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A Comparative Study of Human Well-Being Indicators Across Three Puget Sound Regions

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ABSTRACT

Simple frameworks that generalize the best metrics of human well-being related to the natural environment have rarely been empirically tested for their representativeness across diverse regions. This study tested the hypothesis that metrics of human well-being related to environmental change are context specific by identifying priority human well-being indicators in distinct regions. The research team interviewed 61 experts and held 8 stakeholder workshops across 3 regions to identify and prioritize locally relevant indicators. Results from the three regions were compared to determine the degree of geographic and demographic variability in indicator priorities. The team found broadly similar domains and attributes of human well-being across the regions, yet measurable indicators were specific to the contexts. Despite this, the congruence of overarching domains suggests that a high-level framework of human well-being can guide a holistic assessment of the human impacts of environmental change across diverse regions.

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Ecosystem services; environmental management; human well-being; indicators

The Millennium Ecosystem Assessment established that ecosystem services contribute to human well-being and that as we assess global environmental change we are also assessing human quality of life (Millennium Ecosystem Assessment 2005). Thousands of scientists evaluated the status of the world's ecosystems in relationship to their ability to provide security, basic material for a good life, health, good social relations, and the freedom of choice and action. These categories of human well-being were chosen by scientific experts to demonstrate that all ecosystems provide services that are essential for human life, and, because of the inherent two-way relationship between well-being and behavior, to the long-term goal of protecting entire ecosystems.

Identifying and monitoring metrics of human well-being related to natural resources is now seen as a component critical to holistically assessing environmental change (Coulthard et al. 2011; Genskow and Prokopy 2010; Halpern et al. 2012; Milner-Gulland et al. 2014; Anderson et al. 2015). Using fisheries case studies across the globe, for example, Anderson et al. (2015) demonstrated that social indicators, such as economic and community benefits, reveal different outcomes of success than simply ecological or economic outcomes on their own. And Halpern et al. (2014) find significant regional differences in health along the U.S. West Coast by applying the interdisciplinary Ocean Health Index that includes

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sense of place, coastal livelihoods, and food provisioning, among other well-being indicators.

The development of human well-being (HWB) indicators is a growing effort worldwide (e.g., Diener et al. 2009; Rath and Harter 2010; Ura et al. 2012), particularly in countries trying to move beyond gross domestic product (GDP) as the primary metric of social progress. Canada's Index of Wellbeing, for example, measures eight domains that correlate to subjective HWB: community vitality, democratic engagement, education, environment, healthy populations, leisure and culture, living standards, and time use (Canadian Index of Wellbeing 2012). Bhutan's gross national happiness domains (GNH) were derived from Canada's index but modified slightly for the Bhutanese context: psychological well-being, health, time use, education, cultural diversity and resilience, good governance, community vitality, ecological diversity and resilience, and living standards (Ura et al. 2012). And the Organization for Economic Cooperation and Development (OECD) Better Life Index has 11 indicators that have been applied across most nations: housing, income, jobs, community, education, environment, civic engagement, health, life satisfaction, safety, and work–life balance (OECD 2015). While these indicators are not specific to natural resource management, over the past decade several initiatives have emerged from the environmental sector to develop well-being indicators related to natural resources (e.g., Tipa 2006; Donatuto, Satterfield, and Gregory 2011; Scott 2012; U.S. Environmental Protection Agency [EPA] 2012; Biedenweg et al. 2014). Many of these build off the global well-being indicator frameworks.

There is limited holistic guidance on which metrics of well-being are most relevant to natural resources, however, as the science of human well-being related to the natural environment spreads across diverse fields (Biedenweg, Stiles, and Wellman 2016). The fields of psychology, anthropology, and sociology identify factors such as positive thoughts, stress reduction, maintenance of cultural traditions, and strong social ties, respectively, as important human health concerns that are often mediated by the natural environment (Russell et al. 2013; Biedenweg, Stiles, and Wellman 2016). Similarly, political scientists recognize that the governance process contributes significantly to quality of life (Sen 1999; OECD 2013), and health specialists recognize the multiple benefits of environmental health on human bodies, from clean air and drinking water to venues for physical activity (U.S. Environmental Protection Agency 2012). These relationships between people and nature have been identified after decades of research in their respective fields.

Like the Millennium Assessment, the studies conducted by Anderson et al. (2015) and Halpern et al. (2012) relied on expert selection of well-being indicators, with a focus on existing data. While such objectively identified metrics of human well-being are clearly important, most well-being scientists recognize the subjective aspect to defining well-being (Kahneman, Diener, and Schwarz 1999; Diener et al. 2009). Metrics such as life satisfaction and happiness can capture one's assessment of one's overall subjective well-being, but the selection of any well-being indicator relies on subjective decisions that represent an individual's well-being priorities (Diener et al. 2009). Since the selection of well-being indicators has largely been conducted by external observers (except, e.g., Woodcock et al. 2009; Copestake 2008), the validation of the emic importance of human well-being indicators in diverse regions is difficult to find in the published literature. A key question persists: Are priorities for human well-being regionally specific?

