Received: 30 April 2024 | Revised: 4 November 2024 | Accepted: 20 November 2024

DOI: 10.1111/cobi.14459

Conservation Biology

PRACTICE AND POLICY

Human well-being indicators as a boundary object for social science integration into conservation

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Article Impact Statement: Human well-being indicator development and monitoring can help integrate the social sciences into conservation.

Abstract

Social science integration into conservation has taken many forms. We considered social science integration through human well-being indicator development and monitoring in Puget Sound (Washington, USA). We frame human well-being as a boundary object, which through boundary work and embedded social science research, has led to the integration of the social sciences into regional conservation. Through our framing, we show how human well-being indicator development and monitoring has produced 5 outcomes, which include the enhancement of a social-ecological narrative; institutionalization of social scientific expertise; integrated restoration planning and actions; funding for social science and monitoring; and provision of environmental justice data.

KEYWORDS

boundary object, human well-being, Puget Sound, social science

INTRODUCTION

Human well-being has a reciprocal relationship with the functioning of the natural environment in that a thriving natural environment contributes to a healthy human population and vice versa (Dasgupta, 2001; Haines & Frumkin, 2021). For example, human physical health relies on clean drinking water, uncontaminated soils, and fresh air. Human psychological health benefits from being outdoors, engaging in recreational or cultural practices, and a strong sense of place (Haines & Frumkin, 2021). Industries and economic livelihoods depend on the ability to harvest and process natural resources.

Many conservation approaches conceptualize and operationalize conservation through an integrated social-ecological systems (SES) lens, often integrating human well-being goals or outcomes with conservation goals and outcomes (Aguilar & Webb, 2024; Collins et al., 2011; Lischka et al., 2018). Although the concept of human well-being can be used to understand the positive and negative social impacts of conservation interventions, it can also be integrated into the planning and promotion of pathways that link well-being and ecosystem functioning. This integration requires the tools and knowledge of the social sciences.

Global efforts to integrate human well-being in conservation largely emerged from the Millennium Ecosystem Assessment (MA) (MA, 2005) and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services plenary meetings (Diaz et al., 2018). Both efforts defined categories of human well-being relevant to conservation and supported human well-being monitoring as a mechanism to promote human outcomes. Because most conservation efforts include the monitoring of ecological indicators, human well-being indicators could have a seamless integration with existing work. Moreover, because of the institutionalization of indicator monitoring, the integration of human well-being indicators can assist in integrating the social sciences in conservation.

Although human well-being indicator monitoring efforts are growing, they have largely focused on framework development (Breslow et al., 2017; Loveridge et al., 2020) and one-time studies (Abunge et al., 2013; Mbaru et al., 2021; Nguyen et al., 2023). Examples of such efforts are common in the literature and in some cases emphasize social science integration. Yet, some of this literature note that support for long-term investigations and monitoring are needed (Nguyen et al., 2023).

To our knowledge, the development and application of human well-being indicators for long-term monitoring is not widely conducted, with exceptions (Gurney et al., 2014; Halpern et al., 2012; Biedenweg & Trimbach 2021). One example is the Ocean Health Index (OHI), which focuses on monitoring the condition of the world's oceans (Halpern et al., 2012). The OHI includes a set of quantitative, standardized, scalable, and transparent measures that have been applied in numerous contexts

