Human Dimensions of Nearshore Restoration and Shoreline Armoring, with Application to Puget Sound

Thomas M. Leschine[1]

Abstract. Human relationships with the environment are exceedingly complex. Human dimensions research, with origins both within the academic community and among resource management agencies, is aimed at shedding light on those relationships. Because ecosystem restoration is an activity underlain by human values, findings from human dimensions research should be important underpinnings to its conduct. The role of the environment in quality-of-life is one important touchstone in human dimensions research. Human dimensions studies directly applicable to coastal and estuarine environmental programs in the Puget Sound region have been relatively few, especially with regard to human relationships with the specific environmental attributes that can be altered by nearshore ecosystem restoration. Seawalls and other engineered features of occupied shorelines embody the many contradictory aspects of human relationships with nature. Because they protect property from erosion or wave attack, seawalls are generally regarded as making positive contributions to human well being. However, they may also diminish sediment delivery to the nearshore, negatively affecting its associated bundle of ecosystem goods and services. Improved scientific understanding reveals numerous tradeoffs across ecosystem functions, goods, and services associated with the extensive armoring that now exists along Puget Sound's shores, but understanding of how people in the region value these tradeoffs remains incomplete. Dialogue with public stakeholders can enlarge understanding of the roles that removal of shoreline armoring can play in a restored Puget Sound ecosystem in which humans are viewed as integral elements. However, stakeholder engagement is not a substitute for the kind of understanding that emerges from directed and sustained research. Integrated human-dimensions and natural scientific research is an attractive but as yet little utilized avenue for enlarging scientific understanding relevant to nearshore ecosystem restoration.

The 'What' and 'Why' of Human Dimensions Research Applied to Nearshore Restoration

Ecosystem restoration is an activity, which, although dependent on numerous scientific disciplines in its planning and execution, is rooted in human values and preferences. This idea is captured well by environmental philosopher Eric Higgs, who argues that, "To restore something means to consider *what that thing is and what it means*" (Higgs, 2003, p. 41, emphasis in original). As in other areas of human endeavor, meanings can be multiple, disputed, exist on multiple levels, or change over time. For example, a long dominant idea in the thinking of restoration scientists is that to restore an environmental system is to in some sense put it back the way it once was, motivated by the desire to recover lost (and valued) aspects that the system formerly possessed. Bradshaw (2002) characterizes ecosystem restoration as the return of environmental systems to their former ecological condition or to former levels of ecological functioning. In that sense, some, including Higgs (2003), have likened environmental restoration to restoring works of art. From another perspective, ecosystem restoration is an opportunity to test ecological theories (Young and others, 2005), while another emerging strain of thinking regarding the purpose of ecosystem restoration is that rather than looking backwards to past conditions, restoration should aim to build resilience into ecosystems so that they will be sustainable under conditions they have never before experienced, namely those created by climate change (Harris and others, 2006).

As defined by the Society for Ecological Restoration (SER), restoration is "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (Society for Ecological Restoration, 2004). Restoration may seek to recover directly structural aspects of ecosystems or be process-based, in which case impaired ecological processes are the restoration targets (Palmer and Filoso, 2009). The broader goal may be to recover lost or impaired ecosystem services (National Research Council, 2004; Tallis, and Polasky, 2009), making the removal of process impairment a means to that end. In consonance with these ideas, the Puget Sound Nearshore Ecosystem Partnership (PSNERP) emphasizes process-based restoration and sees reduction in human-caused impairment to these processes as the means to restore lost ecological functions, goods and services. In the end, recovered or maintained ecosystem services are important restoration targets because of their roles in human well-being (ICSU-UNESCO-UNU, 2008). To restore the environment is to desire that it be in a state different from its current condition, which is fundamentally an expression of values.

[1] School of Marine Affairs, University of Washington.

Elaborations on the meaning and content of ecological restoration often couch discussion in terms like *ecosystem health*, *ecological integrity*, or *environmental sustainability*. Society for Ecological Restoration (2004) notes, "The terms ecosystem integrity and ecosystem health are commonly used to describe the desired state of a restored ecosystem." Considerable scientific input is required to give such concepts the concreteness required for their effective use in restoration planning. Nevertheless, to manage ecological systems for health or integrity is to make values-based judgments (Lackey, 2001). Not surprisingly, expert constructions of ecosystem health or integrity often differ substantially from those of laypersons. How laypersons go about constructing their environmental valuations is poorly understood (Cox and others, 2006; Stinchfield and others, 2008), and thus a central question for human dimensions (HD) research (Endter-Wada and others, 1998). Analytical challenges abound. Values may prove malleable and not easily "measured" in the sense that natural scientists employ the term. They may be influenced by the ways they are measured and also by participation in decision making, which ideally leads to social learning (Sabatier and Jenkins-Smith, 1993). In this sense, public participation and outreach represent opportunities for regional environmental management programs like that of PSNERP.

Divergence of views of the lay public from those of experts seems especially likely if laypersons see their personal interests at stake in the restoration actions being considered (Buckley and Haddad, 2006). Under such circumstances, scientific analysis may fail to influence public sentiments (Sabatier and Jenkins-Smith, 1993; Carr, 1995; Endter-Wada and others, 1998). People may generally be in favor of ecological restoration, but see it specifically as (a) an overriding ecological imperative; (b) generally desirable, but conditional upon non-ecological considerations; or (c) in some other still different way (Woolley and McGinnis, 2000).

