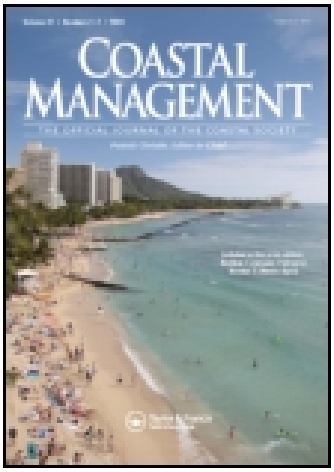

Coastal Management
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/ucmg20

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Kelly Biedenweg[ab], Adi Hanein[c], Kara Nelson[d], Kari Stiles[e], Katharine Wellman[f], Julie Horowitz[g] & Stacy Vynne[e]

[a] Woods Institute for the Environment, Stanford University, Palo Alto, California, USA

[b] Puget Sound Institute, University of Washington, Tacoma, Washington, USA

[c] School of Marine and Environmental Affairs, University of Washington, Seattle, Washington, USA

[d] Kara Nelson Consulting, Seattle, Washington, USA

[e] Puget Sound Partnership, Tacoma, Washington, USA

[f] Northern Economics, Inc., Anchorage, Alaska, USA

[g] Hood Canal Coordinating Council, Poulsbo, Washington, USA

Published online: 27 Jun 2014.

To cite this article: Kelly Biedenweg, Adi Hanein, Kara Nelson, Kari Stiles, Katharine Wellman, Julie Horowitz & Stacy Vynne (2014) Developing Human Wellbeing Indicators in the Puget Sound: Focusing on the Watershed Scale, Coastal Management, 42:4, 374-390, DOI: 10.1080/08920753.2014.923136

To link to this article: http://dx.doi.org/10.1080/08920753.2014.923136

Coastal Management, 42:374–390, 2014

ISSN: 0892-0753 print / 1521-0421 online
DOI: 10.1080/08920753.2014.923136

Developing Human Wellbeing Indicators in the Puget Sound: Focusing on the Watershed Scale

KELLY BIEDENWEG,[1,2] ADI HANEIN,[3] KARA NELSON,[4] KARI STILES,[5] KATHARINE WELLMAN,[6] JULIE HOROWITZ,[7] AND STACY VYNNE[5]

[1]Woods Institute for the Environment, Stanford University, Palo Alto, California, USA
[2]Puget Sound Institute, University of Washington, Tacoma, Washington, USA
[3]School of Marine and Environmental Affairs, University of Washington, Seattle, Washington, USA
[4]Kara Nelson Consulting, Seattle, Washington, USA
[5]Puget Sound Partnership, Tacoma, Washington, USA
[6]Northern Economics, Inc., Anchorage, Alaska, USA
[7]Hood Canal Coordinating Council, Poulsbo, Washington, USA

Planning for and monitoring human wellbeing (HWB) as a component of ecosystem recovery is a growing trend in environmental management. Within the Puget Sound specifically, organizations at the watershed and basin scale have been developing recovery action plans with placeholders for HWB or quality of life indicators. While the actual incorporation of HWB into policy has been limited, there is significant interest to receive guidance for developing indicators and begin addressing HWB in practice. This article describes the results of a pilot process to develop scientifically and practically relevant HWB indicators for the Hood Canal watershed of the Puget Sound. We gathered data on why residents and visitors value the Hood Canal from prior surveys, workshops, and nineteen open-ended interviews with diverse residents from the region. We coded these values into potential indicators of HWB for six domains: Psychological, Cultural, Social, Physical, Economic, and Governance. Three facilitated workshops with expert-stakeholders and an online survey with social scientists helped refine and rate indicators for recommendation to the regional watershed recovery coordinating council. We present the final indicators, detail the methods for getting to them, and discuss how they will be applied to enhance watershed recovery in the Hood Canal watershed. We then describe how this process can be replicated elsewhere and how it will be used to test hypotheses about scalability of HWB indicators in the Puget Sound.

Keywords coastal zone management, human wellbeing indicators, watershed recovery

Address correspondence to Kelly Biedenweg, Center for Urban Waters, University of Washington, Tacoma, Box 358438, Tacoma, WA 98421, USA. E-mail: kbied@uw.edu

Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/ucmg.

Introduction

Identifying measures of human wellbeing (HWB) for environmental planning has become a growing trend in environmental management (e.g., Bowen and Riley 2003; Tipa and Nelson 2008; Genskow and Prokopy 2010; Donatuto, Satterfield, and Gregory 2011; Mitchell and Parkins 2011; Scott 2012; Day and Prins 2013; U.S. Environmental Protection Agency 2013). While environmental agencies and organizations have dedicated significant efforts to recovery of biophysical and ecological features and processes, limited focus has been placed on how humans benefit from and directly or indirectly affect natural resources, and, conversely, how actions to recover biophysical and ecological features affect HWB (Alberti et al. 2003; Berkes, Colding, and Folke 2003; Head and Muir 2006; Fox et al. 2006). Since the publication of the Millenium Ecosystem Assessment (2005), however, we have increasingly seen literature discussing the relationship of HWB to ecosystem health through the lens of ecosystem services (such as the compiled papers in Kareiva et al. 2011 and Naeem et al. 2010, as well as the hundreds of papers published per year on ecosystem services). Although the field of ecosystem services has significantly advanced the translation of ecological benefits to humans, there has been minimal work identifying the suite of HWB attributes related to environmental health. One of the primary reasons natural resource agencies wish to identify and measure how HWB relates to the status of the environment is a perception that this knowledge will enhance the effectiveness of natural resource planning, strategy design, and monitoring by highlighting social values as well as key drivers and impacts of human behaviors in the environment.

