Collaborative Science: Moving Ecosystem-Based Management Forward in Puget Sound

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Recent calls for improving ocean health have advocated implementing ecosystem approaches to the management of marine environments (e.g., USCOP 2004). Although scientific principles for implementing such approaches are being developed (e.g., Francis et al. 2007), much of the challenge of practicing ecosystem-based management (EBM) lies in applying it to local systems. The challenges are scientific, logistical, financial, and political, and include conveying scientific information accurately and using it transparently. A common statement from the scientific community clearly articulating what is known about an ecosystem can provide positive momentum from which decision makers and scientists can work together in EBM implementation (van Cleve et al. 2004).

Recently, science and policy leaders encouraged natural and social scientists in the Puget Sound region to take an important step towards implementing ecosystem-based management by synthesizing current understanding of the structure and function of the marine ecosystem. The document—*Sound Science: Synthesizing Ecological and Sociological Information about the Puget Sound Ecosystem*—describes in accessible language the connections among biotic, physical, and human elements of the ecosystem (Sound Science 2007). The motivation for the report is that a common understanding of the ecosystem that is broadly supported by scientists will help managers and policy leaders make more informed decisions as they pursue regional objectives for Puget Sound. The process of developing this common vision was central to the report's value, and may serve as a model for other scientific collaborations supporting regionally-focused EBM.

FACILITATING A LARGE-SCALE, MULTI-DISCIPLINARY COLLABORATION

The Puget basin lies between the crests of the Cascade and Olympic mountain ranges and encompasses approximately 2,330 km^2 of inland marine waters and their shorelines (Figure 1). Stunning in appearance, the Puget Sound hosts over 340 marine and terrestrial species on state and federal endangered species lists. An effort to protect and restore the ecosystem is being led by a public-private partnership (Puget Sound Partnership 2006) and a newly-minted state agency coordinating the multi-stakeholder ecosystem coordinated board established in 2007 (WA SB 5371 2007-08). The effort is ambitious—$300 million for the first two years—and over-arching; it is charged with recovering the sound by 2020 using the best scientific principles. The initial partnership adopted six ecosystem goals encompassing both natural ecosystem and human health and well-being elements.

Sound Science was developed to support this and other conservation efforts in the region. Four elements of the process leading to this collaborative report were particularly important for its success. The first was early and ongoing discussion between scientists and natural resource managers and policy makers. Second was deliberation among scientists spanning many disciplines and organizations. Third was providing multiple opportunities for participation in refining content. Finally, a formal signing and transfer of the report to state government increased awareness and use of this project as legislation was being crafted and as implementation of a new EBM approach begins.

Science-policy discussions

Discussion with managers and policy-makers occurred throughout the development of *Sound Science,* making the report relevant to current and future management issues. Scientists became more confident that their results would be interpreted correctly and used in practice.

We initiated this collaboration with a joint policy-science discussion to identify key policy issues that could be informed by ecosystem science. This meeting included overview presentations and facilitated discussion open to all. *Sound Science* was maintained as a strictly scientific document, without policy judgments or statements—critical for eventual acceptance by a broad array of policy makers. Review comments from policy and management experts improved clarity and relevance of issues included in the document.

Widespread participation

Sound Science was created from the input of more than 30 contributors and benefited from the insight of over 100 natural and social science reviewers representing more than 35 organizations—universities, non-governmental organizations, tribes, county, state and federal agencies,

industry, and the public. This inclusion ensured that the groups with interest in the health and management of Puget Sound had opportunities to provide scientific input. Having both academic and agency scientists provided a balanced perspective of conceptual underpinnings and pragmatic applications.

The process of creating a common statement from natural and social scientists highlighted the value of considering both human and natural elements of the ecosystem. The human element is a component that is often missing from analyses informing EBM, but is a critical one, since such management efforts usually depend on changing human behavior (Hennessey and Sutinen 2005).

Opportunities to participate

Gathering broad scientific input required soliciting participation in many ways. After a core group of contributors created a first draft, scientists, managers, policy makers, and the public reviewed the content. A second discussion draft responding to the reviews served as the basis for an open workshop.

Advertised broadly, this workshop allowed all interested parties to provide input into the final report. Discussions focused on key areas for ecosystem-based management: human interactions, landscape processes, food webs, and habitats. For each topic, groups identified areas of agreement and disagreement and threats to the system, while prioritizing critical gaps in our understanding for each topic. Then a whole-group facilitated discussion addressed primary threats to ecosystem functions, key gaps in understanding, ecosystem responses to perturbations, and the process for finalizing *Sound Science*.