These considerations can lead to the view that human dimensions research should focus primarily on political issues, such as how to educate the public so that people become more understanding and accepting of the goals experts set for ecosystems (Endter-Wada and others, 1998). While such concerns may be legitimate aspirations for HD research, they are far from the full agenda. At its core, human dimensions research is the attempt to understand human—environment interactions—as Endter-Wada and colleagues put it (1998, p. 892), to generate "substantive social data about humans in ecosystems." Both public involvement and education efforts and social analysis contribute to the social learning that is necessary for ecosystem-based management. A key underlying premise of the fully formed HD research agenda is that humans are integral parts of ecosystems and not entities standing outside them and causing "impacts" (fig. 1).

The origins of "human dimensions" studies or perspectives can be traced both to the academic community—particularly to researchers in the social and natural sciences concerned with the increasing pace and scale of anthropogenically driven global environmental change (National Research Council, 1992)—and to federal resource agencies like the U.S. Forest Service (Carr, 1995) and NOAA. The motivation for the federal agencies was the recognition that people and communities needed to be explicitly included

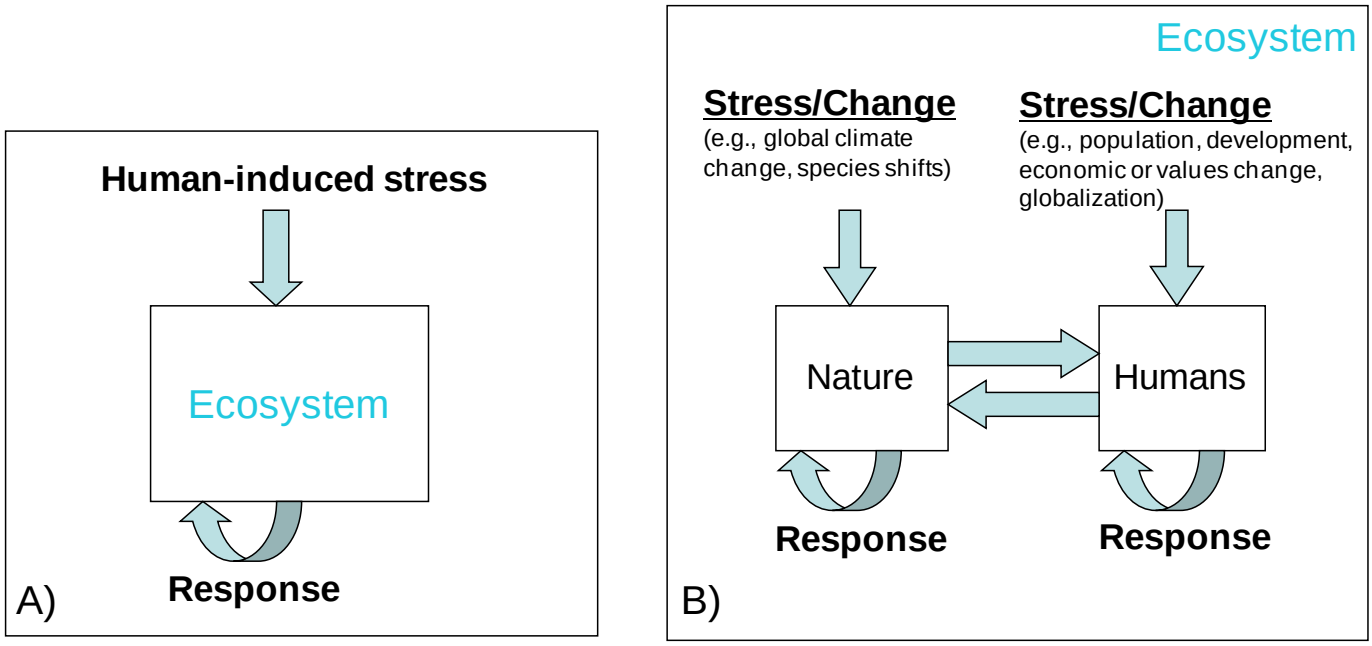

Figure 1. Two views of ecosystems.

in resource management decisions that affected them. An underlying driver is the desire that those decisions result in improved environmental outcomes, an elusive goal when agencies and affected interests are at loggerheads (Carr, 1995). As elaborated by NOAA's National Centers for Coastal Ocean Science (NCCOS), the goals of HD research are to better understand human – environment interactions, and to put that understanding to work in support of decisions affecting environmental processes and related societal outcomes. The belief is that by so doing, the use of science in decision making can be improved (http://ww.nccos.noaa.gov/human/welcome.html).

Puget Sound Nearshore Restoration in 'Human Dimensions' Terms

That the human dimensions perspective is essential to gauging the likely effects of the program of nearshore ecosystem restoration envisioned by PSNERP—particularly the removal or modification of existing shoreline armoring—becomes evident when one considers the nature of the envisioned program of restoration in light of current human uses of the Puget Sound shoreline. Much of the Puget Sound shoreline, particularly in the central reaches of the sound, is in private ownership (Lombard, 2006) and much of the shoreline in private hands is armored. Often this armoring is to protect private homes along the shore or local road access. Where lands are publicly owned, such as state and local parks, the perceived needs that motivated armoring are often similar, protection of infrastructure and access.

Another major and heavily armored feature of the Puget Sound shore is the Burlington Northern–Santa Fe (BNSF) railroad corridor that runs along the sound's eastern shore between Seattle and Everett. The rail corridor presents a major restoration opportunity given the inevitability of transportation upgrades in the next few decades. But this will involve those with interests in the rail corridor's future including the region's major seaports (Seattle, Tacoma, and Vancouver, B.C.), the regional mass transit agency (Sound Transit), and BNSF itself, one of the U.S.'s "Big Four" railroads.