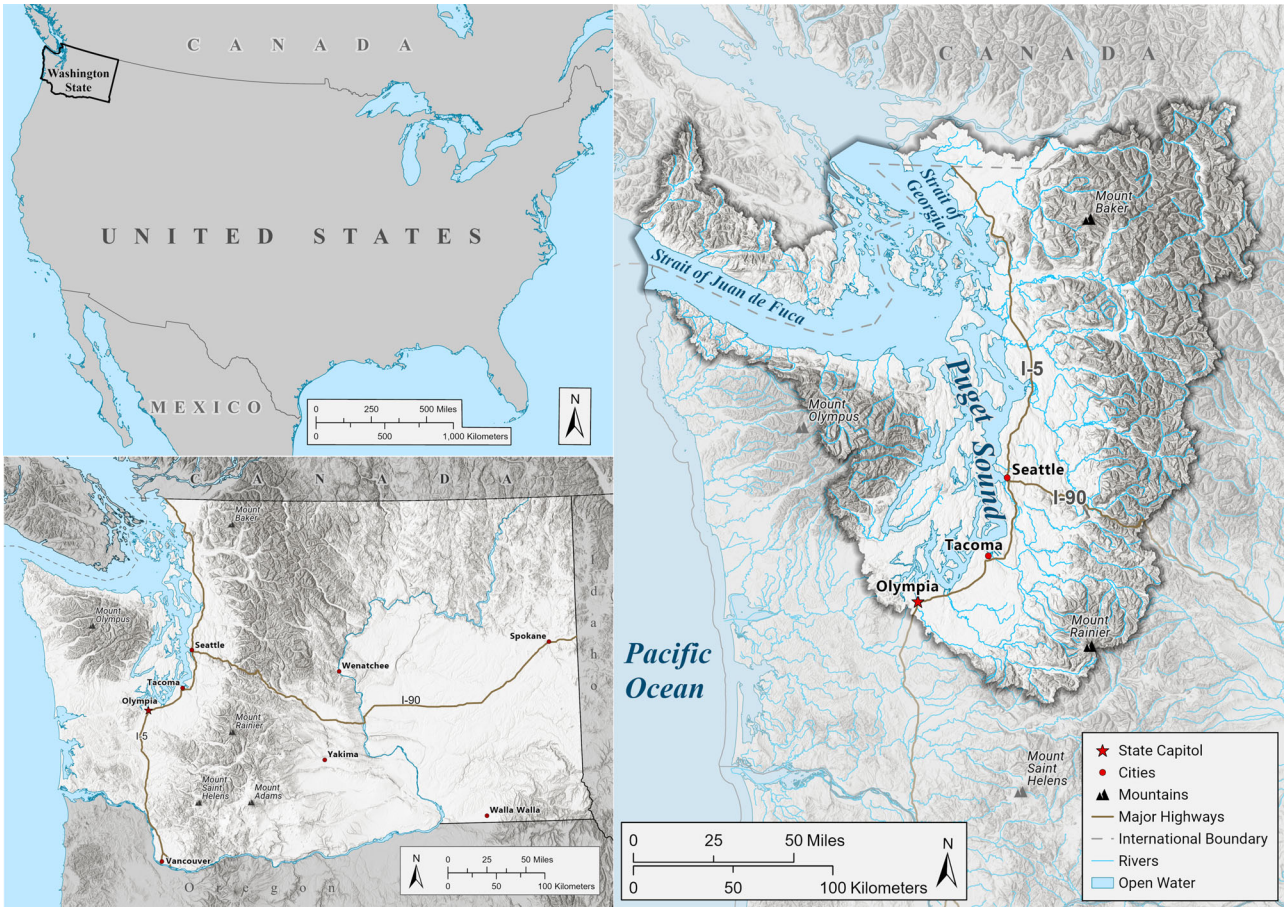

FIGURE 1 Puget Sound shown at multiple geographic scales, where long-term human well-being monitoring has been conducted.

(Blenckner et al., 2021; O'Hara et al., 2020; Selig et al., 2015) and allow comparability across geographies and time. Although OHI's longevity and wide applicability demonstrates a need to recognize human well-being in monitoring, this growth did not necessarily equate to a growth in or integration of the social sciences in conservation.

Efforts in the Puget Sound region of Washington State (USA), however (Figure 1), provide an example of long-term human well-being monitoring that has facilitated social science integration in conservation (Biedenweg, 2016; Biedenweg et al., 2017). The Puget Sound Partnership (partnership), the collaborative state environmental restoration agency and science-policy interface (SPI) focused on Puget Sound recovery, adopted 10 human well-being vital signs (indicators) in 2015 to be measured every 2 years from existing data and primary data (a randomized resident survey). Data from these indicators are reported alongside data for 13 biophysical health indicators. Together, the indicators are used to tell a holistic story of Puget Sound human health and ecosystem recovery and to drive restoration planning. We considered the development of these indicators and 5 ways in which human well-being monitoring facilitated the integration of social sciences in conservation.

EMBEDDED RESEARCH, BOUNDARY OBJECTS, AND POSITIONALITY

We derived key insights from results of long-term embedded research within the partnership (Kneale et al., 2024; Roux et al., 2019). Embedded research is a research approach that entails researchers working inside host institutions or organizations and acting as a form of intervention that allows for greater boundary spanning or bridging between research producers and consumers through mutually beneficial work (James et al., 2022; Kneale et al., 2024). Embedded research emphasizes institutional access and benefits to collecting data, obtaining funding, or disseminating research results (McGinity & Salokangas, 2014). Embedded research is increasing and has evolved into a typology of embeddedness (e.g., physical, cultural, institutional, and procedural) entailing various research directions (e.g., research to policy, policy to research, and others) and activities (e.g., research production, research facilitation, and brokering of knowledge) (Kneale et al., 2024; Roux et al., 2019). Although not without limitations (Cameron, 2021), embedded research can contribute much to conservation, including supporting research projects, building social capital among collaborators, facilitating 2-way communication among researchers and institutions,

driving and supporting long-term monitoring efforts, and aligning research with institutional priorities (Roux et al., 2019). For over 10 years, we, as conservation social scientists, have been embedded physically, culturally, institutionally, and procedurally within the partnership and its collaborators. Such embeddedness has included leading human well-being indicator development and monitoring efforts for the agency and actively integrating social science into local and regional conservation initiatives. Based on our embeddedness, we considered our observations and supporting evidence on human well-being integration and its impacts on social science integration.

