

1. INTRODUCTION

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BACKGROUND

Puget Sound is the second largest estuary in the United States and is richly endowed with diverse natural resources and aesthetic beauty. Its productive waters and adjacent lands provide critical life-support functions for diverse communities of fishes and wildlife, including breeding, feeding, rearing, refuge, and migration. These characteristics are the result of thousands of years of natural processes that have formed the Puget Sound region that we know today.

Since the end of the last glacial period ten to twelve thousand years ago, the Central Puget Sound Basin has evolved to support a diverse assemblage of species and habitat types. The carving of the Puget Trough and deposition of sediments with the advance and recession of glaciers over the millennia formed the geophysical foundation for the Puget Sound landscape. The landscape was further developed by other key elements such as climate, hydrology, and the establishment of vegetation, fish, and wildlife. The interaction of multiple physical, chemical and biological processes formed, and continue to form and maintain, habitat that supports organisms that are all specially adapted to thrive in the environment that has evolved.

One of the most significant results of this evolutionary process was the formation of the Puget Sound estuary. Estuaries are recognized as some of the most productive ecosystems on earth because they act as nursery areas for most of the world's fisheries. Estuarine ecosystems are unique, highly productive, and extremely complex for a number of reasons, including:

1. Their salinity is variable, creating an environment that is neither strictly marine nor freshwater;
2. They act as nutrient traps and acquire nutrients from the ocean, rivers, and the adjacent land;
3. They are semi-enclosed, tidally influenced bodies of water that provide shallow refuge, rearing, feeding areas, and migration corridors;
4. The land-aquatic interface tends to moderate climate; and
5. Their geomorphology and other physical properties provide habitat complexity.

Aquatic and terrestrial organisms thrive in estuaries because they typically have high primary and secondary productivity, are rich in nutrients and food resources for young and adults, and provide refuge in their relatively low energy, shallow waters. Estuaries support abundant and diverse communities of organisms. For example, the Puget Sound estuary supports over 200 species of fishes, approximately 10 species of marine mammals, and hundreds of species of aquatic invertebrates and plants, and is critical to the survival of shorebirds, waterfowl, and upland wildlife species. The interplay between species and the environmental characteristics (i.e., geology, climate, topography/bathymetry, freshwater and saltwater input) in which they have evolved in time and space has resulted in a complex ecosystem. In this system, survival is dependent upon maintaining a delicate balance between the physical, chemical, and biological processes that form and maintain habitat. Disruptions in, or disturbance of, any of these processes weakens the ecosystem structure, thereby reducing habitat quality and species survival.

Although disturbance is a part of the natural system, most species have evolved with a tolerance threshold for the types and levels of disturbance they can withstand in space and time. Exceeding threshold levels (i.e., changing water quality, reducing prey or nutrients, eliminating spawning habitat, and changing substrate, or habitat structure) can have a dramatic effect on the health or viability of an organism, or communities of organisms.

PROBLEM STATEMENT

The scenic landscapes, moderate climate, productive land and waters, and economic opportunities have also drawn humans to the Puget Sound region. Within this region, the Central Puget Sound Basin has become the most heavily urbanized area and the impacts of human activities have taken a toll on living natural resources and the habitat that supports them. Nearshore habitat alterations, degradation, and losses have resulted from a number of activities, including filling, dredging, shoreline armoring, overwater structures, waste and wastewater disposal, non-point pollution, vegetation removal, shoreline development, roads, and changes in hydrology. Many of these activities (i.e., sport and commercial fishing, timber harvest, shipping, real estate development) have depended upon natural resource and aesthetic values. Yet none of these activities have been conducted with an adequate understanding or assessment of how they are affecting the very ecosystem that sustains our economic interests and valuable natural resources.

Despite the fact that ecosystems tend to be somewhat resilient, population growth in the Puget Sound region has had a dramatic adverse effect on habitat and species native to this area. In less than 130 years, humans have significantly altered the landscape and have extirpated or reduced species diversity and abundance. The rates of reduction and loss are compounded by the fact that we have reacted slowly and inadequately to habitat and species losses (McMurray and Bailey, 1998). Much of this damage was done unknowingly, or due to the lack of scientific information for proper management and protection measures. However, much of this loss and destruction continues despite warnings from scientists, resource managers, and the environmental community.