Common local natural features that may or may not still be present in the nearshore system compared to their pre-European settlement distribution are barrier beaches, coastal lagoons and other embayments (that were typically protected by barrier beaches and sometimes backed by bluffs of loosely consolidated post-glacial sediments) (Shipman, 2008). Over time, development in the nearshore has "simplified" the shoreline, leaving it less heterogeneous as to shore type compared to how it was in the middle and late 1800s. One important premise of the proposed PSNERP ecosystem restoration program is that the systematic armoring of so-called "feeder bluffs" has reduced and reconfigured the supply of sediments to shorelines, inducing in turn losses in numerous ecosystem functions, goods, and services. There is evidence that people like the idea of restoring nearshore features that have been lost over time to development and also value the ecosystem services that have been lost (Lipsky, 2010). But there is also countervailing evidence that people along the shore value what they have now and are resistant to local change, a classic NIMBY (not in my backyard) response not inconsistent with the first view (Safford and others, 2009).

Likewise, a formerly extensive system of deltas and estuaries and associated saltwater wetlands has been dramatically reduced in acreage via filling and levee construction. In major river systems, a primary rationale was the development of ports and harbors and the coastal cities that supported them. In other cases, these modifications were done for agriculture or to facilitate the logging industry, purposes that may or may not remain economic in their original locations today.

The human legacies of these many transformations of Puget Sound's shores are many. Considerable enjoyments are associated with waterside living and recreating, while private ownership of shorelines (commonly extending in Washington State to mean low water) has also meant relatively restricted and regulated access. Agricultural lands, even if no longer productive, may still provide "free" open space to surrounding populations. Abandoned or lightly used reclaimed agricultural lands, often with dikes and drainage that is still maintained, may provide hunting, fishing, and wildlife viewing opportunities.

On the other hand, fish spawning and rearing habitat has shrunk, notably for salmon, fewer beaches provide clamming opportunities, and the habitat and food support for a variety of nearshore-dependent wildlife is not what it once was. Chinook salmon and Killer Whales have iconic value in the region, and both are now listed as "threatened" under the Endangered Species Act. Populations of other species that are highly dependent on the nearshore, including some shorebirds and seabirds that utilize the nearshore for feeding or nesting habitat, are in decline.

From a human dimensions perspective, ecosystem restoration is replete with tradeoffs that do not have simple bivariate value states associated with them. Different interests in society will view prospective environmental change in different ways and the same people may value change that occurs nearby and similar changes in more distant locations differently (Buckley and Haddad, 2006). Shoreline armoring in particular, because of its propensity to promote one set of human values at the expense of others, and in some cases to benefit some groups to the possible detriment of others, embodies these contradictions. In short, how people value the changes in landscape and amenities that come with restoration requires human dimensions research, the collection of "substantive social data", as Endeter-Wada and others (1998) put it.

Quality-of-Life Impacts and "Wicked" Environmental Problems

Human values are exceedingly complex and intimately bound up with notions of quality of life, also referred to as human well being (Schneidler and Plummer, 2009). In support of an effort to undertake the monitoring of quality-of-life worldwide, the World Health Organization (WHO) has given the term explicit definition (1999; quoted in Cox and others, 2006):

> "An individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals expectations, standards and concerns. It is a broad concept affected in a complex way by a person's health, psychological state, personal beliefs, social relationships *and their relationship to salient features of their environment*" [emphasis added].

Environment, while important, is not the sole determinant of quality-of-life. Determining with more precision the role that perceived environmental condition plays in the quality-of life-judgments people make has proved elusive. It has not been well studied by HD researchers from the perspective of how interactions with specific types of environmental features influence quality of life (Cox and others, 2006).

Much of the work done to date with reference to shoreline armoring has been motivated by a desire to identify socio-economic benefits and costs associated with the *protection* such features afford from flooding and other storm-related damage. The approach is typically cost-benefit analysis (for example, Bouma and others, 2009). Recreation of all types has been extensively studied, with some of that work directed at beach recreation. Work that takes into account qualitative aspects of beach character or other more readily quantifiable characteristics of beaches has often been done by resource economists whose aim is "non-market valuation," given locational factors or the presence or absence of amenities (see for example, Bell and others, 1990; Parsons and others, 1999). With appropriately chosen research sites, "hedonic price modeling" (Bartik, 1988) could be used to explore the interaction between the amenity value of living on or near a "wild" shoreline on the one hand and the value of averted risks associated with the presence of shoreline armoring on the other. Such a study could provide insights into how the dual presence of amenities and risks (or avoided risks) is reflected in average housing prices.

As the WHO definition of quality-of-life makes clear, however, what people value about a place (sometimes referred to as their *sense of place*) may be bound up in deeply held personal feelings and beliefs or in social relationships, with the physical place itself serving more as context. Thus people may have great attraction to highly modified shorelines of little ecological value or aesthetic appeal to most (for example, beach goers who recreate in highly modified and crowded beachscapes). Or they may have strong affinities for sites of high ecological value, but for reasons that have little or nothing to do with that value ("I come here because it's a place where I can think.")