HWB is a multifaceted concept that incorporates various aspects of our quality of life, including our physical and mental health, economic stability, and cultural and spiritual practices (Diener et al. 2009; Scott 2012). The components of HWB that are related specifically to coastal resources have been defined and organized in diverse ways (e.g., Donatuto, Satterfield, and Gregory 2011; Day and Prins 2013). Day and Prins (2013), for example, developed four overarching realms called Social and Cultural, Economic, Institutional, and Physical. Donatuto, Satterfield, and Gregory (2011) relied on indigenous knowledge to identify twelve health components that were organized into four health indicators (a category similar to Day and Prins' realms): Food Security, Ceremonial Use, Knowledge Transmission, and Community Cohesion. What each effort has in common is a hierarchical structure to organize indicators into informative groupings. Within each domain or realm, for example, lie specific attributes that are relevant to the social–ecological system in question. Each attribute can then be assessed by several questions, with specific indicators selected based on their relevance to particular environmental management efforts.

Throughout the discussion of HWB indicators, considerable debate has occurred over using objective or subjective measures (Diener et al. 2009; Scott 2012). Objective measures of HWB can be derived from a third party and therefore not dependent on a person's individual assessment (e.g., Gross Development Product & Genuine Progress Indicators). While some research has demonstrated direct, objective links between human health and interaction with natural resources (i.e., Kaplan and Kaplan 1989; Clayton and Myers 2009; Bratman, Hamilton, and Daily 2012; White et al. 2013), little research has illuminated the subjective understandings of these relationships. Subjective measures of the relationship between human health and natural resources rely more on an individual's assessment of values, needs, interests, and desires, such as perceptions of safety, overall satisfaction with life, and expressed trust in neighbors and political leaders. Subjective indicators have been less well developed and have only gained international traction in the past decade as critical to the overall measure of HWB (e.g., items from Gross National Happiness

(Ura et al. 2012) and The World Happiness Report (Sachs, Helliwell, and Layard 2012). It is generally agreed within wellbeing research that a complete understanding requires measurement of both objective and subjective facets as neither alone can represent the multiple dimensions of HWB (Diener et al. 2009).

The scientific community is in a phase of considerable experimentation on how to rigorously develop and define HWB indicators related to coastal zone management, whether at a local, regional or nation-wide scale (e.g., Tipa and Nelson 2009; Genskow and Prokopy 2010; Donatuto, Satterfield, and Gregory 2011; Day and Prins 2013). These efforts aim to identify a small set of indicators that tell the best story to inform environmental management, but the process is challenging. Most efforts have focused either on a local stakeholder process (e.g., Donatuto, Satterfield, and Gregory 2011; Tipa and Nelson 2009) or an elicitation process with scientists and policymakers (e.g., Day and Prins 2013; Mitchell and Parkins 2011). None of the efforts we reviewed incorporated all three groups: local stakeholders, scientists, and policymakers. The fact that HWB is assessed through both objective and subjective measures means that some indicators can only be identified through a public participation process whereas others may be best selected by social scientists who understand the limitations of what are commonly considered objective indicators (Gregory et al. 2012; Scott 2012). Moreover, the need for a policy process to adopt, measure, and implement strategies based on HWB indicators requires a certain amount of political buy-in to the selected indicators. Thus, it is inevitable that the selection of locally relevant HWB indicators will be a subjective process; the extent to which this process can incorporate multiple perspectives using scientifically rigorous decision analysis tools, however, may define its level of acceptance by the public, scientists and policymakers.

Balancing the need for a comprehensive list of objective and subjective data is a difficult task for policymaking organizations, including in places like the Puget Sound basin. Since 2009, the state recovery coordination agency, the Puget Sound Partnership (PSP), has attempted to identify human-related status and trend indicators as part of its performance management plan. Schneidler and Plummer (2009) used literature review to develop a long list of potential social indicators that included everything from sense of place to population growth. This early attempt resulted in the adoption of two objectively measured indicators as PSP vital signs: nature-based recreation (currently measured as the percent of beaches meeting water quality standards during swim season) and working resource-based lands (currently measured as annual commercial fisheries harvest and shellfish beds open to harvest). The process for identifying and selecting these indicators, however, has concerned the PSP, its Science Panel, and other regional collaborators. Many have felt that because of the subjective and localized nature of HWB, its associated indicators may only be identifiable and validated at smaller spatial scales.

This article describes a pilot process for identifying a more comprehensive suite of subjective and objective indicators of HWB related to the environment at a watershed scale: the Hood Canal. The process incorporated a regional literature review, stakeholder workshops, and a social science panel to identify and rank HWB indicators related to the status of the Hood Canal environment. At the watershed scale, the indicators will be used to monitor HWB related to environment health, to evaluate the potential effectiveness of proposed management strategies, and to monitor the impact of management strategies based on what Hood Canal residents want to preserve or enhance. At the Puget Sound scale, this process will be replicated in other watersheds to test the hypothesis that HWB indicators are only relevant at a watershed scale; different indicators would be required across different watersheds to represent the watershed-based nuances of HWB related to the environment.