We partly framed our observations by approaching human well-being as a boundary object or set of objects emerging through complex boundary work that consisted of a series of structures and activities aimed at eroding boundaries (Henning & Carvalho, 2024; Steger et al., 2018; Zurba et al., 2019). This work has largely consisted of collaboration and dialogue, where diverse perspectives converge that share a broad identity and are able to adapt to local needs (Steger et al., 2018; Hayes-Conroy et al., 2022). Boundary objects can be concrete (e.g., tools, maps, or images) and abstract (e.g., concepts, ideas, or classification systems) and typically embody distinct characteristics, including an ability to satisfy diverse user needs and help coordinate user communication; to inform an information need stemming from work-related systems or processes; and to be flexible and able to transition from a broad general concept to a more highly tailored concept (Hayes-Conroy et al., 2022; Steger et al., 2018). Boundary objects are analytical tools that offer insights into complex collaborative processes, including how such objects form, generate impacts, and evolve into standardized or routinized infrastructure (e.g., technologies, tools, terms, or practices) that are more embedded in or contribute to said processes and communities of practice (Steger et al., 2018). Although dynamic, boundary objects often go through a life cycle process, that includes: being shared among diverse groups with varying understandings of that boundary object and its representation; standardization, often done by governing bodies; further standardization, leading to their formation as an infrastructure (e.g., technologies, tools, terms, or practices) and restriction in their flexibility and ambiguity; and residualization, whereby standardization systems create residual categories, which may generate new boundary objects (Steger et al., 2018). In our case, human well-being, as a boundary object, has evolved through boundary work with the partnership. The partnership acts as a boundary organization (i.e., facilitates science use and interactions) and linked boundary chain and includes other state natural resource agency collaboratives, local watershed-based recovery groups, and academic institutions, including scientists from Oregon State University (OSU) and the University of Washington (UW) (Biedenweg et al., 2021; Kirchhoff et al., 2015; Koontz, 2019). We examined human well-being indicator development and monitoring as a boundary object, shifting through boundary work via a boundary organization and chain from a broadly defined ambiguous concept to a more organized and standardized principle to integrate the social sciences in Puget Sound conservation.

We are both interdisciplinary social scientists with a distinct grounding in human geography and conservation psychology. K.B. has worked with the partnership since 2011 and was the lead developer of human well-being vital signs. D.J.T. worked directly with the partnership from 2017 to 2022. We have collaborated with one another since 2017. We have expertise in theoretical and applied social sciences, including training in positivist and nonpositivist paradigms. We have both had multilingual community-embedded research experiences in other contexts, including Latin America and the Baltic Sea region. We are White and of European descent and have divergent gendered experiences because we represent different genders in the sciences and institutions in which we work. Our intersectional identities, privileges, and experiences as social scientists navigating the value- and power-laden spaces in which we are embedded differ somewhat. Our work reflects relationship building at varying ends of relational power dynamics in the region because we have worked with high-level decision-making institutions and those groups and communities affected by those decisions. We hold positions on different scientific decision-making bodies, including the partnership's Science Panel (statute-defined scientific body of elected members that provide oversight in regional recovery) and Social Science Advisory Committee (SSAC), and the Northwest Straits Commission's Science Advisory Committee. We acknowledge our positions in Puget Sound conservation and recognize the roles we have played in human well-being and social science integration.

PUGET SOUND CONTEXT

Puget Sound is one of the largest estuarine SES in the United States. It faces innumerable wicked problems, ranging from habitat degradation and land use pressures (e.g., eroding marine shorelines), keystone species decline (e.g., chinook salmon [Oncorhynchus tshawytscha], southern resident killer whales [Orcinus orca]), and toxic contaminants in aquatic species (e.g., salmon, sole, and herring) (Puget Sound Partnership, 2023). Such problems, coupled with human population growth and a shifting climate (Puget Sound Regional Council, 2021), have fostered calls for the monitoring of Puget Sound functioning and recovery indicators.

The indicator work is led by the partnership. The state of Washington established the partnership in 2007 to coordinate a complex SPI in the 12-county region (Figure 1), which consists of scientists, planners, policymakers, and others (Biedenweg et al., 2021; Koontz, 2019). Through this collaborative boundary work, the partnership manages a cadre of restoration entities and efforts, including the monitoring of Puget Sound's functioning SES and recovery (Scott & Thomas, 2015; Biedenweg et al., 2021; Koontz, 2019). Such entities include strategic initiative leads (SILs), multistate agency collaboratives focused on specific recovery topics (e.g., shoreline armoring, marine vegetation, and stormwater); the Salmon Recovery Council, multijurisdictional advisors for salmon recovery; and local integrating organizations (LIOs), local watershed-

based groups tasked with helping coordinate local restoration (Biedenweg et al., 2021; Koontz, 2021). The SILs and LIOs help with recovery and science priority setting, including through the development of recovery plans and the allocation of project funding. The partnership coordinates a diverse range of recovery efforts, including creation of the Action Agenda, a regional recovery plan (Puget Sound Partnership, 2016, 2018, 2022); creation of the Puget Sound Ecosystem Monitoring Program, a collaborative group of scientific and monitoring experts focused on varying subject areas (e.g., marine mammals, marine birds, and salmonids); and establishment of regional scientific priorities through its Science Panel (Biedenweg et al., 2021). The Puget Sound region has become "institutionally thick" with numerous layered participating entities (e.g., government agencies, partnerships, and programs) (i.e., a boundary chain) and "well-resourced… scientific research" (Koontz, 2019: 4), distinctions that make it ripe for the examination of social science integration in conservation (Biedenweg et al., 2021; Cheng et al., 2024; Wellman et al., 2014).