For such reasons, perhaps, people may react strongly if they feel that what really matters to them is threatened. Under such circumstances, environmental problems can begin to take on a character that has been called "wicked" by social scientists, whereby they cease to have right or wrong answers, but rather solutions that are more or less useful from holistic, often political, perspectives (Carr, 1995). Science, being reductionist in nature, becomes less useful as an arena for resolving complexity and uncertainty in such circumstances, as competing understandings are brought by different research groups into the decision-making arena (Sarewitz, 2004). This can pose problems for both the social and the natural sciences (consider the controversy in which climate science is presently embroiled). The fear of getting trapped in "wickedness" may serve to turn government agencies away from social analysis in particular and instead toward reliance on "selling" programs through stakeholder involvement and public education strategies. Reliance on feedback from polling and other approaches to gauge the public mood then takes the place of real social understanding.

Applying Human Dimensions Considerations in Nearshore Restoration and Shoreline Armoring Removal: Some Practical Considerations

Human Dimensions Thinking Applied to Indicators of Human Well Being

The Washington State Legislature, in creating the Puget Sound Partnership (PSP) for the purpose of restoring Puget Sound by the year 2020, directed that the Puget Sound recovery program be guided by a quality-of-life goal (in addition to other goals for a healthy Puget Sound). In the PSP's 2008 *Action Agenda*, that goal is stated as "A quality of human life that is sustained by a functioning Puget Sound ecosystem" (Puget Sound Partnership, 2008). As with its other goal statements, the PSP describes several "desired outcomes" that point in turn toward potential indicators to help assess progress toward the goal (Puget Sound Partnership, 2008, table 1-1). They include aesthetic values and recreational opportunities, tribal treaty rights and values, ecosystem support for natural resource and marine industry uses, and economic prosperity that is compatible with the protection and restoration of Puget Sound.

Schneidler and Plummer (2009) supported the above PSP goal through development of a conceptual approach for choosing indicators of human well being. Although similar to the so-called "DPSIR" framework (drivers-pressure-state-impact-response; see Cairns and others, 1993), Schneidler and Plummer departed from DPSIR by incorporating feedback flows into the underlying conceptual model. The intent is to incorporate institutional responses to the environmental externalities that are otherwise the end target of the typical DPSIR approach. In effect, these researchers argued that, when humans are agents of actions with both deleterious effects and benefits, it is the net of the benefits and losses associated with the actions themselves, and the net outcomes of efforts to deal with them, which ultimately define the level of human well being (HWB).

With this approach, short-term and long-term HWB impacts may be different; initially HWB benefits from activities affecting the environment may be quite high, but unsustainable if they come at the cost of declining environmental health (for example, overfishing). Policy interventions may initially reduce HWB as it pertains to unsustainable activity, but at the benefit of initiating ecosystem recovery, ultimately to the benefit of HWB as well. In effect, thinking about "impacts" has shifted away from a unidirectional model by which impacts are delivered mostly from humans to ecosystems (as in fig. 1*A*), and instead to a coupled-systems perspective that more easily highlights both near- and longer-term impacts on HWB (fig. 1*B*). Stress or change affecting either humans or the environment has repercussions for both systems, because of the ways in which they are linked. The "stress" of sea-level rise may precipitate shoreline property owners to reinforce existing shoreline armoring, while also inducing policy makers to impose setbacks on new construction that result in greater protection for nearshore processes (and increased restoration opportunities) at broader spatial and longer temporal scales.

Accounting for feedbacks and dynamic responses in both human and natural systems over relevant spatial and temporal scales adds complexity but also realism. Understanding of the characteristics that "good" indicators should possess is enlarged, thereby enriching discussion regarding how to think about human values in relation to environmental change (Bowen and Riley, 2003). As these authors point out, each of the individual elements of the DPSIR framework can be populated with socio-economic attributes and indicators as well as indicators amenable to natural scientific measurement, thereby creating broad latitude for consideration of social, cultural and economic dimensions—along with traditional environmental impacts—in environmental decisions.

Ecosystem Services as Vehicles for Integration Across Natural and Social Sciences

Ecosystem services are essentially benefits to humans from nature (Daily, 1997; Leschine and Peterson, 2007). The desire to make the protection and restoration of ecosystem services central to environmental decision-making is currently very high (Daily and others, 2009). But the ability to do so has been considerably constrained by a lack of scientific understanding (Ellison, 2009). The limitations extend to both the natural and social sciences. From the natural science side, the problem is to understand better the "production functions" by which ecosystems generate services (National Research Council, 2004; Palmer and Filoso, 2009; Ruckelshaus and Guerry, 2009; Tallis and Polasky, 2009). Process-based restoration, PSNERP's primary focus, has the greatest chance of producing positive gains for ecosystems, in the view of Palmer and Filoso (2009). However, the lack of scientific understanding hampers prediction of environmental outcomes and their associated benefits. From the social science side, the limitations are primarily a need for a better understanding of the key human–environment relationships as they are affected by the production, realization, and consumption of ecosystem services.

Because ecosystem services flow from biophysical processes, yet represent benefits to HWB, incorporating the goal of protecting and restoring ecosystem services into management offers opportunities for the integration of natural and social science in decision making. By implication, these are opportunities for integrated natural science and human-dimensions research, as ecosystem services are key linkages that bind social and ecological systems (McLeod and Leslie, 2009). Nature produces ecosystem services, while humans modify nature in ways that affect its capacity to produce them. Humans also develop and apply technologies whose purpose is to facilitate realization of the variety of benefits derivable from natural systems.