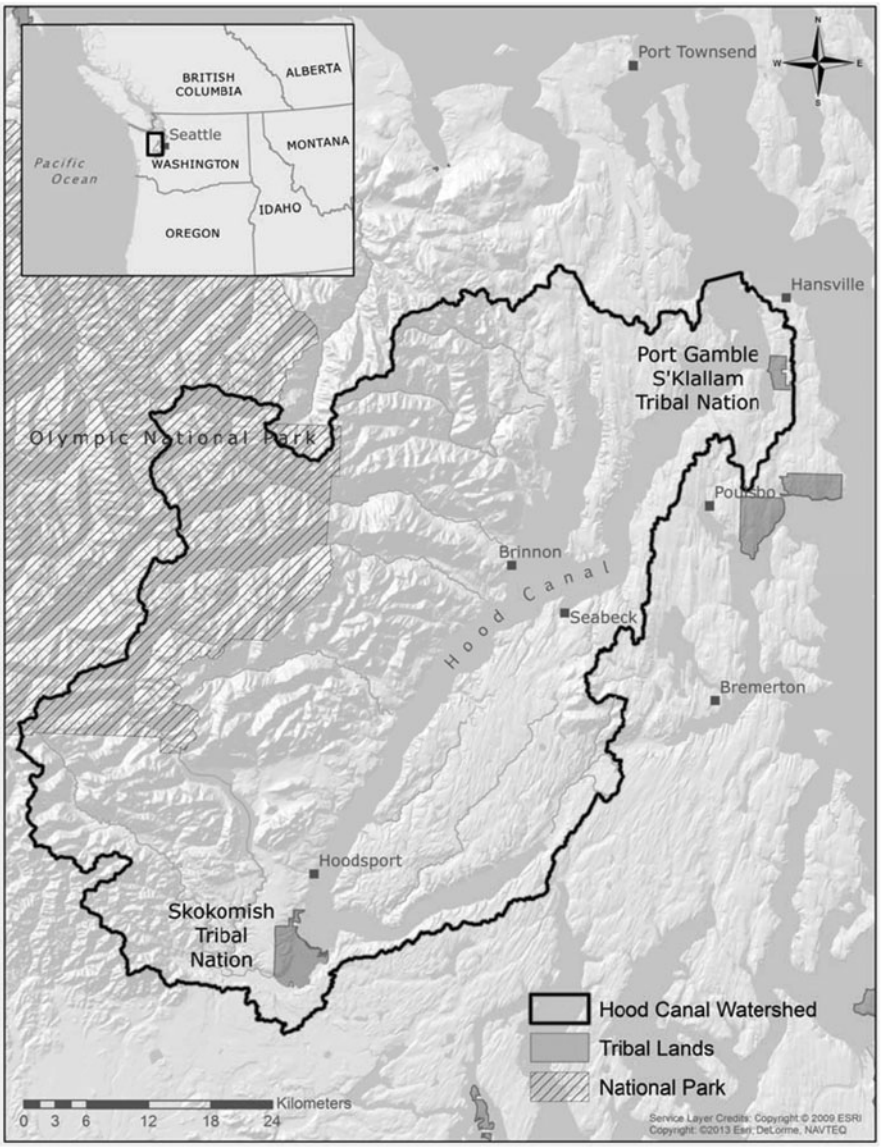

Figure 1. The Hood Canal Watershed. Image created by Jennifer Burke, Puget Sound Partnership.

Background of Project

Hood Canal is a glacier-carved fjord on the western edge of the Puget Sound (Figure 1). This long and narrow fjord is influenced by ocean water entering from the Strait of Juan de Fuca mixed with freshwater from rivers and streams originating in the Olympic Mountains. The Hood Canal uplands are dominated by forests and freshwater systems and a significant portion of area is in the Olympic National Park and Forest. The nearshore and marine habitats include gently sloping beaches and associated shoreline vegetation and eelgrass

beds, steep bluffs, large and small estuaries, and deltas. These habitats support shellfish, evolutionarily significant chum and Chinook salmon, other populations of salmon and trout, marine mammals, and birds. While Hood Canal is a relatively pristine and productive system; the long and narrow shape results in marine waters that are low in oxygen and rich in nitrogen. These low dissolved oxygen conditions periodically kill important fish. Human impacts on the watershed may exacerbate these conditions; however, there is substantial uncertainty in the available science (Cope and Roberts 2012).

Hood Canal is valued for many qualities such as natural beauty, recreational opportunities, natural resource extraction including shellfish, salmon, and forests, and a general rural quality of life. The human population density is low and centered in towns and along the shorelines of Hood Canal, with the majority of the lands in public and private forestry. Summer residents and tourists significantly increase the population seasonally. Major industries include a naval base, commercial and recreational fisheries (shellfish, salmon, crabs, and shrimp), tourism, forestry, and agriculture. Two tribal reservations are located in the Hood Canal watershed, the Port Gamble S'Klallam Tribe and the Skokomish Tribal Nation, which hold treaty rights to local resources along with the Suquamish Tribe.

The Hood Canal Coordinating Council (HCCC) is a watershed-based council of governments tasked with coordinating salmon recovery and aquatic rehabilitation in the region. The HCCC is made up of representatives from the three counties and two tribes and is currently leading the development of a coordinated strategy for Hood Canal, the Integrated Watershed Plan (IWP), which will guide natural resource-based actions for the health and wellbeing of the Hood Canal community (HCCC 2013). The development of the IWP has been a community-based process, with engagement of the Hood Canal community in visioning, establishing goals, and selecting priority strategies. This process included a series of public and expert workshops and community engagement meetings to gather input and establish public priorities for both social and ecological values and actions in Hood Canal. The planning process produced fifteen natural-resource-based ecological and social priority values or components: agriculture, beaches, bottomfish, commercial fishing, commercial shellfishing, cultural heritage, deltas and estuaries, forests, forestry, recreation, riparian areas, rivers and streams, salmon, shellfish, and water for human health and prosperity. While the ecological priorities and details of the IWP were well developed, a gap remains in the social and HWB information due to limited expertise on an appropriate process for developing and gathering useful indicators. Throughout the process, participants and leadership requested a focused effort on human wellbeing, but acknowledged this would require a different group of experts and approach specific to these values. Specifically, HWB indicators were requested to fulfill the primary purpose of reporting on HWB related to the environment in a regular State of the Hood Canal report. Secondarily, the identification of specific indicators would inform the development of environmental management strategies that can also positively influence identified HWB priorities. The project detailed here was launched to address this gap while testing a method for developing locally relevant HWB indicators relevant to environmental health.