The lack of adequate levels of scientific information has been one of the most imposing barriers to our understanding of how the Puget Sound system works and for the development of recommendations and decision making for improved natural resource protection and management. Furthermore, there is a lack of coordinated research and comprehensive documentation of marine and estuarine ecosystem studies for Puget Sound. Although scientific knowledge is not complete for freshwater and terrestrial ecosystems, Puget Sound marine and estuarine systems have received much less attention and our knowledge is therefore much less advanced. Some of the reasons for this include:

1. Marine/estuarine sciences are relatively young and evolving;
2. There is a lack of adequate funding for marine/estuarine studies;
3. There is a lack of marine science professionals;
4. Marine systems, especially estuaries, are extremely complex; and
5. The Puget Sound region has not kept up with advancements in estuarine studies elsewhere.

Improving our understanding of marine systems and making informed management decisions requires us to break through these barriers. Improved management decisions will also require an acknowledgment of the linkages between the integrity of habitat and species production. Furthermore, it will require a broader landscape perspective and an ecosystem approach to assessment and management actions. This ecosystem approach requires an understanding of the fundamental linkages among ecosystem components, biological responses to physical and geochemical processes, rates and variability of these underlying processes, and the effects of disturbance and other modes of ecosystem change (Simenstad, et al. 2000).

Past, recent, and potential future listings of several Puget Sound salmonids and other species as threatened or endangered under the Endangered Species Act (ESA) have prompted a series of watershed inventories and analyses to provide science-based policy direction for regional conservation planning efforts. The marine nearshore environment plays a critical role in the life history and ecology of salmon and many other species in the region. Puget Sound is the basin into which flows the drainage from the surrounding land and acts as the “margin” between the uplands and the deeper marine environment. Because of its location, its health, processes, structure, and ability to function in support of salmon and other species is inextricably linked to direct drainages, the adjacent land, and the sea. Urbanization and development of the Central Puget Sound shorelines have led to historical losses, degradation, and fragmentation of nearshore habitats. Although there is a large amount of data on some Central Puget Sound nearshore habitats, no existing report provides a comprehensive summary of the data, resources, or the state of our current knowledge of ecosystem “health.” Jurisdictions in King County have begun preparing watershed assessments for Watershed Resource Inventory Areas (WRIAs) 8 (Cedar River Watershed) and 9 (Green/Duwamish River Watershed). A detailed understanding of nearshore resources and processes is prerequisite to completing these watershed assessments and salmon recovery plans.

PURPOSE OF REPORT

The purpose of this State of the Nearshore Report (SONR) is to provide a current, fundamental understanding of major ecological conditions, habitats, processes and resources that occur in the nearshore zone of WRIAs 8 and 9. The report is a preliminary, reconnaissance-level assessment that is limited in size and scope due to the complex nature of the system, the lack of comprehensive ecosystem analysis and reporting, and timing. The report pulls together the major sets of information developed in other key reports and data sets, and identifies gaps in current understanding. The intent is to have, in one place, a preliminary summary of the nearshore ecosystem in WRIAs 8 and 9 that will serve as a foundation for future work and decision-making.

The report will serve several specific purposes/objectives:

1. Provide a basis for nearshore watershed planning and salmon recovery efforts;
2. Provide direction for future technical work through identification of data gaps; and
3. Serve as a resource to researchers, planners, and managers dealing with nearshore issues in WRIAs 8 and 9.

Additionally, the contents of this report may be of interest and value to other regions and resource managers.

It should be noted, however, that this report is considered to be a work in progress. Although a tremendous amount of effort was expended in preparing this report, there remains a significant amount of information that was not included due to time and resource constraints. There are also significant data gaps in our understanding of the nearshore ecosystem, and although we have attempted to identify these, some may have been overlooked. Our intent in preparing this report, along with other, concurrent watershed and salmon recovery planning efforts, is to develop a holistic approach to understanding the nearshore ecosystem within the watershed landscape. Assessments of many nearshore species, habitat types, ecosystem and landscape processes, and habitat restoration are not included in this report, but are recommended for future reports.

Geographic Scope

The Lake Washington-Cedar-Sammamish watershed (WRIA 8) and the Green-Duwamish watershed (WRIA 9) both have marine shorelines. WRIA 8 extends roughly from Elliot Point in the north to West Point in the south. WRIA 9 includes Seattle's Elliott Bay, defined by West Point in the north and Alki Point in the south, and continues south to just north of Dumas Bay. Vashon and Maury Islands (WRIA 15) also are included in this report. Discussions are underway between WRIA 9 and WRIA 15 to transfer planning responsibility for the islands to WRIA 9.

The entire study area is presented in Figure 1. The authors have further divided the study area into 12 sub-areas (reaches) to assist in describing the location and status of particular marine resources in this report. WRIA 8 encompasses reaches 1 through 3, and WRIA 9 includes reaches 4 through 12; reach 4 represents Elliott Bay and the Duwamish estuary, and reaches 9 through 12 cover Vashon and Maury Islands.