Issues of scale also enter into the equation, adding additional complexity. As McLeod and Leslie (2009, p. 4) put it: "Human well-being is intimately connected to ecosystems through the delivery of ecosystem services across a range of scales. Cultures, economies, and institutions form and evolve in response to their local or regional ecosystem contexts." Humans also continually modify ecosystems, at local, regional, and increasingly, at global scales. A multitude of cross-scale couplings exist, both within the individual domains represented by human and nature systems as well as across those domains. These provide challenges and opportunities for integrated natural and social scientific research and the application of integrated understanding in the name of better environmental decisions.

The benefits of better understanding both sides of the natural science – social science equation are illustrated by consideration of shoreline armoring from an ecosystem services perspective. By considering shoreline armoring from an ecosystem services perspective, one is not necessarily led to unambiguous conclusions about what to do—that is, remove it or keep it in place. Viewing the matter from a human dimensions perspective reveals two potential complications. First, the actual *production* of many ecosystem services as "end products" of nature depends as well on non-nature products and services (Boyd and Banzhof, 2006; Leschine and Peterson, 2007). As an example, full realization of the provisioning service of fish production (that is, food for humans) requires that someone go fishing, implying that a fishing rod or net and maybe a boat have been employed. Second, there are inherent tradeoffs in the production of some ecosystem goods and services when viewed as outcomes of potential decisions that managers can make. Thus, consideration of the ecosystem services associated with various decision outcomes can argue for leaving armoring in place as well as for removing it, and in some instances, for building it where it does not presently exist (table 1).

Table 1. Contributions and detriments of shoreline armoring to human well being, via provision of ecosystem and non-nature services.

Type of service	Specific services or goods affected by Shoreline Armoring	Roles of armoring *vis-à-vis* service provision	How argues for (+) or against (-) leaving armor in place
Supporting	Nearshore sediment supply and distribution	Armoring generally understood to impede supply and influence patterns of distribution	**-:** Healthy sediment supply likely contributes recreational and aesthetic value (for example, well nourished beaches) and material support for such HWB constituents as biodiversity and marine foods; argues for removal.
Provisioning	Food: As produced from terrestrial, estuarine or marine systems, and via wild capture or via culture	May protect low-lying agriculture lands and access to food supply; may however have eliminated marsh and estuarine contributions to food provision in its original placement	**±:** Food security a central element of HWB; + likely outweighs – in many instances, esp. where levees support agriculture in lowland rivers and deltas prone to flooding.
Regulating	Flood regulation	The *raison d'être* for armoring in many instances; may in some cases exacerbate flooding "downstream"	±: Presence of housing and built infrastructure argues strongly for leaving in place, as shelter and access to goods and services are basic HWB constituents
Cultural	Aesthetics and recreation	"A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community." (Leopold,1949)	**±:** Recreational choice much studied but hard to reduce to predictive rules; otherwise, "beauty is in the eye of the beholder." –unk.

It is clear from table 1 that tradeoffs are inherent in thinking about seawalls, even when the objectives set for decision making is confined to the realm of service provision. Moreover, the existence of significant uncertainties (in both natural and social scientific understanding) heightens prospects that shoreline armoring decision making will take a "wicked" turn as tradeoffs are considered or otherwise become apparent. Better understanding of both biophysical and social and cultural relationships is necessary, and an integrated approach that brings a common set of assumptions to both the natural and social science inquiry would be useful (Liu and others, 2007; 2008). As Liu and others (2007) note, a scenario-based approach to organizing the research might be most useful.

Key sources of uncertainty include the effects of climate change (including, but not limited to sea-level rise) in relation to the trajectories of the "with project" vs. "without project" scenarios. The aim is to estimate the aggregate impacts on ecosystem services of each scenario, as projected into the future, so that the two can be compared. Similarly, social scientists would like to understand better how citizens and other affected interests value the potential impacts and tradeoffs given the same scenarios of change. The need to understand those values should be reflected in the scientific (natural and social) research agenda, in essence, coupled HD and natural-science research pursued within a framework that is "analytic-deliberative" (National Research Council, 1996): Science *informs* citizens' deliberation of alternatives and feedback from that deliberation helps *frame* the research that is done. The second proposition that stakeholder process should help frame scientific inquiry is particularly challenging for ecological science. While it is rarely done (albeit fairly common in public health science), the importance of doing so is increasingly being highlighted, as it was in the 1996 report of the Ecological Society of America's (ESA) Committee on the Scientific Basis for Ecosystem Management (Christensen and others, 1996).

As the shoreline armoring example in table 1 illustrates, humans experience ecosystem goods and services in bundles. If asked what factors are most important to the value they derive from interactions with nature, people will often include attributes that nature played little role in producing, or identify goods and services that cannot all be produced simultaneously (Leschine and Peterson, 2007). As was discussed above, ecosystem goods and services, while inarguably essential to human well being, are not everything as far as human decision making and behavior go. People act to maintain or enhance their quality of life, and non-nature goods and services are also required for fulfillment. To understand how the ecosystem goods and services produced by successful nearshore restoration are valued is to engage what Endeter-Wada and colleagues (1998) refer to as the "public involvement" portion of the HD research agenda. In addition to better understand what humans value in the context of living in the nearshore is to engage in the broader "social analysis" aspect. Tools like InVEST, under development by the Marine Initiative of the Natural Capital Project at Stanford University (Ruckelshaus and Guerry, 2009; Tallis and Polasky, 2009) can help. InVEST aims to assess changes in flows of ecosystem services under different scenarios of marine and coastal use (Tallis and Polasky, 2009).