Selecting Potential HWB Indicators

The methods used to develop and refine indicators were adapted from several international efforts to incorporate social and cultural indicators into coastal and watershed planning processes (e.g., Tipa 2009; Day and Prins 2013). The process involved iterative phases of gathering and refining potential attributes and indicators with soliciting feedback from stakeholders, policymakers, and social scientists in participatory, on-line, and one-on-one

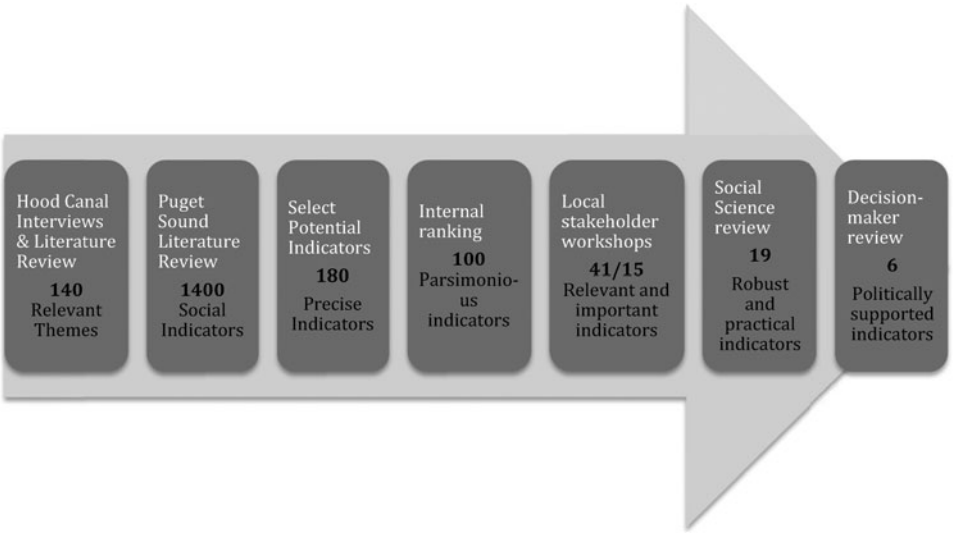

Figure 2. Key aspects of the indicator development. Each phase builds off the outcomes of the prior.

formats. Data were compiled and ranked from these various sources to result in one final set of recommended indicators to the HCCC. This diverse use of methods was unique in our review of the literature on social indicator development, as the majority of other processes used only one of these methods. We adopted this multi-step approach to provide greater opportunity for local, scientific, and political input for the greatest chance of developing widely supported HWB indicators for the Hood Canal.

Phase 1: Identifying Hood Canal HWB Attributes

To begin the process of developing human wellbeing indicators related to the health of the Hood Canal ecosystem, we compiled existing data about resident values (Figure 2). These data came in various formats from diverse projects, including a database of geospatially located values associated with natural resources completed by 62 residents (McLain et al. 2013), conceptual modeling workshops held with diverse stakeholders, social marketing assessments from the local extension offices, and reports describing the proceedings of visioning workshops for the Hood Canal Coordinating Council (Table 1). We also reviewed two edited compilations of news stories (Brody 1991; Sande 2010) and one 15-minute video summary of a prior process that assessed the relationship of people to the Hood Canal ecosystem (Hood Canal Community Circle 1996). These documents were deductively coded for their discussion of HWB as it related to six domains: Psychological, Physical, Social, Cultural, Governance and Economic. These six domains were used as they had already been vetted and approved by HCCC staff and the Social Science Subcommittee to the Puget Sound Partnership. Thus, it had both political and scientific backing.

To complement existing data, we conducted nineteen open-ended interviews lasting from 15–90 minutes (median = 45 minutes) focused on the question "How does living in the Hood Canal contribute to your wellbeing?" Interviews were conducted by phone ($n = 7$) and in person ($n = 12$) and participants were recruited using a snowball sampling procedure. We started with a short list of tribal and non-tribal residents who had contributed to discussions

Table 1
Sources of data for the development of local values associated with Hood Canal natural resources