HUMAN WELL-BEING INDICATOR DEVELOPMENT

The partnership and its collaborating partners (e.g., universities and public agencies) supported the identification and continuous monitoring and reporting of the status of Puget Sound's SES through the vital signs (indicators) (Puget Sound Partnership, 2023; Stiles et al., 2015). The vital signs were informed by the state statutes that formed the partnership (RCW 90.71.210) and formalized its monitoring activities (RCW 90.71.060), including the partnership's focus on human health and quality of life (RCW 90.71.300). One statute states that the partnership's goals and objectives include,

> A healthy human population supported by a healthy Puget Sound that is not threatened by changes in the ecosystem… and [a] quality of human life that is sustained by a functional Puget Sound ecosystem (RCW 90.71.300).

In response to this statute, the partnership initiated a process aimed at identifying and monitoring human well-being indicators (Stiles et al., 2015) (Figure 2). This process reflected human well-being's boundary object life cycle in the context of the partnership's boundary organization role and its linked boundary chain. There was a shift from an ambiguous concept expressed in the mandate tied to the partnership (RCW 90.71.300), to a concept and component of the evolving social-ecological restoration narrative (Harguth et al., 2015; Stiles et al., 2015), to a set of formalized indicators that are a part of the monitoring process and system (Biedenweg et al., 2017; Schneidler & Plummer, 2009), to a foundational topic of conservation social science inquiry (beyond monitoring) (Poe et al., 2016; Trimbach et al., 2022), and finally to an integral part of planning, including strategies and outcomes (Puget Sound Partnership, 2016, 2018, 2023). For example, in 2008, an expert-based topic forum produced discussion papers on human well-being goals, which was followed up with a provisional indicator task group that produced a provisional list of social indicators (Schneidler & Plummer, 2009; Stiles et al., 2015).

Over time, the partnership working in collaboration with K.B., then a social scientist at the Puget Sound Institute of UW, Tacoma, conducted a multiyear collaborative project to identify Puget Sound-relevant human well-being measures (Biedenweg et al., 2017; Stiles et al., 2015). This project initiated the development of a social-ecological conceptual model (Harguth et al., 2015); created a framework for describing key human well-being attributes associated with the natural environment that could be applied across multiscalar planning initiatives (Biedenweg et al., 2016); developed social-scientific methodology to identify locally relevant and place-based social indicators (e.g., social, cultural, economic, and political) (Biedenweg, 2016, Biedenweg et al., 2014); and recommended candidate human well-being indicators for future monitoring (Biedenweg et al., 2017). This effort led to the adoption of human well-being indicators by the Leadership Council of the partnership (its primary decision-making body) and the adoption of a social-ecological framework.

The final list of human well-being vital signs included: air quality, drinking water, local foods, outdoor activity, shellfish beds, cultural well-being, economic vitality, good governance, sense of place, and sound stewardship (Stiles et al., 2015). Each human well-being vital sign also included measurable indicators, some of which were compiled as indices (e.g., good governance index). The indicator development process provided an initial entry for social science into the region's planning and monitoring process. For example, the partnership and its partners funded social science research projects aimed at improving the understanding of potential indicators and their regional relevancy (Harguth et al., 2015; Poe et al., 2016). This early work culminated in a special issue of *Coastal Management* focused on social sciences in Puget Sound recovery (Wellman et al., 2014). This sequential integration helped cement social science as integral to human well-being monitoring and future research. This integration also demonstrated the boundary object life cycle, highlighting how human well-being shifted from an ambiguous concept with varying meanings to a more standardized conservation infrastructure with residual categories with more boundary objects and associated research opportunities. This also illustrated the partnership's boundary organization role in helping facilitate boundary work associated with human well-being and its life cycle.

HUMAN WELL-BEING CURRENT MONITORING AND RESULTS

Six of the 10 human well-being vital signs have been monitored by OSU's Human Dimensions Lab since 2018 (Fleming et al., 2019; Fleming et al., 2021; Harrington et al., 2023). The other 4 (air quality, drinking water, economic vitality, and shellfish beds) are monitored by external partners, including other WA state agencies and environmental consultancies that rely on

