriateness during a follow-up workshop with twelve tribal community members. In the watershed, the indicator development process included four phases: compiling social indicators that had already been identified in the region (found in [24]), selecting those which were relevant to the attributes derived from the interviews, ranking and refining these indicators during three workshops with thirty-two expert stakeholders, and ranking and refining these indicators with seven social scientists from outside the region (summarized in [5]). All meetings were professionally facilitated and extensive notes were taken during conversations about the indicators to assist final refinement.

3.3.3. Assessing validity of proposed HWB domains

With the validated indicators at hand for each project, the evaluation of the framework was then scaled up to determine whether the six originally proposed domains were inclusive enough to encompass all indicators, and, alternatively, whether all six domains were necessary to provide a comprehensive yet easily accessible index of HWB related to environmental management. This was a qualitative process that focused on two criteria: (1) whether any items from the interviews were coded as HWB attributes but did not fit within one of the six domains (as agreed by the two coders) and (2) whether workshop participants in either region expressed the need to modify the domains by either refining the titles or adding or combining domains. Open conversations about this topic were facilitated throughout the research process.

4. Results

Table 1 presents example indicators derived from the QIN process, organized by domain and attribute. Indicators were identified for all six domains and several attributes are represented within each domain. For example, within the Cultural domain, “Frequency of sharing salmon legends annually” and “Percent of population participating in first salmon ceremony in past year” were identified as relevant and useful indicators of the attributes Traditional Practices and Spiritual Practices, respectively. Overall, the workshop participants found the classification of HWB into the six domains to

Table 1
Human wellbeing attribute and indicator examples related to salmon in the Quinault Indian Nation.

Domain	Attribute example	Indicator Example
Psychological	Identity	Contribution of salmon to tribal identity
	Pride	Level of pride in personal relationship to salmon
Physical	Dietary health	Percent salmon contributes to diet annually
Social	Sharing	Frequency of donation of salmon within community annually
	Social interactions	Frequency of community meals with salmon as main dish annually
Cultural	Traditional practices	Frequency of sharing salmon legends annually
	Spiritual practices	Percent of population participating in first salmon ceremony in past year
Economic	Income and Revenue	Percent annual income provided by salmon
	Jobs	Number of tribal jobs provided by hatchery
Governance	Access	Percent of traditional grounds in tribal ownership
		Reported ability to access traditional grounds
	Community participation	Number of non-government workers participating in decision-making meetings each year

accurately and comprehensively capture their understanding of HWB as it relates to the natural environment and to provide a useful tool for identifying the important attributes and associated indicators of HWB related to salmon within the QIN.

In the Hood Canal, a total of 26 indicators were identified through the stakeholder input process and recommended to the HCCC for consideration [5]. Table 2 presents example attributes and indicators from the set of 26. As with the QIN case study, indicators were identified for each of the six domains of HWB. These specific indicators and the attributes that further defined each domain, however, differed between the QIN and the HCCC study. For example, in the Psychological domain, the Identity attribute was common in both the QIN and the Hood Canal. The Pride attribute, however, was only salient in the QIN. And, although Identity was an attribute for both locations, the most relevant indicator differed based on the context. In the QIN, where the focus was on salmon restoration, the indicator was the extent to which salmon contributed to an individual's identity. In the Hood Canal, however, where the focus was on overall watershed management, the indicator was the extent to which residents felt attached to the place. The two studies resulted in different attributes and indicators because the attributes and indicators were developed to best describe the regionally specific issues within each domain.

5. Discussion

The first step toward development of a useful set of HWB indicators is to identify the aspects of HWB that are most influenced by the health of the environment. The HWB framework presented

here highlights six broad domains – Cultural, Social, Psychological, Physical, Economic and Governance – that encompass attributes scientifically supported to relate to environmental health. While our framework is only one of many ways to organize the relationship of HWB to marine management, the case studies in this article demonstrate that the six domains and their classification into locally relevant attributes and indicators is a useful tool for developing HWB indicators related to marine policy. The domains appear to be comprehensive and broadly applicable to different cultural and environmental contexts. In contrast, attributes and indicators of HWB were found to be more specific to the contexts. That said, while there were no issues with coding attributes and indicators into each of the six domains, it was sometimes difficult to select only one domain in which to code the indicator. The authors suggest, however, that it is not imperative that the domains hold mutually exclusive indicators. Rather, the six domains are offered as a guide to ensure consideration of diverse components of HWB. In fact, an indicator that can represent several domains is ideal as it can minimize data collection while ensuring that a diversity of HWB aspects is considered.

In addition to suggesting that contextually specific indicators are necessary to capture local variability in the way that people engage with the marine environment, the case studies demonstrated that a diversity of indicator types, e.g. direct measures, constructed measures, and proxies, can be useful for monitoring the health of HWB. In the QIN, for example, Identity, an attribute of the Psychological domain, was measured with a constructed measure on a scale of 1–5 of the extent an individual perceives salmon as contributing to their tribal identity. In contrast, a direct measure, the percent of diet that is composed of salmon, was developed as an indicator of Dietary Health, an attribute of the

Table 2
Human wellbeing attribute and indicator examples for Hood Canal.