In many ways the answer to this question depends on scale: the scale of the framework for defining well-being and the scale of society that we wish to represent (i.e., individuals vs. regions). For example, indicators can be grouped into hierarchies from general to specific. In the Ocean Health Index, these include Goals, Subgoals and Indicators (Halpern et al. 2014). In the Puget Sound, these include Goals, Focal Components, Key Attributes, and Indicators (Kershner et al. 2011). While different terminology can be problematic when communicating these types of projects, what's most important is recognizing that there are different levels at which a suite of human well-being metrics may represent broad definitions well-being.

To empirically explore this question, it is ideal to engage a multiregion, stakeholder-based process to identify those indicators most important for assessing environmental determinants of human well-being. This article describes the results of a project that tested the representativeness of overarching domains, attributes, and indicators of human well-being related to environmental health that can be used by natural resource managers everywhere. After gathering information from local stakeholders in three different regions, we found compelling patterns to suggest that domains and attributes of human well-being indicators are broadly representative of emic definitions of human well-being.

Methods

Context and Site Selection

In the state of Washington, the Puget Sound encompasses 14 watersheds that represent diverse regions, including the Seattle, OR, and Tacoma, WA, metropolitan areas, the Skagit and Nooksak agricultural valleys, and the more pristine Hood Canal and San Juan Islands (Puget Sound Institute 2015). The health of the entire Puget Sound is monitored by the state ecosystem recovery coordinating agency, the Puget Sound Partnership, via indicators for water quality, water quantity, habitat, species and the food web, and human health and quality of life (Puget Sound Partnership 2015). When the indicators were originally adopted, five human health and quality-of-life metrics were included (on-site sewage, swimming beaches, shellfish beds, recreational fishing, commercial fisheries harvest) and placeholders were identified for an additional two (quality of life and sound behavior) with the recommendation that all be improved with empirical research (Wellman, Biedenweg, and Wolf 2014). The research presented is this article addressed this need by developing indicators with stakeholders at regional scales and then testing the hypothesis that relevant human well-being indicators related to the natural environment are contextually unique.

The research team used a comparative case study, working in three diverse regions to develop regionally specific indicators. A region in this context is defined by the geographic organization of action areas with the Puget Sound Partnership. The regions were selected to maximize diverse social–ecological relationships and to work with local resource management agencies that had interest in considering human well-being indicators for their local planning efforts. The first region, Hood Canal, has a comparatively low population density, with about 72,000 inhabitants within a 68-mile-long fjord (Table 1). The Hood Canal is considered relatively pristine, with some of the country's most lucrative shellfish, and is home to both natural-resource-based communities and second-home owners. The second

Table 1. Geographic and sociopolitical comparison of the three research regions.

	Hood Canal Watershed	Puyallup Watershed	Whatcom County
Area	68 miles long	1050 square miles	2,500 square miles
Population	~72,000	~420 K	~200 K
Number of incorporated towns	1	17	7
Numberof tribes	5	2	2
Numberof counties	3	2	1
Primary natural resource industries	Fishing, shellfishing, tourism, agriculture, forestry	Forestry, agriculture, fishing, tourism	Agriculture, mining, industrial, fishing, forestry
Coordinating agency	Intergovernmental watershed council	Privately funded watershed initiative	County

region, the Puyallup watershed, is home to the urban area of Tacoma, Mt. Ranier National Park, and agricultural communities. It has the highest population density of the 3 regions, with about 420,000 residents within 1050 square miles. Lastly, Whatcom County is the site of the Nooksak watershed, where agriculture, timber, and fishing are prominent, and to the politically liberal college town of Bellingham. Each of these regions is also home to at least one tribal community.

Framing the Study

The research team used a general human well-being framework to organize information and test the hypothesis that human well-being priorities differ across regions (Biedenweg, Stiles, and Wellman 2016). This framework defines six domains of interaction between human well-being and the natural environment: physical health, psychological health, cultural health, social cohesion, governance of natural resources, and economic health related to natural-resources-based industries. Following the terminology of the state management agency, the research team defined attributes as a second level of categorization that refined domains into overarching concepts of interest. At the finest level, indicators were the specific metrics used to assess the state of attributes and domains. For example, during the research, healthy local foods and outdoor activity were identified as attributes of the physical health domain. Their indicators included residents' perceived access to local foods and average hours of outdoor activity, respectively. Because equity and social justice are also critical well-being issues that span all aspects of human life, the framework recommends disaggregating all indicators across all domains to determine equitable distribution of interactions and benefits. These attributes and indicators were identified through the qualitative methods described in the following.