Source	# Of respondents	% Female	Age distribution (N)	Years in Hood Canal Area (N)
USFS Values Mapping Project	62	45%	18–40 = 5 40–65 = 33 Over 65 = 20	0–5 = 9 6–10 = 7 11–20 = 15 Over 20 = 27
WSU Extension Survey of Households in Hood Canal Area	167		18–35 = 32 35–65 = 113 Over 65 = 35	0–5 = 12 6–10 = 24 11–20 = 55 Over 20 = 75
WSU Shoreline Property Owner Interviews/Focus group	15	60%	Unkown	0–5 = 1 6–10 = 2 11–20 = 7 Over 20 = 5
WSU Social Marketing Survey for Environmental Practices	354	45%	60% over 60	56% more than 15 years
Building a Community within a Watershed VHS	23	26%	Unknown	Unknown (all long term)
Human Wellbeing Interviews	19	58%	18–40 = 2 40–65 = 9 Over 65 = 8	0–5 = 2 6–10 = 1 11–20 = 4 Over 20 = 10

about the management of Hood Canal. We then asked these participants to recommend other community members who thought differently than they did about the determinants of wellbeing in the Hood Canal. Each interview was immediately transcribed after the interview and coded into the six HWB domains. We stopped at nineteen interviews because all nineteen interviewees mentioned a core set of attributes that applied to the domains with very little variation. The final four interviews provided only two new attributes, thus allowing us to determine data saturation (Guest, Bunce, and Johnson 2006).)The interview data were combined with the literature review data, resulting in a list of 36 attributes, coded into the six domains, specific to the Hood Canal (Table 2).

Phase 2: Refining Potential HWB Indicators for Application to Hood Canal

To develop indicators for these 36 attributes, we filtered a Puget Sound database of about 1,400 social indicators that were being measured or intended to be measured by government and nongovernment organizations as of 2012 (Hanein and Biedenweg 2012). Each of the

Table 2
Initial domains and attributes relating human wellbeing to Hood Canal natural resources from literature and interviews, prior to indicator refining and ranking

Domain	Attribute	Number of sources for attribute*
Economic	Community-supportive job sector	5
	Agriculture	2
	Commercial Fishing	2
	Shellfishing	6
	Timber	4
	Tourism	3
	Non-extractive/non-tourism	1
Governance	Access to natural resource extraction	2
	Access to recreational opportunities	3
	Communication	4
	Trust in government	2
	Social capital	1
	Stewardship	3
	Public participation	2
	Effectiveness of Public Policies	2
	Enforcement	1
Physical	Outdoor exercise	3
	Healthy diet	6
	Environmental health	2
	Recreation	6
	Shelter	2
Psychological	Identity	2
	Positive emotions	3
	Restoration/therapeutic	4
	Self-actualization	3
	Satisfaction	3
	Value formation	2
	Uniqueness	2
Social	Future and Past Generations	4
	Strong Families	4
	Strong Friendships	2
	Sense of Community	2
	Pets	1
Spiritual/Cultural	Spiritual connection	4
	Cultural heritage	4
	Rural character	2

*Refers to the data collection source, not to each individual surveyed or interviewed.

1400 indicators had also been coded into one of the six domains as well as relevant attributes within those domains. Aside from these coding schemes, no attempt was initially made to reduce the data; when data sources were provided, the majority was based on standardized data sets such as the U.S. Census or state natural resource monitoring programs and was thus

often redundant. We thus conducted an iterative reduction process to narrow the original list of 1,400 so as to facilitate our attempt to match existing indicators with Hood Canal values. First, we removed all indicators and attributes that we assumed to have indirect relationships to environmental health (e.g., teen pregnancy rates, average commute time, housing vacancy and graduation rates) or were duplicated in the data set (e.g., various measures of air and water quality). To choose among duplicate indicators, we selected those with an identified data source. For indicators that had multiple data sources all examples were maintained. Second, we removed indicators that were not applicable to the Hood Canal watershed because they were specific to urban areas or other regions. Examples include indicators for the percentage of Pierce County city fleet vehicles that are hybrids, ferry traffic counts, and percent of King County children eligible for the Free and Reduced lunch program. This data reduction process brought the total 1,400 existing indicators from Puget Sound down to 386 existing indicators that were less redundant and potentially generalizable to Hood Canal.

Phase 3: Matching Potential HWB Indicators with Hood Canal HWB Attributes

We then returned to the 36 Hood Canal attributes, and used them to search for potential indicators from the reduced list of 386. Because both the Hood Canal attributes and the Puget Sound indicators had been coded into the same domains, and the Puget Sound indicators had further been coded into attributes, we started work at the attribute level. Considering each Hood Canal attribute individually, we searched the indicator database first by domain, then by attributes that closely resembled the Hood Canal attribute. We then selected all indicators that could potentially describe the health or status of one of the 36 attributes. This resulted in a total of 241 potential indicators that could be Hood Canal specific.

Phases 4–6: Refining and Ranking Indicators

Because our intention was to present the HCCC with a short list of indicators that had been vetted by local stakeholders and social scientists, we needed to further reduce this list of 241 to a more manageable set of potential indicators to refine and rank. We used a three-phased process that focused on four criteria: relevance (how well it represented the issues of Hood Canal), importance (how important the indicator was in relation to the other indicators to provide a complete representation of the domain), robustness (how well the indicator measured the intended attribute and domain), and practicality (how feasible it would be to get data for the indicator). These four criteria were selected to enhance the robustness of the selection process and are a subset of criteria used in other indicator ranking processes (i.e., Kurtz, Jackson, and Fisher 2001; Kershner et al. 2011; Day and Prins 2013).

The first ranking phase was an internal review of the potential indicators. Our research team of five ranked each indicator with a single score on a scale of 1–5 considering the four criteria simultaneously, resulting in a list of 100 potential indicators. The primary outcome of this first step was to further remove redundant and irrelevant indicators.

