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PUGET SOUND NEARSHORE PARTNERSHIP

Guidance for Protection and Restoration of the Nearshore Ecosystems of Puget Sound

RESTORING OUR ECOSYSTEM HEALTH

Prepared in support of the Puget Sound Nearshore Partnership (PSNP)

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Cover: South Fork of the Skagit River, Washington, is an example of a large estuarine delta. Courtesy of Hugh Shipman, Washington Department of Ecology.

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Preface

The Puget Sound Nearshore Partnership (PSNP) was formed to support efforts to improve the condition of the nearshore ecosystems of Puget Sound. In support of PSNP's efforts, the Nearshore Science Team (NST) is producing interrelated, science-based technical products such as a set of Guiding Principles and a Conceptual Model. These products are intended to help identify problems with the nearshore ecosystems of Puget Sound, determine major information needs, and identify potential solutions. The purpose of this document is to provide guidance for developing, selecting, and evaluating actions and projects targeted at protecting and restoring the nearshore ecosystems of Puget Sound.

The document should be regarded as an interim product that reflects our current state of knowledge about the nearshore, representing the first step in a longer-term, evolving process. As we learn more from restoration actions, monitoring, and research, the guidance provided by this document *may* also change. Ultimately, our goal is to develop interactive decision-making tools or models that will allow potential outcomes of particular actions to be evaluated.

This guidance document was developed based upon our understanding and knowledge of the best available scientific literature. For additional information on the topics covered here, a list of references is provided at the end of this document. Following this preface and the introduction are three main parts:

First, we define and develop key concepts, principles, definitions, and terms.

Second, we describe a framework for a comprehensive, strategic planning process that we propose to employ to guide our development and selection of restoration projects in Puget Sound. We believe that such strategic restoration planning is (1) necessary to ensure that all project actions have the appropriate ecological context and (2) a critical part of developing specific restoration actions. While this planning framework was developed by the NST for PSNP, we also believe it can be more broadly applied at smaller scales by other practitioners in Puget Sound to design, construct, and monitor protection, restoration, or other conservation actions.

Third, we describe criteria to help evaluate and select projects directed at recovery of the nearshore ecosystems of Puget Sound. We recognize that the full strategic plan and our process-based model will take some years to fully develop. However, the degraded condition of portions of Puget Sound suggests a compelling need to implement recovery actions before these products are completed. These two concerns can be simultaneously addressed by initiating carefully targeted protection and restoration activities where there is a high amount of certainty in their ecological benefits, low risk of damage, and opportunity to generate needed information about how to protect and restore the Puget Sound nearshore. We believe there can be considerable value in such early action projects, which can provide the basis for scientific assessments of new technologies, test alternative approaches to restoration, and develop assessment protocols. As with the strategic plan, these criteria can also be more broadly used by other restoration practitioners to help guide their efforts.

Executive Summary

Significant degradation in the form and functioning of the nearshore ecosystems of Puget Sound has occurred and resulted in significant adverse impacts to many valuable biological, cultural, and social resources. The Puget Sound Nearshore Partnership (PSNP), formerly the Puget Sound Nearshore Ecosystem Restoration Project, was created to guide efforts to improve the condition of Puget Sound nearshore ecosystems. The Nearshore Science Team (NST) provides guidance, advice, and direction for PSNP and is producing interrelated, science-based technical products to help identify problems with the nearshore ecosystems of Puget Sound, determine major information needs, and identify potential solutions.

The purpose of this document is to provide guidance for PSNP on the development, selection, and evaluation of projects designed to support recovery of the nearshore ecosystems of Puget Sound. It is an interim product that reflects our current state of knowledge about the nearshore and so represents a first step in a longer-term, evolving process. The long range goal of the NST is to develop interactive, decision-making tools that will allow potential outcomes of various actions or combinations of actions to be evaluated. While developed for PSNP, we believe the guidance provided in this document can be useful to other restoration practitioners.