Data Collection

The research team was composed of a university social scientist, Puget Sound Partnership adaptive management scientists, a private economist, and regional liaisons to the Puget Sound Partnership. We worked in one region at a time, replicating methods while streamlining and simplifying as appropriate. We used literature review and interviews to identify locally relevant indicators, then stakeholder workshops with a purposive sample of individuals representing domain-specific knowledge to rank and refine indicators (Biedenweg et al. 2014). The literature reviews focused on research and planning documents that

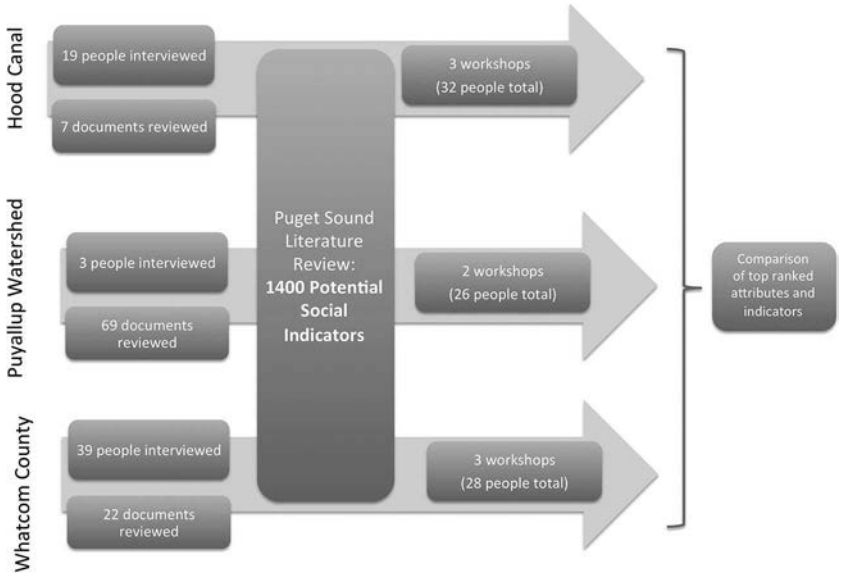

Figure 1. Data collection process for the three case-study regions.

expressed citizen values associated with the natural environment of that region (Figure 1). Simultaneously, we conducted interviews with residents using a snowball sampling technique (Bernard 2006). The interviews focused on the question "How does the [name of corresponding region] environment contribute to your well-being?" When necessary, the interviewees were prompted using the six domains of well-being to ask how the natural environment contributed to their psychological, cultural, economic, physical, and social health, as well as their perceptions of governance. For each region, the first two interviewees were recommended by the regional collaborating agency and subsequent interviewees were identified at the end of each interview by asking for recommendations of people who think differently about their relationship to the environment.

All documents and interviews were coded by two researchers to identify potential attributes for each of the six domains. We first coded items from the documents and transcripts into the six predetermined domains and then coded attributes within each domain using grounded theory (Saldaña 2012). We stopped interviews upon reaching theoretical saturation at the attribute level (Guest Bunce, and Jonhson 2006), which occurred after 19–24 interviews. The primary variation to this sampling scheme was in the Puyallup watershed, where we identified the majority of local values from reports rather than interviews. This was because the collaborating agency had previously conducted stakeholder meetings with diverse groups that specifically asked about values and goals for watershed management. We coded their its meeting notes, rather than conducting interviews with essentially the same participants. In Whatcom County, the primary difference was that we conducted a 15-person focus group in addition to individual interviews, at the request of local residents.

Our first step at deriving specific indicators for each coded attribute was to search a database of social indicators from the Puget Sound region (Hanein and Biedenweg 2012). When the wording for an indicator did not already exist, we developed a constructed

measure that best matched the interviewees' intent (Satterfield et al. 2013). This resulted in 350–380 potential indicators relevant to each region, a number too large to present to stakeholders for prioritization. In the Hood Canal and Puyallup watersheds, an internal research team made up of the project researchers and collaborating agency staff rated this list by relevance (the degree to which the indicator would be meaningful to residents and relevant to management priorities) and importance (the degree to which the indicator provided unique added value to a suite of well-being indicators). By the time we worked in the Whatcom region, we also selected indicators that (1) represented values mentioned more frequently by Whatcom residents and documents and (2) were similar to those that were highly rated in Hood Canal and Puyallup. This internal rating resulted in final lists of 98–103 indicators that were presented to local experts in regional workshops.

To identify local priorities of indicators, we held two or three identical 3-hour workshops in each region (Figure 1). We held stakeholder workshops rather than administering a broadly distributed survey instrument because our intention was to allow people to reword and recommend new attributes and indicators. Based on our field experience, we were aware that the concept of indicators, their measurability, and the breadth of indicator options were not general knowledge. Thus, we selected individuals who could represent the types of data and the critical issues of the regions based on the fact that they were already working with and applying social data. Workshop participants included professionals from county public health departments, economic development departments, tribal governments, historical societies, extension agencies, natural resource-dependent businesses, representatives of environmental protection organizations, and representatives of multiple political parties. Participants were identified through conversations with the collaborating agencies, recommendations from interviewees, and targeted outreach by the researchers to ensure representation of diverse perspectives across all HWB domains.