The second ranking phase included three stakeholder workshops held throughout the watershed with participants who had regional expertise in measurement or first-hand-knowledge of one of the domains. Participants were selected based on key informant recommendations and inquiries to regional government and non-profit organizations. A total of 32 participants out of 161 invitees attended the workshops, including representatives from each of the three counties and two tribes in the region. Each participant was

pre-assigned to one of four small groups focused on 1–3 of the domains. A total of nine people participated in the Economic groups, including representatives from county departments of economic development, private businesses, and university extension offices; seven people participated in the Social/Cultural/Spiritual groups, with representatives from tribal council, religious organizations, social researchers, and long-term residents; seven people participated in the Governance groups, including representatives from tribal council, long-term community activists, non-profits, and researchers; and nine people participated in the Psychological/Physical groups, representing tribal and county health, extension and historical departments as well as independent recreation groups. Each group was given 22–27 indicators from which they were asked to refine and prioritize less than ten to facilitate the narrowing of indicators to the most relevant. Participants were informed of their group placement and provided the potential indicator list prior to their attendance at the workshop.

The participants used a two-step process to refine and rank potential indicators. The first step was to independently rate each indicator for relevance to the region, placing green (good indicator), yellow (potentially good but needs modification), and red (not relevant) sticker dots on poster-sized printouts of the indicators for their thematic group. This first step allowed participants to see where they had some agreement and allowed the second step to proceed more efficiently. In the second step, each group worked with a facilitator to refine their list of indicators to less than ten based on relevance and importance, considering relevance first and then using the importance criterion to confirm the narrowed list. In this step participants were also invited to add any indicator or attribute that they perceived as critical. Although we recommended methods for doing this, each group chose a different path to accomplish this task. Some approached this step by discussing the potential indicators (yellow stickers), trying to refine these so they better filled a gap or choosing to eliminate them altogether. Other groups looked primarily at the good indicators, those that had received all green stickers, and asked participants to rank those. Each group was facilitated by a member of the research team who kept detailed notes of the conversations in a spreadsheet or directly on the printout. Results from all three workshops were compiled; indicators that were highest priority in at least two workshops were retained and new indicators were created based on stakeholder comments if the concepts were discussed in at least two workshops.

Of the 100 potential indicators provided for consideration, forty-one indicators were given highest priority in at least two of the three workshops (Figure 3). Fifteen of these indicators were recommended by all three workshops. The indicators that were selected to be part of the final list during the group process were positively correlated to the percent of initially placed green stickers for that indicator (Pearson correlation .547, $p = .000$) and negatively correlated to the percent of stickers that were red (Pearson correlation = –.441, $p = .000$).

All domains and initial attributes were represented in the list of 41, although some were collapsed. In the Physical domain, safe food and drinking water were combined into a single attribute and shelter was added as an important attribute discussed in two workshops. Similarly, in the Psychological domain, all the positive emotion indicators were merged into a single indicator, as were the restoration/therapeutic indicators.

Finally, in the third ranking phase, we sent this list of 41 stakeholder-reviewed indicators to seven local social scientists representing economics, anthropology, environmental psychology, and political science. We selected these scientists based on their diverse fields, their expertise with regional trends, and their familiarity with existing datasets and data collection methods, therefore contributing topical expertise while ensuring the final list of

Domain	Attribute	Indicator	Highly rated in all 3 workshops	Highly rated by social scientists (an overall score of at least 4/5)
Physical	Exercise	Approximate number of hours residents engage in outdoor activities (divided into work that involves outdoor physical activity, swimming, hiking, walking, running, mountain biking, human-powered watercraft, skiing, scuba, home care (garden, yard), & other motorcraft) per week	X	X
	Exercise	Percent of swimming beaches that meet safe swimmings tandards at all times during the summer		x
	Access to Local Food	Availability of commonly harvested species (e.g. hardshell clams, crabs, shrimp, salmon, deer, elk, mushrooms, rose hips, willow, cedar, other plants or animals)	X	X
	Safe Drinking Water	Drinking water testing results from Community Groups and wells		X
	Safe Food	Toxin levels in shellfish harvest areas, commercial and recreational: PSP, crypto, giardiasis, vibriosis, notoviris	X	X
	Air Quality	Number of days during the calendar year that air quality was good, moderate, unhealthful, very unhealthful, or hazardous (must include pollutants from smoke)	X	X
Psychological	Positive emotions	Percent of residents who describe experiencing positive feelings/emotions from being in nature in Hood Canal, such as awe, inspiration, fulfillment, appreciation, solitude, relaxation, sense of peace and reflection	X	X
	General subjective wellbeing	Percent of residents who express high life satisfaction or happiness and percent who express living in Hood Canal as a contributor to this		X
	Place Identity	Percent of residents who express a positive connection to the region		added
Governance	Access	Percent of shoreline that is publicly accessible or owned	X	x
	Access	Percent of residents who are satisfied with their access to public shorelines		added
	Communication	Percent of Hood Canal residents who have learned about resource 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	x	X
	Trust in government	Number of Hood Canal residents who report trust in experts and local and state government and collaborative government efforts		X
	Effectiveness of Public Policies	Percent of identified PIC failures with corrective action initiated within 2 weeks		X
	Stewardship	Percent of participants engaging in a natural resource stewardship activity/year	X	
Cultural	Cultural Events	Percent of residents who participate in natural-resource inspired cultural activities	X	
	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	X	X
	Rural Character	Distribution and quantity of urban, rural, agriculture, forest, mineral resource, conservation and stewardship lands.		X
Social	Trust	Percentage of residents who trust people in their surrounding community	X	
	Strong Families and Friendships	Average number of days/year participate in outdoor activities with family members and/or friends	X	
	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		x
Economic	Community Supportive Job Sector	Percent of economic activity that is from small business		x
	Community Supportive Job Sector	Number of jobs and living wages per worker by resource-based employment/industry categories and economic clusters by county, and unemployment rates at subarea level matching state database		x
	Community Supportive Job Sector	Number of new jobs created by natural resource employment sector/year	X	
	Industry	Percent of revenue to local economy from agriculture, commercial shellfish, commercial fishing, timber, non-timber products and tourism	X	x
	Industry	Number of local supporting businesses to industry, by natural resource sector	x	x

Figure 3. Human wellbeing indicators highly ranked by all three workshops and by social scientists.

indictors was both rigorous and consistent with existing monitoring when possible. The scientists were sent an Excel datasheet via e-mail with a 2-page background document and were requested to rank each indicator on a scale of 1–5 for three criteria separately: robustness, practicality, and importance.