This guidance document has two main sections. The first section presents a framework for a comprehensive, strategic planning process that we propose to employ to guide the development and selection of projects in Puget Sound. We believe that such strategic planning is necessary to ensure that proposed actions have the appropriate ecological context and to help ensure that the recovery actions that are implemented will have a high probability of successfully improving the condition of Puget Sound nearshore ecosystems.

A fundamental principle of this strategic plan is that recovery of nearshore ecosystems can best be achieved by reestablishing or significantly improving ecosystem processes. Ecosystem processes are any interaction among physiochemical and biological elements of an ecosystem that involve changes in character or "state." Ecosystem processes operate at naturally varying rates, frequencies, durations, and magnitudes that are controlled or constrained by various anthropogenic and natural factors. The NST proposes that the main processes that have been disrupted in the nearshore ecosystems of Puget Sound are those involving sediment, water, and food webs.

Process-based ecosystem recovery involves implementing projects that make it possible for the system to generate and maintain natural ecosystem processes that in turn generate desirable ecosystem structures (e.g., habitats) and important functions (e.g., salmon production, bivalve production, clean beaches, and clean water). Because ecosystem processes cross land, water, and air boundaries, a major theme of this recovery plan is the connectivity of the nearshore with other freshwater (upstream), terrestrial, shoreline, and marine ecosystems. Recovery of the nearshore cannot be disconnected from these other segments of the landscape.

The following are the major elements of the strategic plan. We wish to make clear that this document does not present a plan but rather presents elements of the plan the NST proposes to include.

1. Define goals
2. Develop and use a conceptual model
3. Identify impaired ecosystem processes using a change analysis
4. Create strategies that are spatially explicit
5. Obtain knowledge of critical, dependant biota
6. Identify actions
    a. Protection
    b. Restoration
    c. Rehabilitation
    d. Substitution/creation
7. Prioritize actions
8. Develop performance measures
9. Adaptively manage recovery
10. Monitor

The second part of this document presents a set of criteria that were developed specifically to help evaluate and select projects to support recovery of nearshore ecosystems of Puget Sound over the near term. We recognize that the strategic plan and our process-based model will take some years to fully develop but that the degraded condition of portions of Puget Sound suggests there is a compelling need to implement some recovery actions before these products are completed. Any so-called early action projects should be carefully targeted activities where there is a high amount of certainty in their ecological benefits, there is low risk of damage, and, most importantly, there is an opportunity to generate needed information about how to protect and restore the Puget Sound nearshore. The following are the criteria recommended at this time by the NST (stated as questions) to help select projects over the near term:

1. Does the project have clearly stated goals and objectives and are they appropriate for ecosystem recovery?
2. Does the project have a conceptual model?
3. Does the project contribute significantly to our understanding of nearshore ecosystems or how to restore them?
4. How likely is it that the project will have significant ecological benefits?
5. What is the landscape context of the project?
6. Does the project incorporate habitats important to key biota?
7. Is the project part of a portfolio of recovery actions?

8. What are the relationships between uncertainty, risk, expected ecological benefits, and learning for the project?
9. What are the costs of the project relative to other factors?
10. Is the project sustainable within the context of the expected natural evolution of the target ecosystem?
11. Does the project have clear performance measures?
12. Does the project have a rigorous monitoring plan?
13. Does the project have an adaptive management and contingency plan?
14. Do partnerships exist among communities, organizations, and agencies who may be involved in the action and who own the land?

Introduction

Shallow-water environments of Puget Sound estuarine and marine shoreline areas (in this document, we collectively refer to these areas as the nearshore) represent the aquatic boundary or interface between freshwater, air, land, and the open marine waters of Puget Sound. Estuaries include the deltaic portions of river mouths encompassing the upper extent of tidal influence (i.e., tidal freshwater or head of tide) to the outer extent of the delta. By definition this includes fjord systems such as the major inland passages of Puget Sound that technically make up an estuarine complex. The nearshore includes upland and backshore areas that directly influence conditions along the shoreline, and it extends seaward to the greatest depth of the water column that encompasses the photic zone.