We held multiple workshops in each region for two reasons: (1) to increase the likelihood of geographic representation by providing locations closer to people's homes and (2) to replicate the workshops to reduce the possibility that group dynamics were the sole factor in final prioritizations. We held only two workshops in the Puyallup region in an attempt to simplify the process, but found that the variation in prioritizing governance indicators was so high that it was difficult to determine commonly prioritized governance indicators for the region. We thus hosted three workshops in Whatcom to improve the comparison by increasing the sample size.

Overall, 86 workshop participants worked in facilitated small groups focused on 1–2 domains to refine and rate a maximum of 10 well-being indicators relevant and important to the natural environment for their domain. During the workshop, participants were first asked to individually rate the indicators on large printouts using colored dots: red = not a good indicator, yellow = potential but needs some work, and green = good indicator. We conducted this first step so that participants could gather their thoughts before engaging in group discussion. Additionally, the visual image of colored dots for each indicator provided the foundation for a group conversation about which indicators they commonly held as priorities for the region. Working with trained facilitators, participants were welcomed to eliminate, combine, revise, or add indicators or attributes in their task of identifying a maximum of ten for their domain. The facilitators took notes of the conversations around each indicator and this qualitative information was used to summarize the similarities across workshops.

Finally, to determine which attributes and indicators were relevant at the Puget Sound scale, we compared the prioritized results from the three regions. All attributes that had been identified in at least two workshops in at least two regions were considered to be candidates for broadly representing Puget Sound human well-being. When those attributes also had common indicators, we identified the specific indicators as broadly representative.

Results

Domain, Attribute, and Indicator Representation Within Regions

Representativeness to the local scale was initially analyzed by looking at the number of attributes and indicators per domain that were prioritized in *at least two workshops* per case study. In total, 21 attributes were prioritized by at least 2 workshops in the Hood Canal Watershed, 17 in the Puyallup, and 21 in Whatcom County (Table 2). Within these attributes, 24 indicators were prioritized in the Hood Canal Watershed, 19 in the Puyallup, and 31 in Whatcom County (Table 2). The distribution of recommended attributes and indicators across the six domains was similar across the regions, with the exception of the Puyallup Watershed because it had one fewer workshop by which it could meet the criterion. This only impacted the governance and social domains, however.

In each case study, more attributes and indicators were prioritized for the economic and physical domains than the social, cultural, and psychological. In fact, no social indicators were prioritized in either of the workshops for the Puyallup Watershed. Governance indicators were also highly prioritized in Hood Canal and Whatcom, yet none met the criteria of being prioritized in the two Puyallup workshops because of the different categorization schemes used by the workshop participants, resulting in several highly recommended attributes and indicators that did not overlap. While we highlight these patterns in domain relevance, we also emphasize that the domains and attributes are not mutually exclusive; many attributes and indicators can represent concepts from more than one domain, although the categorization presented was vetted during the workshops.

Attribute Representation across Regions

For the second level of analysis, we looked at the overlap of specific attributes and indicators across regions. First, some of the prioritized attributes had essentially the same

Table 2. Number of attributes and indicators recommended by at least two workshops by human well-being domain.

	Hood Canal Watershed		Puyallup Watershed		Whatcom County	
Domain	Attributes	Indicators	Attributes	Indicators	Attributes	Indicators
Governance	5	5	2	0	6	6
Social	3	3	0	0	3	6
Cultural	3	3	2	3	2	2
Psychological	3	2	3	4	2	3
Physical	5	6	5	5	6	6
Economic	2	5	5	7	4	8
Total	21	24	17	19	21	31

meaning with slightly different wording from other workshops. These were consolidated and are summarized in Table 3. In total, 40 attributes were prioritized in at least 2 workshops (Table 3). Of these, 28 (70%) were prioritized by at least one workshop in at least 2 regions and 16 (40%) were prioritized by at least 1 workshop in all 3 regions. Five of these broadly important attributes were within the physical domain (access to local food, access to safe/healthy food, outdoor activity, air quality, and drinking-water quality), two were in the economic domain (natural resource industries and natural resource jobs), four were in the governance domain (stewardship, effective governance, access to natural resources, and land use change), one was in the social domain (community cohesion), and two were in the cultural domain (cultural events and cultural heritage).

Access to local food, outdoor activity, air quality, drinking water, cultural events, and natural resource industries were prioritized by at least two workshops in all three regions (Figure 2).

Table 3. Attributes that were prioritized by at least two workshops.