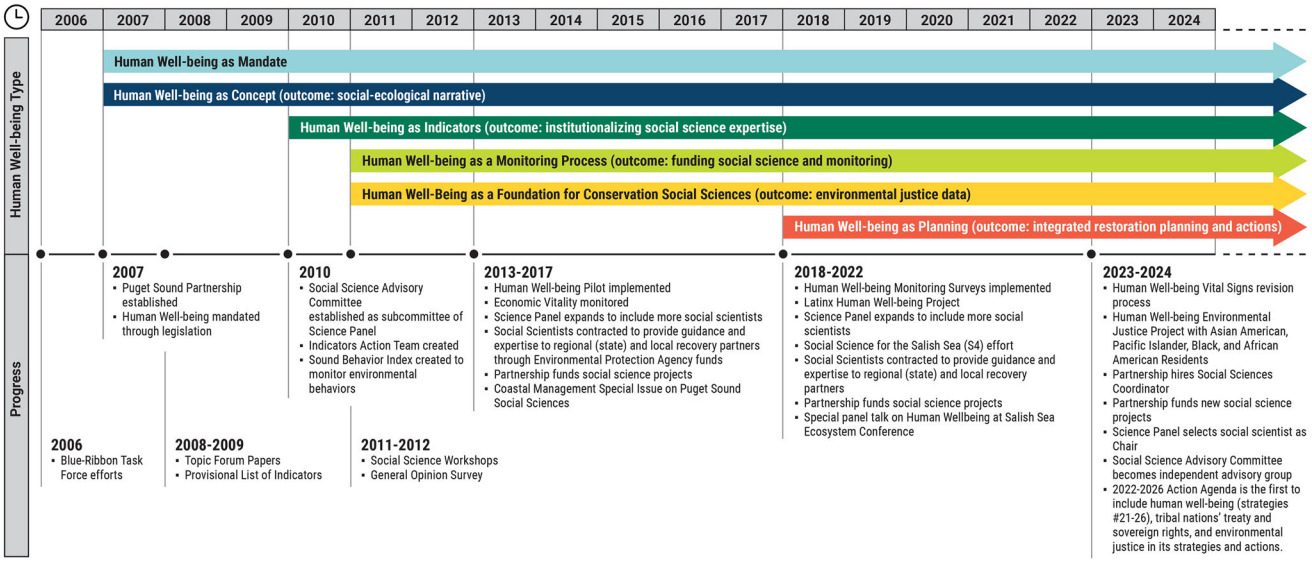

FIGURE 2 Process of human well-being integration in Puget Sound conservation. Human well-being is framed as a boundary object in the integration process.

(prevital signs) existing data collection efforts. The 6 vital signs measured by OSU are collected through a state-funded biennial 12-county residential survey (Harrington et al., 2023). The survey questions are based on pilot testing (Cranston & Biedenweg, 2016) and vetting by the partnership's SSAC. Most questions are Likert scale, often with a 1–5 or 1–7 point system. Other questions ask for frequency or percentage of participation in indicator-relevant activities. For example, good governance is an index measured by agreement with 7 statements, such as "I feel well represented by the leaders of Puget Sound natural resource management processes." The survey is distributed, using the tailored design method, through the mail to a stratified random sample of 9000 Puget Sound residents (Harrington et al., 2023).

After 3 iterations (2018, 2020, and 2022), the survey results have largely been consistent (Figure 3). The lack of variation in measured values raised questions about the sensitivity of selected indicators to changes in the system, shifting baselines of survey participants, and frequency of survey implementation, among other considerations. These hypothetical explanations sparked interest and conversation in using social scientific theory and methods to inform an indicator revision process. At the time of publication of this article, these conversations were ongoing.

OUTCOMES OF DEVELOPING, MONITORING, AND REPORTING ON HUMAN WELL-BEING

The development and monitoring of human well-being in Puget Sound have sparked a range of outcomes related to integrating social science in conservation (Figure 2). We categorized these outcomes as follows: social-ecological narrative; institutionalizing social scientific expertise; integrated restoration planning and actions; social science and monitoring funding; and environmental justice data. We identified outcomes in consultation with partnership staff. These outcomes were determined through our observations and experiences and additional substantive research, including research focused on social science integration and human well-being (Biedenweg et a. et al., 2021; Justiniano et al., 2021; Trimbach et al., 2023).

Social-ecological narrative

There has been an observable narrative shift with how human well-being is framed (Harguth et al., 2015; Stiles et al., 2015). This is reflected in the increased frequency of human well-being used in major agency documents and how it has been presented (Figure 2). For example, human well-being is consistently captured by the agency's Action Agenda (2016–2018, 2018–2022, 2023–2026) (Puget Sound Partnership, 2016, 2018, 2023) and State of the Sound Report, its biennial report on the condition and recovery of Puget Sound (Puget Sound Partnership, 2019, 2021, 2023). In the 2018–2022 Action Agenda, human well-being was referenced 7 times and was conceptualized with a monitoring lens (Puget Sound Partnership, 2018). However, in the 2023–2026 Action Agenda, human well-being was referenced 68 times and was framed as an outcome of conservation actions and as a product of social science research (Puget Sound Partnership, 2023).

In early versions of the State of the Sound Report, human well-being content was largely symbolic and high level. However, that discursive representation of human well-being changed and is now more conceptually and instrumentally baked into the document. This lack of inclusion was partly due to the human well-being indicators not being fully monitored at that time (lack of data); however, human well-being's purpose and articulation was also limited. For example, in the 2019 version, human well-being was referenced 14 times and the term