The Future HD Research Agenda, with Implications for Puget Sound Nearshore Restoration

With some 7 million residents spread over a catchment basin of some 41,500 km^2, Puget Sound is a *human-dominated ecosystem* (Vitousek and others, 1997; Alberti and others, 2003). The implication is that social, cultural, economic, and institutional factors are likely to influence strongly how restoration takes place within the region. The findings of a recently completed comprehensive review of the social and economic research that has been done relative to Puget Sound restoration speak to this point (Stinchfield and others, 2009):

- Restoration occurs in particular socio-economic and institutional contexts, and these influences can act either to impede or to facilitate its conduct.
- To people in the Puget Sound region, both urgency and knowledge with respect to the need for restoration are low.
- People need compelling reasons to support and participate in restoration (for example, salmon recovery and leaving future generations a healthy environment).

To paraphrase Stinchfield and others (2009) most basic finding, however, although a fair amount of social and economic research has been done on questions pertaining to Puget Sound protection and restoration, relatively little systematic understanding has emerged. The reasons for this are many, but of particular importance is that funding has been limited and thus has resulted in episodic work that occurs as isolated, one-time and small-scale studies where generalization is problematic. Too many studies, especially the many public opinion polls and surveys whose primary purpose is to gauge the public mood on matters environmental, have been *atheoretical* in their design, compounding the problem of applicability of results. The situation is not unlike that in the field of ecology that led NSF to launch programs like Long-Term Ecological Research (LTER), whose overarching goal was to create larger, better formulated, and longer-term ecological studies that could meaningfully address fundamental questions in the field.

In order to overcome the general lack of robust findings that can more fully inform the region's restoration initiatives from a human dimensions perspective, a more systematic attack on the most important research questions is needed. An important first step is the formulation of a detailed and broadly acceptable human dimensions research agenda for the region, a discussion initiated by the USGS with publication of its CHIPS (Coastal Habitats in Puget Sound) research plan (Gelfenbaum and others, 2006). CHIPS Research Goal 4 is to—

> Understand the effects of social, cultural, and economic values on restoration and protection of nearshore ecosystems.

As elaborated in the report (Gelfenbaum and others, 2006, p. 18 ff.):

> "The purpose of Goal 4 is to provide the scientific basis for better understanding the effects of social, cultural, and economic values on restoration and protection of the Puget Sound nearshore."

They further identify eight specific objectives associated with this goal.

Pursuing a long-term HD research agenda for Puget Sound framed around objectives such as those identified by Gelfenbaum and others (2006) would significantly improve our general understanding of how HWB influences and is influenced by the condition of Puget Sound's nearshore ecosystems and their ability to provide ecosystem services. With respect to shoreline armoring per se, even broadly framed studies aimed at general understanding can help gauge and build support for removal of armor that impedes the flow of ecosystem services (which are social and cultural as well as ecological). By the same token, each area of inquiry lends itself to research relevant to generating more specific understanding of the barriers and opportunities that exist with respect to the removal or modification of existing shoreline armoring.

As examples, consider several of the objectives defined in Gelfenbaum and others (2006) but rephrased to be specific to shoreline armoring: Objective 1—understanding the regulatory and institutional environment that supports the construction and maintenance of armoring in the present era; Objective 2—understanding land use and land cover in areas immediately adjacent to shoreline armoring whose removal may be desired; and Objective 3—understanding human uses of armored shorelines, and the attitudes and beliefs of users in relation to the armoring they encounter as they engage in shoreline use. As Swart and others (2001) point out, the scale of relevant social scientific inquiry in relation to restoration shifts naturally with the locus within the planning process itself—from helping to frame the general principles that guide a particular ecosystem restoration program on the one hand to the design specifics of the particular projects defined within it on the other. Objectives 1-3 reflect roughly, in their order of presentation that shift in framing. For example, studies framed under Objective 3 might reveal that shoreline armoring is important to people locally because of the access it provides to some activity like fishing or to the shore itself, leading planners to incorporate access features into project designs, thereby addressing public concerns and increasing local public acceptance.

Integrating Natural and Social Scientific Research

Opportunities should be sought to integrate wherever feasible human dimensions research elements into research endeavors whose goals are otherwise directed at natural scientific understanding of biophysical processes that govern restoration processes and outcomes. To do so would be to further goals for integrated research on coupled human and natural systems espoused by numerous proponents of greater integration of human and natural systems research (Liu and others, 2007). These same goals are now championed by the National Science Foundation under an initiative labeled Dynamics of Coupled Nature and Human Systems (CNH).

The opportunities for achieving such integrated research are many as the goals and approaches in the natural sciences and social sciences are frequently the same. For example, both natural sciences and studies of human use and social attitudes use a pre- post-intervention monitoring design. A common strategy in the field of Social Impact Assessment (SIA) is to approach situations with potential social impacts with designs intended to capture those shifts, as opportunity presents itself (Branch and others, 1984).

Work of relevance can be done at the level of a single site in both natural and social sciences. Prospects for broader understanding of course increase as one is able to generalize from individual sites. In the social sciences, this is done by treating sites as cases and building multiple case study designs into broader studies aimed at achieving more robust results. To cite one example, PSNERP-supported investigators currently have a small, single-site study of shoreline armoring at a Puget Sound site (Seahurst Park, located in Burien, Washington). At present, it involves natural science-based inquiry only. Companion social studies could focus on how human behavior at the site is influenced by the presence or absence of shoreline armoring, pre- and post-removal. Such work would address the role that environmental attributes (in this case, presence or absence of shoreline armoring) play in quality-of-life at a particular place, along lines of the work of Cox and others (2006) described above.