Domain	Attribute	Hood Canal	Puyallup	Whatcom
Psychological	General subjective well-being	2		
	Aesthetics	1	2	1
	Sense of place/place identity	2	2	
	Positive emotions	3	1	1
	Sense of safety		2	2
	Freedom			3
	Pride			2
Physical	**Access to local food**	3	2	2
	Access to safe/healthy food	3	1	2
	Access to natural areas		2	2
	Outdoor activity	3	2	2
	Air quality	3	2	2
	Drinking water quality	2	2	2
	Freshwater quality		1	1
Economic	**Natural resource industries**	3	2	3
	Natural resource jobs/income	3	1	2
	Equity		2	
	Job satisfaction		2	
	Working lands		2	
	Total revenue multiplier		2	
	Tribal fish catch	1	1	
	Local retention of income	1	1	
Governance	**Stewardship**	3	2	1
	Effective government	2	1	2
	Trust in government	2		2
	Democratic engagement/open participation		2	3
	Access to natural resources	3	1	1
	Collaboration			2
	Communication	3		
	Transparency			2
	Land use change	1	1	1
	Fairness		1	1
Social	**Community cohesion**	2	1	3
	Strong families and friendships	3		1
	Trust	3		2
	Future generations			2
Cultural	Traditional resource practices	3		2
	Cultural events	3	2	2
	Cultural heritage	1	2	1
	Rural character	2		1

Note. Exact number of workshops provided within the cells. Boldfaced attributes overlapped across all three regions.

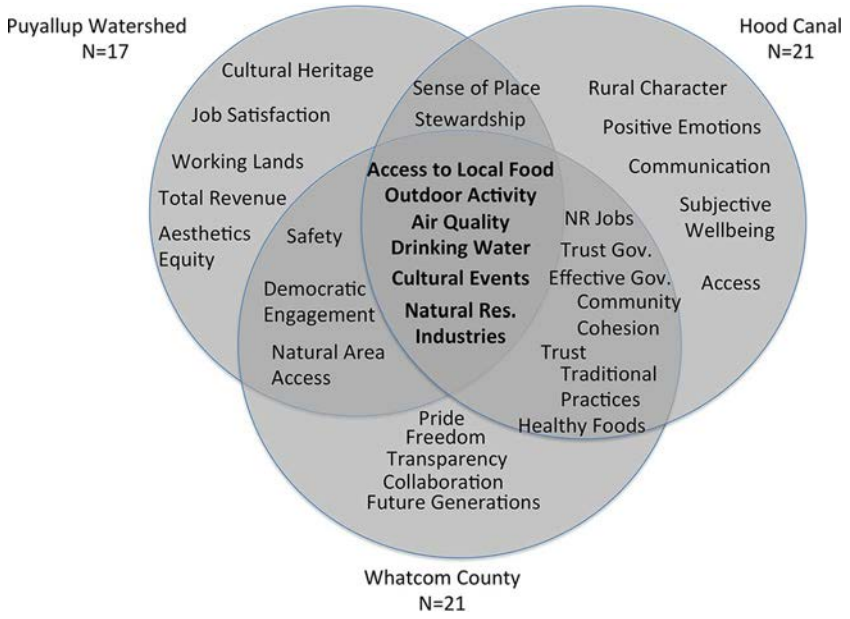

Figure 2. Overlap of prioritized attributes by at least two workshops in a region.

Indicator Representation across Regions

Indicators are the most specific scale of measurement. At the indicator level, only 8 of the 74 indicators (11%) prioritized in at least 2 workshops overlapped across at least 2 regions (Table 4). These included metrics of outdoor activity, natural resource industry revenue, trust in government, trust in community, stewardship, and opportunity and actual

Table 4. Specific indicators that overlapped across regions.

Domain	Attribute	Indicator	Hood Canal	Puyallup Watershed	Whatcom County
Physical	Outdoor activity	Approximate number of hours residents engage in outdoor activities per week			
	Air quality	Number of days during the calendar year that air quality was good, moderate, unhealthful, very healthful, or hazardous			
	Drinking-water quality	Percent of drinking-water systems that comply with relevant water quality standards			
Economic	Natural resource industries	Percent of revenue to local economy from agriculture, commercial shellfish, commercial fishing, timber, nontimber products, and tourism			
Governance	Trust in government	Percent of residents who trust local government to make the right decisions to protect natural resources			
	Stewardship	Percent of population engaging in a natural resource stewardship activity/year			
Social	Trust	Percent of residents who trust people in their surrounding community			
Cultural	Cultural events	Percent of residents who participate in natural-resource-inspired cultural activities			
		Number of opportunities to share and celebrate culture, community, and heritage			

Note. Shaded boxes represent those regions for which the indicator was prioritized in at least two workshops.

participation in cultural events. These specific indicators represent five of the six domains. Only two indicators (3%) overlapped across all three regions. Both were standardized metrics of physical health (air quality and drinking-water quality).