Domain	Attribute example	Indicator example
Psychological	Place Identity	Percent of residents who express a positive connection to the region
Physical	Exercise	Percent of swimming beaches that meet safe swimming standards at all times during the summer
	Safe food	Toxin levels in shellfish harvest areas, commercial and recreational: PSP, crypto, giardiasis, vibriosis, norovirus
Social	Trust	Percentage of residents who trust people in their surrounding community
	Strong Communities	Percent of residents who have worked with other residents to manage resources, prepare cultural events, solve community challenges, or share harvested goods in the past year
Cultural	Traditional resource practices	Proportion of residents who say that they would like to regularly access traditionally/commonly harvested natural resources and are able to do so as much as needed
Economic	Industry	Percent of revenue to local economy from commercial shellfish, commercial fishing and tourism
		Number of local supporting businesses to industry, by natural resource sector
Governance	Access	Percent of shoreline that is publicly accessible or owned
	Communication	Percent of Hood Canal residents who have learned about marine management or recreation issues through different media this year: newspaper, radio, website, printed media, app, educational resources for school aged children, word of mouth; include source
	Trust in government	Number of Hood Canal residents who report trust in experts and local and state government and collaborative government efforts

Physical domain. Finally, a proxy measure, toxins in shellfish harvest areas, was used in the Hood Canal for the Safe Food attribute in the Physical domain because there is no data for incidence of toxicity in Hood Canal residents. Because of the lack of social data for many aspects of HWB related to the environment, and the diversity of types of information that are used to measure HWB (such as subjective and objective measures), this mixture of indicator measures is common and appropriate [44].

One limitation of this framework is its lack of explicit consideration of equity, or social justice. Social justice and equity are among the most important factors related to HWB and the environment. The way this framework approaches justice is to advise that data on all indicators be disaggregated by demographic variables such as poverty level, gender, age, and race. Analyzing *each* of the HWB indicators by gender, socioeconomic status, race, etc. responds to the overall concept of equity; thereby making social justice a transcending concept rather than a stand-alone indicator. The danger in this approach, however, is that if environmental managers choose to report only overall means of indicators, an unequal distribution of benefits and costs will be hidden.

Despite this potential limitation, however, the framework's diverse domains succeed at providing general categories to which many existing indices can be cross-walked. For example, the Hood Canal HWB components (i.e., shellfishing and rural character) that were developed in prior stakeholder workshops fit easily into the six domains. In doing the crosswalk, one of the most important contributions of our framework was highlighted: that attributes or components developed without a conceptual understanding of HWB are often heavily represented by economic indicators, losing the critical diversity of attributes that influence people's HWB. Using a framework that explicitly forces the consideration of more diverse attributes and indicators is more likely to measure the true relationships between HWB and environmental health, and allow for more accurate assessments of socially appropriate environmental management strategies or impacts of existing strategies on HWB.

To validate the HWB framework beyond the case studies, it was presented at several academic conferences, informal meetings with local stakeholders, and advisory boards to public agencies. Academic audiences generally found the framework to be helpful and representative of the way they understand the human dimensions of environmental management. Their primary concerns with its application were data availability and potentially limited opportunities to test any hypothetical linkages between environmental health and HWB. Local stakeholders and private funders, on the other hand, found the HWB domains relevant to them, and found the wheel to be particularly visually appealing. It stimulated their ability to identify the different ways that ecosystems can and do enhance their lives. Individuals who work in policy development agreed with the opinion of both academics and local stakeholders. They also expressed, however, excitement about a conceptual framework that allowed them to understand how and why HWB was important to marine management efforts, how the domains could be fleshed out, and how they could visually illustrate the relevance of social monitoring to the public.

6. Conclusions

Understanding HWB is a critical component to sustainably managing marine environments; environmental protection and recovery often require supporting healthy human populations in order to promote long-term balance in the social-ecological system [17]. Inherent in this statement is the need to assess tradeoffs, or at the very least have an open conversation about the

aspects of ocean health and human wellbeing that could be positively and negatively impacted by management decisions. Those tradeoff considerations may be necessary for different ecological goals (e.g., maintaining both herring and seal abundance), for ecological and social goals (e.g., maintaining nearshore habitats vs. shoreline erosion protection), and for different social goals (e.g., economic benefit for some vs. spiritual benefit for others). The six human wellbeing domains and their breakdown into locally relevant attributes and indicators allow managers to add data and tangibility to those HWB elements that have always been part of complex decisions, but often left out of the equations.

In the QIN, the development of a set of HWB indicators has supported more effective consideration of HWB in decisions about salmon restoration strategies: the tribal Department of Natural Resources is now discussing collecting data for these indicators under different management scenarios to explore potential tradeoffs among economic, ecological, and cultural values when choosing future salmon protection and restoration strategies. In the Hood Canal, baseline data for their indicators has been collected and will be reported in a biannual State of the Hood Canal report. In the future, these indicators are intended to inform the selection of environmental management strategies most likely to result in widespread, desired environmental and HWB goals. Neither of these scenarios would have been possible without the development of relevant HWB indicators that support effective incorporation of human considerations in assessments of potential environmental, economic and cultural benefits associated with different management alternatives. The framework proposed in this manuscript provides a structure for doing so.

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