Summary

In summary, there is growing recognition of the importance of attending to long-neglected human dimensions aspects of ecosystem research. For environmental restoration, especially in the densely populated central regions of Puget Sound, greater attention is a necessity. The current push toward ecosystem-based management is in part a response to a record of less than satisfactory outcomes for resource management decisions that have been largely driven by natural scientific understanding and have poorly incorporated human dimensions.

A strong argument can be made that, given the considerable natural scientific underpinnings that already exist, it makes sense to pursue research on social scientific aspects of nearshore restoration in concert with natural science. In such a "coupled human and natural systems" framework, the questions posed for study should come from an integrated assessment of current understanding and research needs, both social and natural. The idea that the provision of ecosystem goods and services, essentially benefits to humans produced by nature, should be the sought-after endpoints of restoration especially offers opportunities to pursue integrated natural science and human-dimensions research. Opportunities to establish social monitoring baselines in concert with efforts to develop baselines for biophysical parameters should not be neglected.

References Cited

Alberti, Marina, Marzluff, J.M., Shulenberger, Eric, Bradley, Gordon, Ryan, Clare, and Zumbrunnen, Craig, 2003, Integrating humans into ecology—Opportunities and challenges for studying urban ecosystems: BioScience, v. 53, no. 12, p. 1169.

Bartik, T.J., 1988, Measuring the benefits of amenity improvements in hedonic price models: Land Economics, v. 64, no. 2, p. 172–183.

Bell, F.W., and Leeworthy, V.R., 1990, Recreational demand by tourists for saltwater beach days: Journal of Environmental Economics and Management, v. 18, no. 3, p. 189–205.

Bouma, T.J., Olenin, S., Reise, K., Yseaert, T., 2009, Ecosystem engineering and biodiversity in coastal sediments—Posing hypothesis: Helgoland Marine Research, v. 63, p. 95–106.

Bowen, R.E., and Riley, C., 2003, Socio-economic indicators and integrated coastal management: Ocean and Coastal Management, v. 46, p. 299–312.

Boyd, J., and Banzhaf, S., 2005, Ecosystem services and government accountability—The need for a new way of judging nature's value: Resources, v. 158, p. 16–19.

Boyd, J., and Banzhaf, S., 2006, What are Ecosystem Services? The need for standardized environmental accounting units: Washington, D.C., Resources for the Future, Discussion Paper RFF DP 06-02.

Bradshaw, A.D., 2002, Introduction and philosophy, in Perrow, M.R., and Davy, A.J., eds., Handbook of ecological restoration, vol. 1, Principles of restoration: Cambridge, U.K., Cambridge University Press.

Branch, K., Hooper, D., Thompson, J., and Creighton, J., 1984, Guide to social assessment—A framework for assessing social change: Boulder, Colo., Westview Press.

Buckley, Mark, and Haddad, B.M., 2006, Socially strategic ecological restoration—A game-theoretic analysis: Environmental Management, v. 38, no. 1, p. 48–61.

Cairns, J.R., McCormick, P.V., and Niederlehner, B.R., 1993, A proposed framework for developing indicators of ecosystem health: Hydrobiologia, v. 263, p. 1–44.

Carr, Deborah, 1995, Human dimensions in ecosystem management—A USDA Forest Service perspective: U.S. Department of Agriculture Forest Service General Technical Report PSW-156, p. 19–22.

Christensen, N.L., Batuska, A.M., Brown, J.H., Carpenter, S., D'Anonio, C., Francis, R., Frankin, J., McMahon, J.A., Noss, R.F., Parsons, D.J., Peterson, C.H., Turner, M.G., and Woodmansee, R.G., 1996, The report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management: Ecological Applications, v. 6, no. 3, p. 665–691.

Cox, Melanie, Johnstone, Ron, and Robinson, Jackie, 2006, Relationships between perceived coastal waterway condition and social aspects of quality of life: Ecology and Society, v. 11, no. 1, p. 35 (also available at http://www.ecologyandsociety.org/vol11/iss1/art35/).

Daily, G.C., ed., 1997, Nature's services—Societal dependence on natural ecosystems: Washington, D.C., Island Press.

Daily, G.C., Polasky, Stephen, Goldstein, Joshua, Kareiva, P.M., Mooney, H.A., Pejchar, Liba, Ricketts, T.H., Salzman, James, and Shallenberger, Robert, 2009, Ecosystem services in decision making—Time to deliver: Frontiers in Ecology and the Environment, v. 7, no. 1, p. 21–28.

Ellison, Katherine, 2009, Ecosystem services—Out of the wilderness?: Frontiers in Ecology and the Environment, v. 7, no. 1, p. 60 (also available at http://dx.doi.org/10.1890/1540-9295-7.1.60).

Endter-Wada, Joanna, Blahna, Dale, Krannich, Richard, and Brunson, Mark, 1998, A framework for understanding social science contributions to ecosystem management: Ecological Applications, v. 8, no. 3, p. 891–904.

Gelfenbaum, G., Mumford, T., Brennan, J., Case, H., Dethier, M., Fresh, K., Goetz, F., van Heeswijk, M., Leschine, T.M., Logsdon, M., Myers, D., Newton, J., Shipman, H., Simenstad, C.A., Tanner, C., and Woodson, D., 2006, Coastal habitats in Puget Sound—A research plan in support of the Puget Sound Nearshore Partnership: Seattle, Wash., Puget Sound Nearshore Partnership Report No. 2006-1 (also available at http://pugetsoundnearshore.org).