Discussion

External Validity of Domains, Attributes, and Indicators

Exploring representativeness of human well-being indicators is essentially testing their external validity. We found that the six predefined domains of human well-being were widely representative across the three regions. They encompassed all the emic definitions of how nature contributes to human well-being in the three watersheds, and were important for describing the majority of prioritized attributes and indicators in any region. They also largely coincide with the well-being domains used by Canada, Bhutan, and the OECD, including community vitality, democratic engagement, healthy populations, culture, jobs, civic engagement, and life satisfaction. Five of six domains had identical indicators prioritized across at least two regions and all six domains had identical attributes across at least two regions. Many specific attributes were also broadly representative. In particular, the attributes associated with physical health, such as outdoor activity, air quality, access to local food, and drinking water, were important in all regions. Similarly, the status of natural resource industries and cultural events were widely prioritized. We can suggest that these six attributes have substantial external validity for the Puget Sound region (Figure 2). At the indicator level, only two identical metrics were prioritized in all three regions (air quality and drinking water), suggesting that precise indicators may be more context specific. These two indicators were widely prioritized because they have standardized, broadly accepted metrics at county, state, and federal levels. The indicators that varied for other prioritized attributes were often conceptual representations of commonly held values that do not yet have accepted, standardized metrics (i.e., sense of place and community cohesion). In sum, we found that heterogeneity in representative human well-being indicators depends on the scale of the categorization scheme, with domains and attributes being most representative and indicators potentially more nuanced.

Accounting for Bias in the Process

Because the criterion used for identifying representative indicators in each watershed was based on broad representativeness, the method was sometimes ineffective at incorporating underrepresented populations. For example, five indicators from Whatcom County had been prioritized during only one Whatcom workshop, yet they represented common ideas from interviews with groups that were underrepresented in the workshops. The research team recognized the bias of basing human well-being indicator selection on its ability to broadly represent, yet believed such bias will always exist because of stakeholder willingness to participate and limitations on scientists' and resource managers' time. The use of broadly representative indicators is likely the best solution because we know that the indicators are important to all (or most) stakeholder groups, and we can ensure the equitable distribution of benefits by disaggregating data by stakeholder group.

"Expert" Versus Stakeholder Elicitation

We found that the community-based study resulted in different human well-being indicators than had been adopted as a result of "expert" opinion. The initial Puget Sound indicators for human health and quality of life included metrics of swimming beach closures, commercial shellfish bed closures, on-site sewage system failures, recreational fishing permit sales, commercial fisheries harvest, and a broad index of individual environmentally friendly behaviors. These indicators were largely selected because they have existing, long-term data. The quality of the data, however, was not always consistent, and over time the state agency realized that these indicators did not represent the breadth of human well-being related to the Puget Sound. Specifically, these indicators only indirectly measure the opportunity to swim, sell shellfish, access healthy shellfish, catch fish for recreation, and earn money from commercial fishing, respectively. Engaging local stakeholders across a variety of regions allowed us to develop a broader, more representative framework and set of indicators by which to monitor real human well-being impacts of ecological restoration. For example, stakeholders identified the importance of trusting natural resource management, engaging in cultural activities, and maintaining a sense of local identity, none of which have long-term data, yet all of which are critical drivers of satisfaction and compliance with restoration strategies. In addition to these important additions, Scott (2012) found that relying on expert elicitation without stakeholder involvement has often resulted in stagnated processes.

Assumptions and Limitations

We specifically chose a case-study approach to test the hypothesis that representative well-being indicators would be dependent on the social ecological system. Additionally, best practices in social science suggest that the more locally based and interactive the conversation (i.e., developing indicators based on locally derived data and allowing stakeholders to refine those lists), the more likely it is that we can develop relevant, politically supported indicators. Overall, we believe this significantly increased representativeness of the indicators, but it also resulted in two specific downfalls. First, the indicators developed at the regional scales were specific to that watershed or county (although participants were aware of the overall project goals). As such, we made an assumption that the indicators separately developed for Whatcom, Hood Canal, and Puyallup could be scaled in a meaningful way to represent overall relationships within the Puget Sound. We do not believe this is an unreasonable assumption compared to the benefit of the quality provided by a more local stakeholder process. Probably more important to consider, however, is that we do not have quantitative ratings for precisely the same indicator in all three regions. Participants were allowed to modify attributes and indicators to better represent their issues. As a result, we are relying on qualitative comparisons of the recommended attributes and indicators from each workshop and the conversations surrounding those recommendations to summarize preferences across the regions. While having identical indicators in all eight workshops would clearly have made the comparisons easier, it may also have limited our ability to provide locally specific indicators to the collaborating agencies and to derive the precise attribute and indicator meanings from local stakeholders. The team recognizes that these downfalls result in threats to internal validity as a result of variation in sample sizes

between the case studies and the qualitative nature of the study. The richness achieved through these methods, however, outweighed the potential drawbacks from a more regimented study design.

Next Steps

In comparing three regions that themselves had internal replication, we made the first step toward validation of a broadly representative framework of human well-being metrics related to the natural environment. Additional validation requires conducting the same process in other parts of the world and comparing the results of this study to the results of other studies. For example, over the past several years, Donatuto, Satterfield, and Gregory (2011) and Donatuto et al. (2014) have been working with Coast Salish tribes and other resource-dependent communities to identify indigenously defined indicators of health. They used a different categorization scheme, but found similar content. For example, their indicators included natural resources security, cultural use, community connections, self determination, emotional security, and education—all of which were discussed during this project's indicator development process and the majority of which ended up in the final priorities list.