A steering committee including expert scientists and others from 14 organizations served as a final arbiter in areas of disagreement or controversy between reviewers or workshop participants, and ensured an accurate and broadly-accepted final report.

Substantive agreement

A challenge in developing any common statement is finding agreement on content that is detailed enough to move scientific and policy discussions forward. Three particular aspects of this synthesis are useful in this regard.

First, it includes graphics synthesizing a common view from scientists. For instance, we found no simple figure illustrating the primary oceanographic and bathymetric features of the inland marine waters of Washington State. These features (Figure 2)—shallow sills, incoming salty, cold water, and outflowing fresher water—contribute to stratification and retention of de-oxygenated waters and likely are contributing to extreme events of low dissolved oxygen in areas like Hood Canal.

Second, *Sound Science* emphasizes the strong linkages between terrestrial and marine systems in Puget Sound, environments which typically are studied and managed by different groups. Transfer of organic and inorganic materials between these environments contributes to shoreline habitats and substantial quantities of marine-derived nutrients are delivered to upland and freshwater systems through animal movement (Figure 3). This ecological perspective, emphasizing the importance of biotic and abiotic transport between terrestrial and aquatic habitats, is important for those designing restoration.

Third, *Sound Science* includes "issue papers," reviewed by the steering committee and written by experts in areas of emerging interest including climate change and ocean effects on human health (Box 1). These forward-looking treatises discuss potential futures for the region and key gaps in scientific understanding, both essential components of robust adaptive management programs.

Celebrating

The final key element leading to the success of *Sound Science* was a public acceptance of the document by federal, state and tribal governments and transfer to the state. Twelve organizations (Box 2) were signatories who formally presented the report to Washington Governor Gregoire (Figure 4), recognizing the collaborative EBM effort at the executive and legislative levels

Figure 1. Puget Sound Basin. For the purposes of the *Sound Science* report, the Puget Sound region includes the northern basin and the Strait of Juan de Fuca.

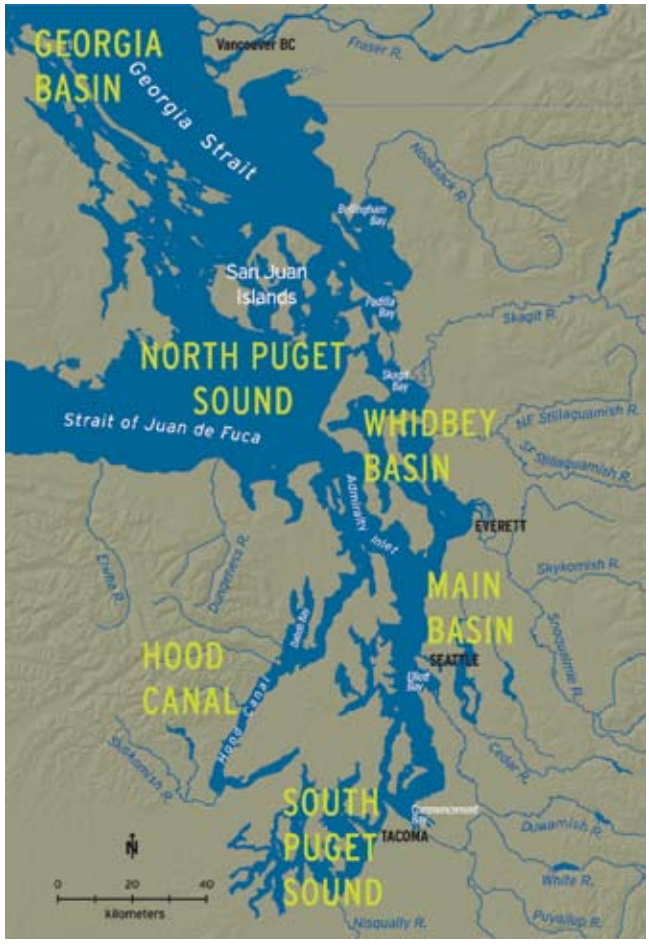

Figure 2. Circulation patterns in Puget Sound, Washington. Cold, salty water enters the Strait of Juan de Fuca, and tends to sink to the bottom, while lighter, fresher water flows out in upper layers. However, sills at the entrance to Admiralty Inlet, Hood Canal and at the Tacoma Narrows cause upwelling and reflux, and restrict some freshwater circulation.