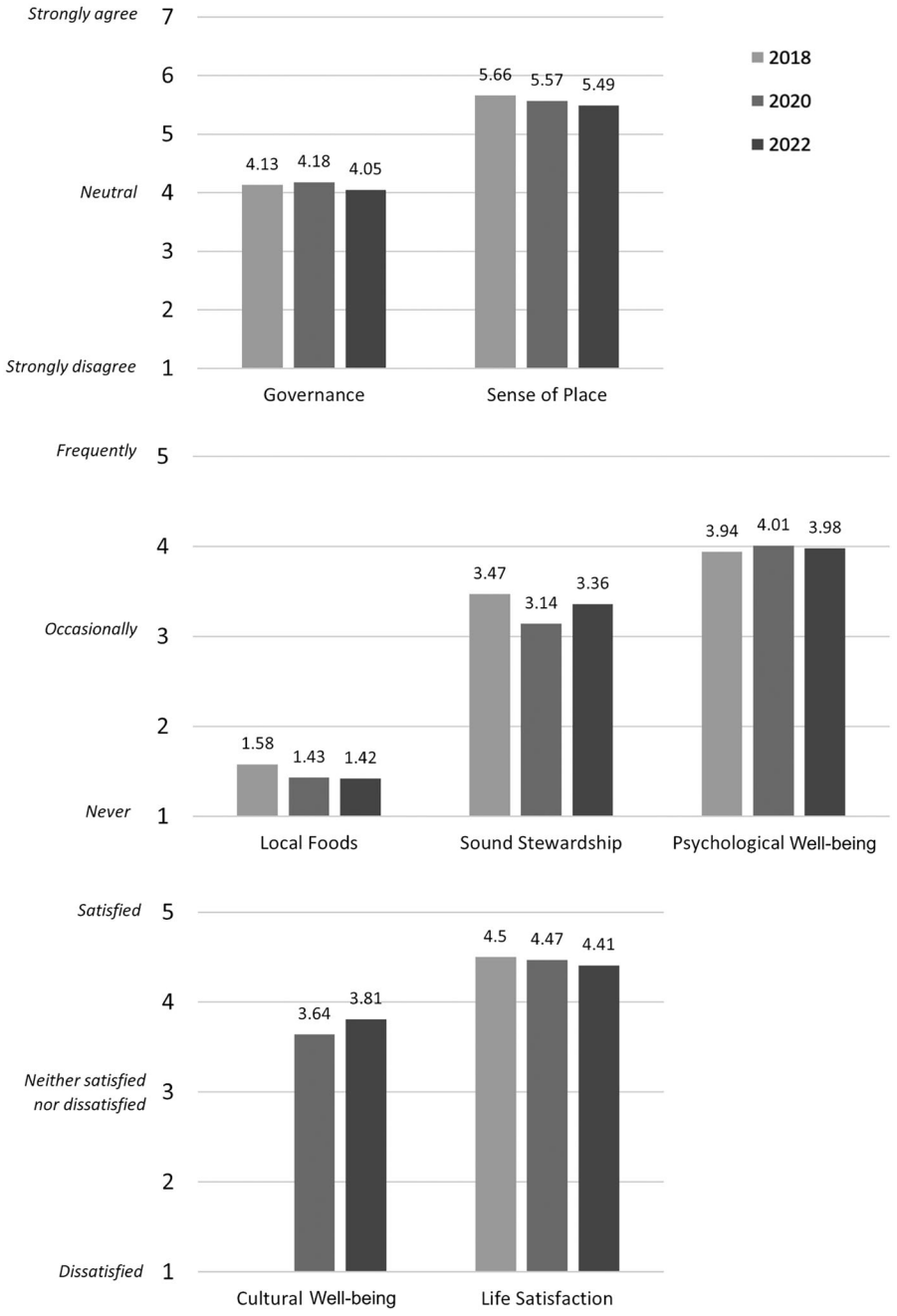

FIGURE 3 Human well-being index values (1-5 or 1-7 scales) over time calculated based on surveys of Puget Sound residents (2018, 2020, and 2022).

was peppered throughout the document without it being related to any substantial content. In the 2023 version, human well-being was referenced 32 times, and designated sections outlined human well-being, including monitoring findings and human well-being research highlights (Puget Sound Partnership, 2019, 2023). Early on, human well-being was conflated with behavior change based on social marketing, education, or outreach. With more social science inputs, nuanced distinctions formed, leading to the creation of agency resources defining and separating the 2 as linked but distinct elements of conservation (Trimbach et al., 2020).

Institutionalizing social scientific expertise

The creation of the human well-being indicators and shifting narrative led to the institutionalization of social scientific expertise. Prior to their adoption, the Science Panel had 1 social scientist among its 13 members. As of 2024, there were 5 social scientists, including its current chair, representing public policy, environmental economics, public health, and environmental psychology. These individuals were recruited by prior panel members and partnership staff to bring scientific and epistemological diversity to the advisory body. Because

such representation was limited prior to 2024, the SSAC was established in 2010 to provide social science expertise when requested by the Science Panel. That committee of volunteers continues and includes around 12 members from academia, state and federal agencies, and for-profit and nonprofit groups.

Social science expertise was also supported by a shift in the Environmental Protection Agency's (EPA) National Estuarine Program's (NEP) funding mechanisms. Prior to well-being indicator development, the EPA funded a large stewardship award directly to the partnership focused on behavior change. After the indicator development and narrative shift, this funding switched to subawards to university and nongovernmental institutions to support a full-time social science coordinator, doctoral students who study human well-being in ecosystem recovery, and an economics team that facilitates the use of economic tools to make decisions. This funding partly led to the further embeddedness of social scientists in the boundary organization and regional boundary work.

In the partnership, a cross-agency Human Dimensions Working Group was created to regularly strategize about how social science could be integrated in the agency's efforts. The group included science, planning, monitoring, and communication teams. In 2024, an internal social science coordinator was hired full-time to facilitate this work. Although these developments are not solely attributed to human well-being monitoring, the fact that human well-being indicators were officially adopted as part of the partnership's monitoring and planning framework demonstrated the need for greater expertise.

Integrated restoration planning and actions

Although part of the intention of the human well-being indicators was to inform planning and actions, this took some time to come to fruition. The partnership's Action Agenda did not include any explicit actions to achieve human well-being outcomes until the 2022–2026 iteration (Puget Sound Partnership, 2022). These were created with the assistance of a selection of SSAC members. Examples of specific human well-being outcomes included "[e]nhance and respect senses of place of Puget Sound residents" and "[i]ncrease engagement in and trust of Puget Sound environmental and natural resource governance" (Puget Sound Partnership, 2022, p. 21).