The nearshore consists of a mosaic of ecosystems that supports valued ecological, economic, cultural, and social services. Population growth and human development in the Puget Sound region have resulted in significant degradation in the form and function of these ecosystems, both as a result of direct impacts on the nearshore landscape and as a result of changes in the freshwater, terrestrial, and open-water ecosystems that interact with the nearshore. Changes to the freshwater portions of watersheds from timber harvesting, agriculture, and urban development have resulted in significant modifications in the quantity, quality, and timing of water, nutrients, woody debris, and sediments entering the nearshore. Water and sediment quality has also been significantly degraded in many areas due to inputs from commercial, industrial, and residential sources. Within the nearshore, practices that include diking, dredging, filling, armoring, aquaculture, and harvesting have displaced, destroyed, or modified the nearshore ecosystems. When one considers that much of the marine shoreline was also logged historically, it is clear that most of Puget Sound's nearshore has been impacted by humans since long before the turn of the 20st Century.

In addition to the physical or structural changes in nearshore ecosystems, many physiochemical functions of nearshore ecosystems important to the maintenance of diverse biota, clean water, and healthy, harvestable organisms have been altered by human development. The loss of estuarine wetlands has altered the ability of estuarine systems to absorb water and has made extreme flooding more likely. Impacts to mudflats and eelgrass beds have affected their ability to recycle and process nutrients. Nearshore, marsh, and riparian ecosystems act as filters for sediments and contaminants that would otherwise concentrate in the Sound. The nearshore is a major supplier of organic matter that is both used in detritus-based food webs and supports biota associated with the nearshore and other ecosystems.

The modification and destruction of nearshore ecosystems have resulted in significant adverse impacts to valuable biological, cultural, and social resources. The depressed status of many species that use Puget Sound nearshore habitats suggests that degradation of the nearshore may be affecting population abundance levels and resilience of these species. For example, three anadromous salmonid species that use the nearshore habitats in Puget Sound (chinook salmon [*Oncorhynchus tshawytscha*], summer chum salmon [*O. keta*], and bull trout [*Salvelinus confluentus*]) are listed as threatened or endangered under the United States Endangered Species Act (ESA). Pacific herring (*Clupea pallasii*) populations that spawn and rear in the nearshore are in such poor condition that they have not been able to support commercial fisheries for many years. Several species of rockfish (*Sebastes* spp.) that use nearshore areas as nursery habitats have been considered for listing under the ESA. Failing septic systems have degraded water quality in some shoreline areas, making it unsafe to eat some species of shellfish.

The degraded condition of Puget Sound has prompted considerable interest in restoring the condition of its nearshore ecosystems. The Puget Sound Nearshore Partnership (PSNP, formerly the Puget Sound Nearshore Ecosystem Restoration Program) was initiated in 2001 specifically to guide efforts to improve the condition of Puget Sound nearshore ecosystems by identifying significant problems, developing potential solutions, and then implementing and evaluating solutions. The scientific guidance, advice, and direction for this program is provided by the Nearshore Science Team (NST). In support of PSNP, the NST will produce a variety of products to help identify problems with the nearshore ecosystems of Puget Sound, determine major information needs, and identify potential solutions.

The purpose of this guidance document is to provide direction for PSNP in the development and selection of protection and restoration actions and projects. On the basis of our review and assessment of large-scale restoration efforts, the NST believes that for ecosystem-scale restoration of Puget Sound to be successful, strategic, comprehensive planning must occur. The elements of our proposed plan are briefly discussed. Although ecosystem restoration cannot be accomplished piecemeal by purely opportunistic actions, considerable value potentially exists in implementing "early action" projects. These projects can provide the basis for scientific assessments of new technologies, test alternative approaches to restoration, evaluate key uncertainties about nearshore ecosystems, develop assessment and monitoring protocols, and provide ecological benefits. In this document we provide criteria for developing and evaluating these types of projects (Section V).