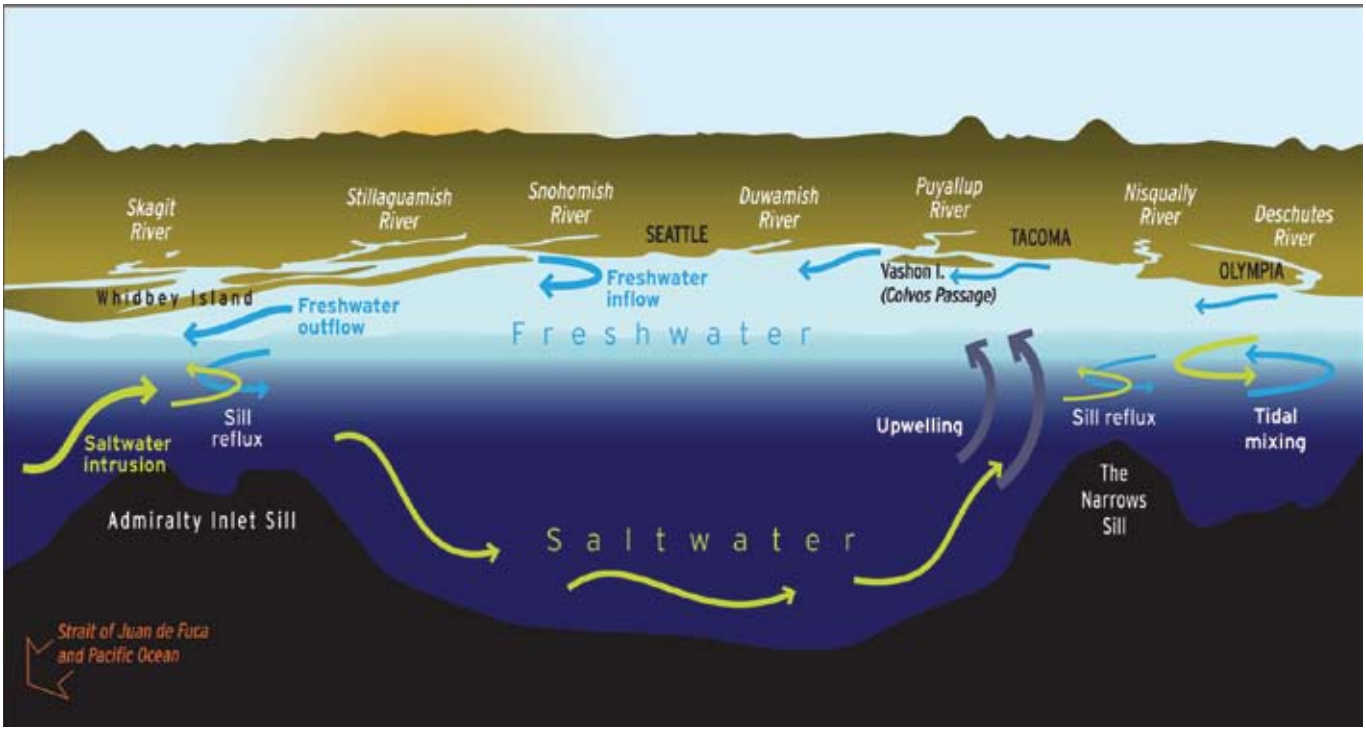

Figure 3. Relative magnitude of Chinook salmon (*Oncorhynchus tshawytscha*) returns to river basins in the Puget Sound ecosystem. The width of arrows indicates relative number of Chinook salmon migrating into rivers to spawn, which is an indication of the potential amount of marine-derived nutrients transported upstream by this species.

of state government and offering policy-makers additional confidence in the content.

MOVING FORWARD—USING *SOUND SCIENCE*

Sound Science is a strong foundation for ongoing collaborative scientific work to support the recovery of Puget Sound as a source of natural and social benefits. The Puget Sound Partnership is using it to guide ongoing science analyses as part of their nascent EBM process. It was written for an educated lay audience and designed for outreach and education efforts. Since only about 20% of current residents are aware that the Puget Sound ecosystem is not healthy, outreach and education are essential tasks. *Sound Science* will be included in marine biology programs offered at high schools, community colleges, and universities, and it has been provided to other organizations interested and invested in Puget Sound. With its comprehensive and straightforward presentation, *Sound Science* will improve public understanding of Washington's inland marine ecosystem.