These human well-being outcomes also included suboutcomes, actions, and subactions. For example, to achieve the sense of place outcome, the Action Agenda emphasized actions aimed at ensuring "place attachments among all residents of Puget Sound are recognized, understood, and respected," including through the implementation of "community-tailored place attachment surveys and other studies in order to more fully capture a more accurate understanding of diverse residents' place attachments" and by supporting and enhancing "place attachment research opportunities in the region, including those focused on vulnerable populations and underserved communities," among other actions (Puget Sound Partnership, 2023, p. 102).

In addition to the Action Agenda, some LIOs have embedded human well-being goals and outcomes in their planning efforts (Hood Canal Coordinating Council, 2017; Island Local Integrating Organization, 2017). For example, the Hood Canal Coordinating Council, an intergovernmental organization and LIO, developed a Shellfish Initiative to meet both human well-being (tribal access, economic vitality, and educational development) and ecological (clean water and native oyster populations) goals (Hood Canal Coordinating Council, 2020). Additionally, other LIOs have used some human well-being outcomes as criteria to help prioritize restoration actions in planning. Regional SILs have further integrated human well-being into their work, including through the creation of appendices or integrated human well-being content into their planning materials (Shellfish Strategic Initiative, 2023).

Funding social science and monitoring

Beyond the human well-being survey, the partnership also facilitates mechanisms that support human well-being monitoring and science. One provides biennial funding to further scientific knowledge guided by the Science Panel's Science Work Plan. The second provides biennial funding to further salmon recovery science. The third provides biennial funding to improve monitoring efforts. Since 2018, these mechanisms have requested and, in the case of the science and monitoring mechanisms, funded social scientific studies that build on the human well-being vital signs. For example, 1 funded monitoring study tested the diverse representation of the vital signs in targeted African American, Asian American, and Pacific Islander communities (Trimbach et al., 2023). Science funding has also prioritized SES approaches. One study focused on the interactions among tree cover, urban climate zones, equity, and community-based urban ecology (Ettinger et al., 2024).

Federal funding for the EPA's NEP has also increased for social scientific efforts to further understand human well-being in Puget Sound restoration. Such funds support the SILs' recovery actions. In developing the recovery actions and the requests for proposals (RFP), SILs are encouraged to consider human well-being integration and impacts as operationalized in the vital signs. For example, the Habitat SIL's 2024 RFP prioritized funding projects that included climate adaptation and resilience; tribal treaty rights; environmental justice; and diversity, equity, and inclusion and received 2 social science proposals. The human well-being vital signs provide a framework that guides these funding mechanisms to better understand social–ecological interactions and integrate the best available science in planning.

Environmental justice data

Human well-being monitoring has also emerged as a potential avenue for the consideration of diversity, equity, inclusion, and justice (DEIJ) in conservation. In the Puget Sound context, this linkage has emerged via multiple factors. For example, WA

state agencies have been affected by the Healthy Environment for All (HEAL) Act in 2021, aimed at ending environmental and health disparities among low-income residents and communities of color (RCW 70A.02.020). In the partnership, staff created a DEIJ working group and DEIJ-relevant positions. These institutional factors coupled with wider calls for DEIJ in government and conservation (Batavia et al., 2020; King, 2022), produced an environment ripe for DEIJ. In fact, LIOs and SILS in Puget Sound shared that DEIJ was a major factor enabling their integration of human well-being and social sciences into planning (Biedenweg et al., 2021).

Collecting human well-being data with a general public survey enables the partnership to assess demographic differences across indicators. For example, Trimbach et al. (2022) used vital sign data to demonstrate that place attachment and stewardship behaviors were not related to the length of residence in the region, whereas the biennial indicator reports test for statistically significant differences across race, socioeconomic status, gender identity, and formal education.

Multiple efforts demonstrated the power of human well-being monitoring to help elevate DEIJ principles, funding, and projects. For example, between 2021 and 2023, monitoring funds were used to collect data from underrepresented communities to enhance human well-being monitoring (Justiniano et al., 2021; Trimbach et al., 2023). In 2024, the EPA launched an RFP backed by $7 million to support DEIJ projects. The partnership also funded and hosted 2 graduate-level fellows with social science expertise. The fellows produced an equity guidebook focused on providing a framework and toolkit to enhance monitoring through an equity lens (Noufi & Sheikh, 2022).

THOUGHTS ON HUMAN WELL-BEING AS A BOUNDARY OBJECT

What has contributed to the successes and challenges of applying human well-being as a boundary object for social science integration in Puget Sound conservation? Establishing a long-term human well-being monitoring effort has been a dynamic process, exemplifying the boundary object life cycle; requiring an assemblage of boundary work (e.g., single social scientists and transdisciplinary collaborations) through institutional resources (e.g., policies, plans, and funding) provided by the partnership, as a boundary organization; and requiring a supportive multisector boundary chain. The tenure of human well-being indicators and monitoring offer many lessons learned.