This document should be viewed as the first step in an evolving process of developing, implementing, and monitoring protection and restoration actions. In the future, we expect to periodically revise it as we learn more from implementing and monitoring actions and research. Our long-term goal is to develop interactive decision-making tools or models that will allow outcomes of various actions or combinations of actions proposed by PSNP (and potentially others) to be evaluated. Although this guidance was developed by the NST for PSNP, the NST also believes it can be broadly utilized by other restoration practitioners in Puget Sound.

Definitions, Principles and Concepts

What Is an Ecosystem?

An ecosystem is a *community of organisms and their physical and chemical environment interacting as an ecological unit*. It thus includes elements of the physical/chemical environment and living components. Ecosystems possess three general types of features: (1) processes, (2) structural components or habitats that are primarily created and maintained by processes, and (3) outputs or functions such as species that are supported by the habitats. Nearshore ecosystems are dynamic, continuously changing systems that naturally evolve over time as a result of the interactions between processes, structures, and functions and responses to different types and intensities of natural and anthropogenic disturbances. Ecosystem boundaries are not easily defined because linkages in the system occur longitudinally (upstream to downstream and alongshore), laterally (upland–onshore–offshore), and vertically (atmospheric–aquatic). Therefore, the Puget Sound nearshore should be viewed in three dimensions as a suite of overlapping ecosystems that vary in extent as a function of the different environmental and ecological linkages. In addition, ecosystems are explicitly taxa-specific, such that the organisms of interest define the scope of influence of the physical, chemical, and biological environments.

What Are Ecosystem Processes?

Ecosystems are not naturally static in space and time but are continuously being shaped and reshaped by physical, chemical, and biotic processes. *Ecosystem processes are any interaction among physiochemical and biological elements of an ecosystem that involve changes in character or "state."* The NST has concluded that long-term recovery of nearshore ecosystems will primarily involve recovery of processes rather than simply focusing on reconstructing habitats or functions. Ecosystem processes operate at naturally varying rates, frequencies, durations, and magnitudes that are controlled or constrained by anthropogenic and natural factors. Climate, landform, bathymetry, and geological setting of an area constrain or control how biota, water, sediment, and organic matter are acquired and moved within the system. Processes also operate at various spatial and temporal scales and they can include such things as changes in chemical composition (e.g., nutrient transformations), biomass (e.g., production and consumption), and movement of material (e.g., sediment transport). For example, sediment can be transported over spatial scales of one to hundreds of kilometers. In an estuary, sediments originate from the watershed, are transported downstream by river flow, and then moved episodically (eroded and deposited) by bidirectional water movements (tides and river flow) through the estuarine gradient. The sediment composition on a beach typically depends upon upland sources of material deposited directly on the beach, movements of material along the beach, and wind and wave action, which are a function of landform/bathymetry, large-scale climate events, and smaller-scale oceanographic processes.

Disturbance is an important factor affecting the form and function of an ecosystem. A *disturbance is any relatively discrete event that disrupts or alters some portion or portions of an ecosystem*. In ecologically healthy systems, most natural disturbances are relatively short in duration and magnitude and do not thoroughly or permanently change the biophysical or ecological structure of the ecosystem. Because nearshore ecosystems have evolved the ability to accommodate natural disturbance regimes, they can typically recover rapidly to a state similar to the pre-disturbance condition. Small- to medium-scale floods and winter wind storms are examples of common types of natural disturbances. Some disturbances such as a large earthquake, 100-year flood, or a 90-mile-per-hour windstorm can reshape the ecosystem so that it does not rapidly recover to its pre-disturbance condition.