Harris, J.A., Hobbs, R.J., Higgs, E., and Aronson, J., 2006, Ecological restoration and global climate change: Restoration Ecology, v. 14, no. 2, p. 170–176.

Higgs, Eric, 2003, Nature by design—People, natural process, and ecological restoration: Cambridge, Mass., Massachusetts Institute of Technology Press.

ICSU-UNESCO-UNU, 2008, Ecosystem change and human well-being—Research and monitoring priorities based on the millennium ecosystem assessment: Paris, International Council for Science.

Lackey, Robert, 2001, Values, policy, and ecosystem health: BioScience, v. 51, no. 6, 437–443.

Leopold, Aldo, 1949, The Land Ethic, in A Sand County almanac: New York, Oxford University Press, p. 201–226.

Leschine, T.M., and Petersen, A.W., 2007, Valuing Puget Sound's valued ecosystem components: Seattle, Wash., U.S. Army Corps of Engineers, Puget Sound Nearshore Partnership Report No. 2007-07.

Lipsky, Rachel, 2010, Stakeholder input in Puget Sound nearshore restoration—An application of the advocacy coalition framework: Seattle, Wash., University of Washington, M.S. thesis.

Liu, Jianguo, Dietz, Thomas, Carpenter, S.R., and others, 2007, Complexity of coupled human and natural systems: Science, v. 317, p. 1513–1516.

Liu, Jianguo, Dietz, Thomas, Carpenter, S.R., and others, 2008, Coupled human and natural systems: Ambio, v. 36, no. 8, p. 639–649.

Lombard, John, 2006, Saving Puget Sound—a conservation strategy for the 21st century: Bethesda, Md., American Fisheries Society.

McCleod, K., and Leslie, H., 2009, Ecosystem-based management for the oceans: Washington, D.C., Island Press.

National Research Council (NRC), 1992, Global environmental change—Understanding human dimensions, Stern, P.C., Young, O.R., and Druckerman, D. (eds.): Washington, D.C., National Academies Press.

National Research Council (NRC), 1996, Understanding risk—Informing decisions in a democratic society: Washington, D.C., National Academies Press.

National Research Council (NRC), 2004, Valuing ecosystem services—Toward better environmental decision-making: Washington, D.C., National Academies Press.

Palmer, M.A., and Filoso, Solange, 2009, Restoration of ecosystem services for environmental markets: Science, v. 325, July 31, 2009, p. 575–576.

Parsons, G.R., Massey, D.M., and Tomasi, Ted, 1999, Familiar and favorite sites in a random utility model of beach recreation: Marine Resource Economics, v. 14, no. 4, p. 299–315.

Puget Sound Partnership (PSP), 2008, Puget Sound action agenda—Protecting and restoring the Puget Sound Ecosystem by 2020: Puget Sound Partnership website, accessed December 10, 2010, http://www.psp.wa.gov/downloads/ACTION_AGENDA_2008/Action_Agenda.pdf.

Ruckelshaus, M., and Guerry, A., 2009, Valuing marine ecosystems: Marine Scientist, v. 26, p. 26–29.

Sabatier, P.A., and Jenkins-Smith, H.C., 1993, Policy change and learning—An advocacy coalition approach—Theoretical lenses on public policy: Boulder, Colo., Westview Press.

Safford, T.G., Carlson, M.L., and Hart, Z.H., 2009, Stakeholder collaboration and organizational innovation in the planning of the Deschutes estuary feasibility study: Coastal Management, v. 37, no. 6, p. 514–528.

Sarewitz, D., 2004, How science makes environmental controversies worse: Environmental Science and Policy, v. 7, no. 5, p. 385–403.

Schneidler, M.M., and Plummer, M.L., 2009, Human well-being indicators—Background and applications for the Puget Sound Partnership: Seattle, Wash., Northwest Fisheries Science Center Processed Report.

Shipman, H., 2008, A geomorphic classification of Puget Sound nearshore landforms: Seattle, Wash., U.S. Army Corps of Engineers, Puget Sound Nearshore Partnership Report No. 2008-01.

Society for Ecological Restoration (SER), 2004, International Science and Policy Working Group—The SER international primer on ecological restoration: Tucson, Ariz., Society for Ecological Restoration International, accessed August 19, 2009, at http://www.ser.org/content/ecological_restoration_primer.asp.

Stinchfield, H.M., Koontz, L., and Sexton, N.R., 2009, Social and economic considerations for coastal and watershed restoration in the Puget Sound, Washington—A literature review: U.S. Geological Survey Open-File Report 2009-1079, 78 p.

Swart, J., Windt, H., and Keulartz, J., 2001, Valuation of nature in conservation and restoration: Restoration Ecology, v. 9, no. 2, p. 230–238.

Tallis, H., and Polasky, S., 2009, Mapping and valuing ecosystem services as an approach for conservation and natural resource management—The year in ecology and conservation biology, 2009: Annual Review of the New York Academy of Sciences, v. 1162, p. 265–283.

Vitousek, P.M., Mooney, H.A., Lubcheco, J., and Mellilo, J.M., 1997, Human domination of Earth's ecosystems: Science, v. 277, no. 5325, p. 494–499.

Woolley, J., and McGinnis, M., 2000, The conflicting discourses of restoration: Society and Natural Resources. v. 13, p. 339-357.

Young, T.P., Peterson, D.A., and Clary, J.J., 2005, The ecology of restoration—Historical links, emerging issues and unexplored realms: Ecology Letters, v. 8, p. 662–673.

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