Applications

Once indicators have been developed, the foundation is set for monitoring and selecting more socially appropriate resource management strategies (Biedenweg et al. 2016). The Hood Canal Coordinating Council, for example, is now collecting data to form part of the "State of the Hood Canal" report that highlights changes in ecological, and now social, health of the region over time (Biedenweg et al. 2014). The indicators can also be rolled up to larger scales. The Puget Sound Partnership, for example, adopted the most representative indicators from the three regions to monitor at the entire Puget Sound scale (Puget Sound Partnership 2015). The indicators are also used in strategy development; workgroups focused on developing approaches to decrease shellfish bed closures, for example, are including in their conceptual models and dialogue the potential benefits and impacts to human well-being indicators. This consideration of ecological, social, and institutional trade-offs should substantially increase the viability of future ecosystem recovery strategies.

Conclusion

Since the relationships between social and ecological systems are equally dependent upon and determinant of regional social–ecological health, it is critical to consider both human and ecological metrics when assessing the consequences of environmental change. Developing robust indicators for healthy human populations and quality of life within natural resource management agencies improves overall ecosystem recovery strategies by identifying the human issues that are relevant and critical for long-term success; human well-being indicators have the dual purposes of holistically monitoring the consequences of environmental change and guiding the development of effective recovery strategies. This research suggests that a generalized framework can guide indicator development with local

communities, acknowledging that specific indicators of the framework will depend on the local system. This is a significantly different approach from the predominantly used expert elicitation that has largely framed environmental monitoring and strategy development. Theoretically, these locally developed indicators should improve on-the-ground management and ultimate sustainability of the landscape.

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References

Anderson, J. L., C. M. Anderson, J. Chu, J. Meredith, F. Asche, G. Sylvia, M. D. Smith, D. Anggraeni, R. Arthur, A. Guttormsen, J. K. McCluney, T. Ward, W. Akpalu, H. Eggert, J. Flores, M. A. Freeman, D. S. Holland, G. Knapp, M. Kobayashi, S. Larkin, K. MacLauchlin, K. Schnier, M. Soboil, S. Tveteras, H. Uchida, and D. Valderrama. 2015. The fishery performance indicators: A management tool for triple bottom line outcomes. *PLoS ONE* 10 (5):e0122809. doi:10.1371/journal.pone.0122809

Bernard, R. 2006. *Research methods in anthropology: Qualitative and quantitative approaches*. Lanham, MD: Altamira Press.

Biedenweg, K., A. Hanein, K. Nelson, K. Stiles, K. Wellman, J. Horowitz, and S. Vynne. 2014. Developing human wellbeing indicators in the Puget Sound: Focusing on the watershed scale. *Coastal Management* 42:374–90. doi:10.1080/08920753.2014.923136

Biedenweg, K., K. Stiles, and K. Wellman. 2016. A holistic framework for identifying human wellbeing indicators for marine policy. *Marine Policy* 64:31–37. doi:10.1016/j.marpol.2015.11.002

Canadian Index of Wellbeing. 2012. *How are Canadians really doing? The 2012 CIW report*. Waterloo, Canada: Canadian Index of Wellbeing and University of Waterloo.

Copestake, J. ed., 2008. *Wellbeing and development in Peru: Local and universal views confronted*. Basingstoke, UK: Palgrave Macmillan.

Coulthard, S., D. Johnson, and J. A. McGregor. 2011. Poverty, sustainability and human wellbeing: A social wellbeing approach to the global fisheries crisis. *Global Environmental Change* 21(2):453–63. doi:10.1016/j.gloenvcha.2011.01.003

Diener, E., R. Lucas, U. Schimmack, and J. Helliwell. 2009. *Well-being for public policy*. New York, NY: Oxford University Press.

Donatuto, J., E. E. Grossman, J. Konovsky, S. Grossman, and L. W. Campbell. 2014. Indigenous community health and climate change: Integrating biophysical and social science indicators. *Coastal Management* 42 (4):355–73. doi:10.1080/08920753.2014.923140

Donatuto, J. L., T. A. Satterfield, and R. Gregory. 2011. Poisoning the body to nourish the soul: Prioritizing health risks and impacts in a Native American community. *Health Risk and Society* 13 (2):103–27. doi:10.1080/13698575.2011.556186

Genskow, K., and L. S. Prokopy. 2010. Lessons learned in developing social indicators for regional water quality management. *Society & Natural Resources* 23 (1):83–91. doi:10.1080/08941920802388961

Guest, G., A. Bunce, and L. Jonhson. 2006. How many interviews are enough?: An experiment with data saturation and variability. *Field Methods* 18:59–82. doi:10.1177/1525822x05279903

Halpern, B. S., C. Longo, D. Hardy, K. L. McLeod, J. F. Samhouri, S. K. Katona, K. Kleisner, S. E. L. J. O'Leary, M. Ranelletti, A. A. Rosenberg, C. Scarborough, E. R. Selig, B. D. Best, D. R. Brumbaugh, F. S. Chapin, L. B. Crowder, K. L. Daly, S. C. Doney, C. Elfes, M. J. Fogarty, S. D. Gaines, K. I. Jacobsen, L. B. Karrer, H. M. Leslie, E. Neeley, D. Pauly, S. Polasky, B. Ris, K. St Martin, G. S. Stone, U. R. Sumaila, and D. Zeller. 2012. An index to assess the health and benefits of the global ocean. *Nature* 488:615–20. doi:10.1038/nature11397