Nineteen indicators received an overall average score of 4 out of 5 across all criteria and raters (Figure 3). As with the stakeholder workshops, the scientists were invited to comment on indicators they felt were crucial and not yet included in the potential list. Two additional indicators for access and identity were developed based on the independent recommendations of three of the scientific reviewers and because the new indicators also responded to concerns that had come up during discussions in the stakeholder workshops. Similar to the stakeholder process, these 19 indicators represented all six domains. The 19 indicators from the social science review were combined with the 15 indicators rated highly in all three stakeholder workshops. Because there was some overlap, this resulted in a final recommended list of 26 indicators to the HCCC.

Phase 7: Adoption of Indicators for Monitoring

The HCCC was presented the combined list of 26 indicators that represented those most highly ranked by stakeholders and social scientists. This list highlighted who ranked each indicator highly and which indicators had data collection methods already in place. The IWP Steering Committee, appointed by the HCCC board, then engaged in an exercise to select those indicators that would be initially incorporated into the IWP and monitored in the Hood Canal. Each committee member was asked to independently select six indicators they felt should be adopted, taking into consideration who ranked the indicator highly (stakeholders, scientists, or both), whether there was already existing data collection for the indicator, how important they felt it was for the Hood Canal, whether it represented the breadth of HWB domains, and how consistent it was with the IWP structure. After the individual selection, a facilitator guided the group through an open deliberation of all selected indicators, with the intent of identifying six initial indicators to recommend for adoption by the HCCC board. It is anticipated that eventually all 26 indicators will be considered for adoption and monitoring.

The initial six priority indicators recommended for adoption by the HCCC IWP Steering Committee represented all of the domains and include the attributes: access to local food, positive emotions, communication, traditional resource practices, strong communities, and industry. In the individual selection process, the industry indicator was selected unanimously, whereas strong communities, traditional resource practices, and positive emotions were initially selected by 75% of the committee. Access to local food was initially selected by 50% and communication by 25%, but both were in the final recommendations following a group discussion that highlighted the need, importance, and appropriate use of the indicators.

Discussion

HWB is multi-faceted and can be enhanced, or negatively affected, by the interactions we experience daily. Many facets of wellbeing are directly related to the health of natural resources; the status of our wellbeing influences the way we make decisions that affect natural resources and the status of those resources, in turn, affect our wellbeing. In many cases, this perspective is left out in natural resource management or recovery. Monitoring HWB as it relates to natural resources, therefore, is a critical component to coastal zone management.

The process described here for developing HWB indicators in the Hood Canal provides an example of how to combine scientific evidence and local social knowledge to develop an integrated set of HWB indicators that are relevant, important, robust, and practical for the purposes of natural resource management. This iterative process resulted in indicators that were more specific than the ad hoc categories for human wellbeing developed during previous HCCC stakeholder meetings, and more relevant to local values and resource management efforts than the indicators initially developed for PSP (Schneidler and Plummer 2009) or compiled in a regional survey of social indicators (Hanein and Biedenweg 2012).

The initial human wellbeing components from prior HCCC stakeholder processes were: Agriculture, Shellfishing, Commercial Fishing, Forestry, Cultural Heritage, Recreation, Livable Communities, Sustainable Employment, and Water for Human Health and Prosperity. The processes did not include development of associated attributes or indicators and the discussion of HWB focused primarily on economic benefits. The final indicators identified through this study extend beyond the focus of economic benefit and provide

a more complete assessment of human wellbeing as it related to natural resource management, including aspects of psychological, physical, cultural, governance, and social wellbeing that are critically linked to the health of natural resources in the Hood Canal. This multi-stage, multi-actor process thus bridged the scientific, stakeholder, and political arenas to develop the most relevant indicators.

Validity of Indicators

Questions about validity and reliability often arise when scrutinizing indicator development. Several results from this process demonstrate that the final recommended set are both valid and reliable indicators for HWB in the Hood Canal. Content and face validity, for example, demonstrate that these indicators make sense for the region and their content is appropriate. When stakeholders, scientists, and regional policymakers read through the indicators, most found them to be representative and providing a relatively comprehensive perspective of HWB in the Hood Canal, despite the small number. The indicators demonstrate another level of construct validity in their resemblance to other indicator sets. One of the most rapidly spreading indices of human wellbeing, Gross National Happiness (GNH), includes 9 domains and 133 indicators (Ura et al. 2012). Six of the nine domains are covered within the Hood Canal index: Health (called Physical in Hood Canal), Psychological Wellbeing (also called Psychological in the Hood Canal), Cultural diversity (called Cultural), Good Governance (called Governance), Community Vitality (called Social), and Living Standards (called Economic). The GNH domains that did not come out from the Hood Canal process include time use, education, and ecological diversity. The last is because ecological indicator development occurred in a separate process. The first two are because these concepts were incorporated into other domains during the refining and ranking process: Economic and Culture, respectively. Stakeholder workshops allowed for individuals to recommend the creation of other domains, yet there were no comments that these GNH indicators should be considered outside the Economic and Cultural domains.