The status of Puget Sound does offer bright spots—including the high value citizens place on the wide range of goods and services that the ecosystem provides, such as seafood, recreation, natural beauty, and transportation. There is good reason to believe that concerted and immediate actions will allow the Puget Sound region to halt or reverse declines in ecosystem health. Documents like *Sound Science,* produced in an open process with diverse contributors, are powerful tools for making scientific knowledge available to policy leaders and individual citizens whose investment decisions will determine the future of ecosystems.

Box 1. Key findings from the *Sound Science* document. The report concluded that the following issues are critical to improving the condition of the Puget Sound ecosystem:

- An understanding of the whole ecosystem, including human roles in its structure and function, is needed to support complex management decisions. Cumulative pressures require that management decisions take a holistic perspective, considering both human and natural processes, in order to increase the likelihood that the ecosystem can be managed sustainably.
- Climate change will result in significant weather, rainfall, flooding and other changes, affecting which species can prosper in the Sound, our livelihoods and quality of life. Proactive planning for water use and urban development has the potential to moderate some of these effects.
- Ecosystem food webs and functions have been significantly altered but are poorly understood. Species at risk include rockfishes, Pacific salmon, orcas, herring, marine birds (including shorebirds), and Pacific cod. Conservation efforts aimed at top-level predators should also consider the forage species and habitats upon which they depend.
- Human population growth and patterns of land development, waste disposal, and other resource uses are increasing demands on the ecosystem. The quantity and quality of available habitats for other species are diminishing due to this population growth and climate change. Conservation strategies that maximize the ecosystem benefits that can be gained from mixed landscapes, including agriculture and timberlands, may help alleviate impacts of urbanization.
- Because the health of humans is inextricably linked to ocean and broader ecosystem health, the input of toxic chemicals, and increases of marine biotoxins and pathogens are threats to human well-being and our economy.
- Collaborative efforts at all levels are needed to develop scientific information and implement robust actions. These include cooperative efforts between natural and social scientists and between scientists and policy-makers.

Box 2. Signatories to the *Sound Science* document.

NOAA—Northwest Fisheries Science Center
Environmental Protection Agency
King County
Northwest Indian Fisheries Commission
Puget Sound Action Team
The Nature Conservancy of Washington State
U.S. Geological Survey
University of Washington
Washington State Department of Ecology
Washington State Department of Fish and Wildlife
Washington State Department of Health
Washington State Department of Natural Resources

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Figure 4. The transmittal ceremony for *Sound Science* with Washington State Governor Gregoire. (left to right): Randy Shuman (King County), Frank Shipley (U.S. Geological Survey), Usha Varanasi (Northwest Fisheries Science Center, NOAA Fisheries Service), Jacques White (The Nature Conservancy of Washington), Bernard Hargrave (U.S. Army Corps of Engineers), Richard Parking, (Environmental Protection Agency), Jeff Koenings (Washington Department of Fish and Wildlife), Jay Manning (Washington Department of Ecology), Brad Ack (Puget Sound Action Team), David Fluharty (University of Washington), Douglas Sutherland (Washington Department of Natural Resources), and Gregg Grunenfelder (Washington Department of Health).

LITERATURE CITED

Francis, R. C., M. A. Hixon, M. E. Clarke, S. A. Murawski, and **S. Ralston.** 2007. Ten commandments for ecosystem-based fisheries scientists. Fisheries 32(5): 217-233.

Hennessey, T. M., and **J. G. Sutinen.** 2005. Sustaining large marine ecosystems: the human dimension. Elsevier Press, Amsterdam.

Puget Sound Partnership. 2006. Sound health, Sound future. Protecting and restoring Puget Sound. Puget Sound Partnership recommendations. Available at: www.pugetsoundpartnership.org

Sound Science. 2007. Sound Science: synthesizing ecological and socioeconomic information about the Puget Sound ecosystem. Mary Ruckelshaus and Michelle McClure, coordinators; prepared in collaboration with the Sound Science collaborative team. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration (NMFS), Northwest Fisheries Science Center. Seattle, Washington. Available at www.nwfsc.noaa.gov/research/shared/sound_science/index.cfm.

USCOP (U.S. Commission on Ocean Policy). 2004. An ocean blueprint for the 21st century. USCOP, Washington, DC.

Van Cleve, F. B., C. Simenstad, F. Goetz, and **T. M. Mumford.** 2004. Ecosystem restoration: lessons learned from large-scale restoration project efforts in the USA (Technical Report 2004-01). Available at www.pugetsoundnearshore.org/material_activity.html#documents.