Halpern, B. S., C. Longo, C. Scarborough, D. Hardy, B. Best, S. Doney, S. Ktona, K. MLeod, A. Rosenberg, and J. Samhouri. 2014. Assessing the health of the U.S. West Coast with a regional-scale application of the Ocean Health Index. *PLoS ONE* 9 (6):e98995. doi:10.1371/journal.pone.0098995

Hanein, A., and K. Biedenweg. 2012. Wellbeing indicators in the Puget Sound Basin: A summary and categorization of types of social indicators and metrics used by government and non-government agencies in the Puget Sound Basin. Report by Puget Sound Institute. http://www.eopugetsound.org/articles/well-being-indicators-puget-sound-basin (accessed August 6, 2016).

Kahneman, D., E. Diener, and N. Schwarz. 1999. *Well-being: The foundations of hedonic psychology*. New York, NY: Russell Sage Foundation.

Kershner, J., J. F. Samhouri, C. A. James, and P. S. Levin. 2011. Selecting indicator portfolios for marine species and food webs: A Puget Sound case study. *PLoS ONE* 6 (10):e25248. doi:10.1371/journal.pone.0025248

Millennium Ecosystem Assessment. 2005. *Ecosystems and human well-being: General report*. Washington, DC: Island Press.

Milner-Gulland, E. J., J. A. Mcgregor, M. Agarwala, G. Atkinson, P. Bevan, T. Clements, T. Daw, K. Homewood, N. Kumpel, J. Lewis, S. Mourato, B. Palmer Fry, M. Redshaw, J. M. Rowcliffe, S. Suon, G. Wallace, H. Washington, and D. Wilkie. 2014. Accounting for the impact of conservation on human well-being. *Conservation Biology* 28:1160–166. doi:10.1111/cobi.12277

Organization for Economic Cooperation, and Development. 2013. *OECD guidelines on measuring subjective well-being*. OECD Publishing. doi:10.1787/9789264191655-en

Organization for Economic Cooperation, and Development. 2015. Better life index. http://www.oecdbetterlifeindex.org (accessed April 26, 2016).

Puget Sound Institute. 2015. Puget Sound factbook v3.0. University of Washington. Tacoma, WA. http://www.eopugetsound.org/sites/default/files/features/resources/PugetSoundFactbook_v3.0.pdf (accessed December 2015).

Puget Sound Partnership. 2015. State of the sound. Tacoma, WA. http://www.psp.wa.gov/sos.php (accessed November 24, 2015).

Rath, T., and J. Harter. 2010. *Wellbeing: The five essential elements*. New York, NY: Gallup Press.

Russell, R., A. D. Guerry, P. Balvanera, R. K. Gould, X. Basurto, K. M. A. Chan, S. Klain, J. Levine, and J. Tam. 2013. Humans and nature: How knowing and experiencing nature affect well-being. *Annual Review of Environment and Resources* 38:473–502. doi:10.1146/annurev-environ-012312-110838

Saldaña, J. 2012. *The coding manual for qualitative researchers*. Thousand Oaks, CA: Sage.

Satterfield, T., R. Gregory, S. Klain, M. Roberts, and K. M. Chan. 2013. Culture, intangibles and metrics in environmental management. *Journal of Environmental Management* 117 (15):103–14. doi:10.1016/j.jenvman.2012.11.033

Scott, K. 2012. *Measuring wellbeing: Towards sustainability?* New York, NY: Routledge.

Sen, A. 1999. *Development as freedom*. New York, NY: Alfred A. Knopf.

Tipa, G. 2006. A cultural health index for streams and waterways: A tool for nationwide use. https://www.mfe.govt.nz/sites/default/files/cultural-health-index-for-streams-and-waterways-tech-report-apr06.pdf (accessed April 26, 2016).

Ura, K., A. Alkire, T. Zangmo, and K. Wangdi. 2012. *A short guide to gross national happiness index*. Thimpu, Bhutan: The Centre for Bhutan Studies.

U. S. Environmental Protection Agency. 2012. Developing the "EnviroAtlas" to support community decisions. http://www.epa.gov/ord/annualreport/2012/enviroatlas.htm (accessed December 2015).

Wellman, K. F., K. Biedenweg, and K. Wolf. 2014. Social sciences in Puget Sound recovery. *Coastal Management* 42:298–307. doi:10.1080/08920753.2014.923129

Woodcock, A., L. Camfield, J. A. McGregor, and F. Martin. 2009. Validation of the WeDQoL-goals-Thailand measure: Culture-specific individualized quality of life. *Social Indicators Research* 94 (1):135–71. doi:10.1007/s11205-008-9357-x