From our perspective, and validated by partnership collaborators, key lessons learned include have emboldened human well-being champions in the SPI and boundary chain (e.g., government leaders, practitioners, scientists, and allies); have strong institutional support (e.g., funding opportunities, trust and legitimacy of the social sciences, planning or policy prioritization, and have buy-in); and narrow problem- and place-centered research foci (e.g., research attuned to practitioners' research problems or questions).

Much of this has been captured by regional social science research (Biedenweg et al., 2021; Koontz, 2019, 2021; Cheng et al., 2024). For example, Koontz (2019) showed how Puget Sound's SPI largely uses science conceptually, which is often balanced with local input and context. A recent affiliated study highlighted how regional conservation partners integrate scientific studies focused on human–nature interactions, social dimensions, and human well-being (Cheng et al., 2024). Similarly, Biedenweg et al. (2021) showed that multiple factors enable or disable social science integration among LIOs and SILs. Overall, 18 factors were identified, including stakeholder DEI, structures and systems (e.g., institutional processes), data and information (e.g., human well-being data), and human well-being (e.g., human well-being indicators and monitoring).

Such efforts have experienced challenges, many of which have been identified in the use of science and social science integration literatures (Massaua et al., 2016; Niemiec et al., 2021). Such challenges include a lack of expertise or training in the social sciences; communication obstacles due to disciplinary language differences; differences in scales, methods, units of analysis, and theories between natural and social scientists; varying perceptions of the role of humans in ecosystems; few employed or supported social scientists; organizational culture, capacity, resources, and processes; and a lack of understanding of how the social sciences can be used (Robinson et al., 2012; Bennett et al., 2017; Walsh et al., 2019; Niemiec et al., 2021). All these challenges have been reflected in our own work. For example, initially, few employed or supported social scientists were included in regional conservation. This has shifted in part through the creation of a formal social science position at the partnership.

We believe that many of these challenges have been addressed through our regional embedded research. This work has included multiple forms of embedded research among us and others who have engaged in social science integration through the human well-being indicator development process and monitoring and through the identification of residual categories or further boundary objects. Through embeddedness, we have been able to bridge the researcher–practitioner divide by making researcher–practitioner links and manager–advisor relationships, which has helped erode barriers and reduce human well-being from being an inhibitory boundary object that hinders boundary work (Walsh et al., 2019; Rödder, 2017). Embeddedness has helped facilitate 2-way communication and academic involvement and provided tools to collect and aggregate data, all of which have been identified as solutions to elevate science use (Massaua et al., 2016). Embeddedness has also fostered confidence in the integration of social science and a belief in the value of social science to inform outcomes (Robinson et al., 2012). The latter has been complemented by a knowledge coproduction approach that has enabled closer collaboration and colearning (Djenontin & Meadow, 2018). Embeddedness focused on indicator development, monitoring, and application has further validated how "developing and evaluating indicators of success (or failure)" can be a conservation planning stage used for effective social science integration (Niemiec et al., 2021, p. 1). Embeddedness could not be accomplished alone

because regional champions for human well-being and institutional support have been necessary to elevate human well-being and social sciences in Puget Sound conservation.

Although some of the approaches to addressing social science integration challenges are specific to the Puget Sound context, other institutions have taken notice of the Puget Sound's human well-being efforts and have been able to translate the lessons to their own contexts. Known translation efforts include the Lake Tahoe Info Monitoring Dashboard (Lake Tahoe Info Monitoring Dashboard, accessed April 2024) (Lake Tahoe, California), the Delta Stewardship Council's Performance Measures and Residence Survey (California) (Delta Stewardship Council, 2023), West Coast Hawaii's Integrated Ecosystem Assessment (Ingram et al., 2020), and guidance for Chilean protected area management plan development (Barone et al., 2023; Biedenweg et al., 2023). These efforts have transpired with close collaboration with the partnership or its partners, including social scientists. In the above cases, the development of human well-being indicators served as a boundary object to integrate social science and social science benefits into conservation practices, address government mandates, and ensure that public investment and decisions are inclusive.

CONCLUSION

The development and monitoring of human well-being indicators has been a growing trend in the integration of social sciences in conservation for over a decade. In Puget Sound, the development and continued monitoring of indicators has broadened and bolstered a cadre of social scientists and their respective subdisciplines, creating a positive feedback loop of additional expertise driving more research and products that further inform a social-ecological narrative in agency documents. Moreover, continued human well-being products function as communication materials for planners, managers, legislators, and the public, driving awareness, interest, and expectations for human well-being in ecosystem recovery as tangible outcomes of conservation. The latter has fueled continued narrative shifting, integrated planning, prioritized funding for projects that include social sciences, and attention to DEIJ. In the near future, the indicators will continue to be evaluated with the potential use of baselines and targets, informed by other ways of knowing, and further examined to determine the overarching long-term impacts on the social-ecological conditions of Puget Sound. It has taken almost 2 decades of consistent data collection and championing of the social sciences for these outcomes to manifest.

ACKNOWLEDGMENTS

We thank the Puget Sound Partnership and collaborators for their contributions to human well-being and social science integration and R. Niggemann, Q. He, and K. Harrington for their contributions to the article.

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How to cite this article: Trimbach, D. J., & Biedenweg, K. (2025). Human well-being indicators as a boundary object for social science integration into conservation. *Conservation Biology*, *39*, e14459. https://doi.org/10.1111/cobi.14459