- Reach 1: Elliot Point to Edwards Point
- Reach 2: Edwards Point to Meadow Point
- Reach 3: Meadow Point to West Point
- Reach 4: West Point to Alki Point
- Reach 5: Alki Point to Point Williams
- Reach 6: Point Williams to Brace Point
- Reach 7: Brace Point to Three Tree Point
- Reach 8: Three Tree Point to Dumas Bay

Figure 1 Study Area

Reach 9: Vashon Point to Point Robinson
Reach 10: Point Robinson to Piner Point
Reach 11: Piner Point to Neill Point (including Quartermaster Harbor)
Reach 12: Neill Point to Vashon Point

DEFINITION OF THE NEARSHORE ZONE

For the purposes of this report, the nearshore zone is defined as that area between the lower limit of the photic zone (approximately minus 30m MLLW) and the upland–aquatic interface (i.e., the riparian zone). The nearshore environment extends landward to include coastal landforms such as coastal bluffs, the backshore, sand spits and coastal wetlands, as well as marine riparian zones on or adjacent to any of these areas. In addition, the nearshore environment includes subestuaries such as the tidally influenced portions of river and stream mouths. Figure 2 shows a cross-section of the nearshore environment, and Figure 3 provides an aerial view of a variety of nearshore habitats.

APPROACH AND ORGANIZATION OF REPORT

The Central Puget Sound region is now faced with Endangered Species Act (ESA) listings of chinook salmon and bull trout. Past and potential future listings of other marine/estuarine dependent fishes and associated wildlife, and a reduction in other ecosystem health indicators, have given scientists, resource managers, planners, policy makers, and other interested parties a strong signal that the natural system is out of balance. Efforts to address ESA issues and restore the balance must be founded on good scientific information. This report is a necessary first step in achieving that goal.

While many steps will be taken in the process of developing watershed and salmon recovery plans, the logical first step is to determine what we know about the nearshore species and the ecosystems that support them. We must also determine what we do not know about ecosystem processes and functions that may play important roles in supporting critical species, and how species respond to natural and anthropogenic disturbances in the system. Using this approach, the Reconnaissance Assessment of the State of the Nearshore Ecosystem Report (SONR) summarizes current and historical scientific information to describe major habitats and species that may be used to characterize the nearshore environment in WRIAs 8 and 9. It is the first report of its kind for Central Puget Sound and will provide the scientific foundation for ongoing nearshore technical work.

The report begins with a discussion of a conceptual model of the nearshore ecosystem, followed by information on the physical features of Puget Sound. Subsequent chapters focus on nutrient dynamics and water quality, primary productivity, the nearshore food web, various habitat types, selected species of fishes and invertebrates, and the effects of human activities on nearshore habitats and species. Chapter 11 provides a special section on Elliott Bay and the Duwamish subestuary, the most heavily urbanized and industrialized portion of the study area and the reach for which the largest body of existing information is available.

CAVEATS

A few caveats are essential to understanding what the report is, what it is not, and how it should or should not be used.

- This report is limited in scope and is representative only of what we currently know about the various species, habitats, processes, and functions contained in the report. Numerous other species and habitats play essential roles in this ecosystem but were not included due to time and budgetary constraints. The exclusion of a particular species or other element of the ecosystem should not be construed as an indication that the species or element is of any less importance in the ecosystem.
- While every effort was made to incorporate the best scientific information and approaches for understanding elements in this ecosystem (i.e., “best available science”), time and budget constrained our ability to gather and incorporate some information. It is our hope that the information contained in this report will be updated and expanded as we continue our assessment of the nearshore ecosystem.
- The degree of certainty and applicability of the information contained in this report is constrained by the level of information available and scientific investigation used to acquire the information. It is advisable for any reader of this report to become familiar with the original source of information to determine the applicability of a particular reference used in this report.
- Maps and other graphic representations of data used in this report are representative only of data made available to the authors and do not necessarily represent complete data sets, or indicate the absence of a particular species or habitat type. Any questions pertaining to graphics should refer to the original source of information.
- Any questions regarding the content of this report should refer to the original authors and the King County technical staff responsible for its production.

Despite the caveats, we feel that this report is an extremely valuable and useful building block that will enhance the discussion of salmon recovery and watershed planning, help to improve our understanding of nearshore ecosystem, and improve the management and protection of this complex, fascinating, and valuable ecosystem.

Figure 2 Nearshore Section Illustrating Typical Zonation

Figure 3 Nearshore Environment Habitat Types