Reliability refers to whether we obtain the same results with the same research tool each time. In the Hood Canal HWB indicator process, this was demonstrated by the initial triangulation of information from diverse stakeholders, including previously derived specific Puget Sound indicators, summaries of several Hood Canal specific data collection processes, stakeholder workshops and scientific review. Each of these steps repeatedly tested the reliability of each indicator to represent human wellbeing in the Hood Canal. For example, one of the more interesting aspects of the process was that although workshop groups often highlighted different issues because of their specific participants or regional focus (the Economic group in one workshop, for example, was convinced that agriculture was irrelevant whereas the other two workshops felt it to be the most important attribute), they often came to similar conclusions on the most important regional indicators. As described above, out of 100 indicators, 41 were ranked very highly by two workshop groups and only 15 were ranked very highly by all three workshop groups. Considering the objective of this stage was to get to a small set of indicators, it appears that the workshop setting facilitated identifying the most important indicators, essentially with a sample size of three group discussions.

Validity of Process

In applied research, we are also often concerned with the validity of the research process as it is interpreted by the data users: scientists, stakeholders, and policymakers. In this study,

we can informally evaluate process validity through comments from the PSP Science Panel and Social Science Subcommittee, comments from the HCCC and PSP staff, and workshop evaluations.

The PSP Science Panel and the Social Science Subcommittee found this to be a scientifically and politically supported process and have supported its replication in other watersheds to confirm the appropriateness of the steps and test the diversity of indicators that might result from other regions. HCCC and PSP staff were similarly pleased with the input from diverse stakeholders, as they are often tasked with incorporating both stakeholder and scientific information and priorities. Their primary concern was whether they could collect data to regularly report on these indicators, an issue that we are working to resolve within the next year.

Based on workshop evaluations, the majority of local stakeholders also found this to be an important activity that facilitated the refinement of indicators. On a scale of 1–10, the average measure of importance was 8.4 while the ability of the workshops to help refine indicators received a 7.8. From a list of 15 potential positive and negative adjectives to describe the workshops, participants most often selected interesting (78% of respondents) and stimulating (70%). They also selected challenging (70%) and rated the ease of completing the ranking tasks a 6.7 out of 10 ($N = 24$). Although the ranking and rating tasks were cognitively difficult, when organized and facilitated, they become a positive experience. Some participants, however, still had a difficult time representing ideas outside of their immediate work sphere or were not entirely satisfied with the workshop process.

Turning Indicator Development into Policy

While the indicator selection process enabled the identification and refinement of indicators, there were still several ways the indicators could be officially selected to present to policymakers. For example, we could have proposed the 15 indicators that were ranked highly in all three workshops, eliminating the scientific review. We could also have recommended only those that were highly ranked by scientists. We chose a transparent middle ground, proposing to policymakers the list of 26 indicators that were highly ranked by stakeholders, social scientists, or both, and explaining divergent opinions to facilitate their decision-making process. For example, footnotes to approximately one-third of the indicators describe potential modifications to the wording or words of caution about measurement from experienced social scientists. In the end, it was up to the HCCC to select which indicators to incorporate to the IWP. They did so through a facilitated discussion among elected committee members. There is probably no getting around the subjectivity associated with choosing the best indicator set, but this multi-stage process improved the ability to distribute the decision across various stakeholders based on multiple criteria.

The HWB indicators recommended by HCCC IWP Subcommittee will be incorporated as part of their regular monitoring of the social–ecological coastal system and will be integrated into their IWP. While it is not yet clear how all the data will be collected or financed, there are options to collaborate with state and county public health, ecology departments, and the state agency Puget Sound Partnership to extract data specific to the Hood Canal. New monitoring efforts may also be required and will be included as part of the IWP implementation and monitoring efforts. The results of this study and future monitoring are intended to influence strategy development for both healthy ecosystems and communities. For example, the HCCC plans to identify strategic gaps in addressing HWB within the current IWP, focusing on creating strategies that can fulfill both ecological

and HWB interests. Additionally, they can develop frameworks to understand the tradeoffs among human wellbeing and ecological components and how potential restoration strategies might differentially enhance certain aspects for specific demographics, and how any changes in wellbeing components might influence decisions that affect coastal resources. While efforts to model these complex interactions will be difficult, a foundational understanding of the relationships will be necessary to develop more relevant policies with the highest likelihood of enhancing both ecosystem health and overall HWB.

Replicability

As mentioned earlier, this was a pilot study to assess a method for developing HWB indicators at watershed scales that considered stakeholder, scientific, and policymaker input. The general lessons from this process indicate that including all three groups enhances the validity and buy-in of the selected indicators. With this process, both subjective and objective measures and local and professional values are considered. We suggest that this process is highly replicable across the United States and other regions seeking to develop HWB indicators related to the environment. In the Puget Sound, we will conduct the same process in two more watersheds to test the hypothesis that indicators selected at watershed scales are different than those that would be selected at solely a basin scale. The final product of this effort will complete one of the remaining gaps in the PSP's vital signs: recommended HWB indicators at the Puget Sound scale.

Acknowledgments

We thank the Hood Canal governments and stakeholders and regional social scientists for their participation. We also thank the journal editors and two anonymous reviewers for their helpful comments to improve this article.

Funding

Funding for this research was provided by NSF Grant #1215886, the Puget Sound Institute, and the US EPA Local Integrating Organization grant.

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