Human land uses alter the rates, duration, frequency, magnitude, and scales of natural processes. Because land-use activities typically operate at large spatial scales and persist for long time periods, they often result in permanent or semi-permanent changes in ecosystem processes. Land-use activities affect processes by resetting or reshaping natural disturbance regimes. For example, urbanization increases the magnitude and frequency of floods and creates new peak runoff events that can result in more sediments being transported more frequently to the estuary. Diking, armoring, and straightening of channels eliminate floodplain area, change hydraulic characteristics, and increase the ability of the water to erode and transport sediments and organic material. In extreme cases like the Duwamish River, we would predict that the location and extent of salinity intrusion is dramatically different than under historical conditions because of changes to the channel and surrounding wetland.

Habitat: What Is It and How Is It Created?

Habitat is *the physical, biological, and chemical characteristics of a specific unit of the environment occupied by a specific plant or animal*. Habitat is unique to specific organisms and basically encompasses all the physiochemical and biological requirements of that organism within a specific location. For example, habitat for juvenile chinook salmon is different than habitat for shiner perch (*Cymatogaster aggregata*), even though both species may occur in the same general space at the same time. To define habitat, we must know where it is in the ecosystem, what plant or animal is being specifically considered, and which unique characteristics or attributes of the habitat support the growth and survival of that organism.

The importance or function of nearshore habitats to any biotic element such as juvenile salmon or a species of forage fish (e.g., smelt) depends upon site-specific or local features of that habitat, quantity of habitat, and the landscape context of that habitat in the nearshore. Historically, habitat was primarily measured and evaluated based upon site scale attributes. In recent years, we have come to appreciate that the function of habitats within an ecosystem also depends upon the landscape context of that habitat. Landscape context refers to the integration of any habitat unit with all other elements of the landscape, including its size, shape, and location; its connectivity to other habitats; and the accessibility of that habitat to biotic resources. As a result, the same type of habitat in two different locations can differ in how it functions for any plant or animal element.

In some cases, organisms directly affect the functions of the habitat they occupy. For example, eelgrass traps and stabilizes sediments, alters water chemistry through photosynthesis, and alters local current patterns.

What Is Ecosystem Recovery?

An important principle of this document is that recovery of nearshore ecosystems can best be achieved by reestablishing or significantly improving ecosystem processes. Conceptually, this involves taking actions that enable the system to generate and maintain natural ecosystem processes that in turn generate desirable ecosystem structures (e.g., eelgrass beds, baitfish spawning gravels) and important functions (e.g., salmon production, bivalve production, and clean beaches and water). Clearly, the fundamental assumption of process-based restoration is that natural functions will return to some degree if processes are restored in the absence of sustained and significant constraints (e.g., shoreline armoring, persistent toxic contamination). Process-based restoration also enables the ecosystem to be naturally productive, self-sustaining (reducing long-term maintenance), and diverse.

A process-based restoration approach has the greatest chance of increasing numbers of valued biota, such as salmon, or improving other functions we value because it addresses the causes of degradation, not the symptoms (e.g., loss of eelgrass). Organisms such as juvenile salmon use habitats that have been damaged by humans modifying the rates, duration, magnitude, and frequency at which habitat forming processes operate. By focusing on repairing these ecosystem processes, we increase our chances of improving the functions we value. Thus, restoration projects that seek to place species-specific habitats, engineered structures, or animals in the landscape are less likely to succeed. Within the Puget Sound nearshore, the problems or causes of degradation are multiple and cumulative and so recovery will also likely involve multiple and cumulative actions. This is distinct from most other large-scale ecosystem recovery efforts such as the Chesapeake Bay, Florida Everglades, and Louisiana programs where a single problem or issue is the focus of ecosystem restoration efforts.

Elements of a Strategic Plan for Developing Nearshore Ecosystem Recovery Actions

To help guide the development and selection of recovery actions, PSNP proposes to develop a comprehensive ecosystem recovery plan in which specific actions and projects are conceptualized, designed, located, and assessed. We propose that actions or projects developed with this type of planning are more likely to benefit nearshore ecosystems than those that do not incorporate these elements. We refer to the process of developing an ecosystem recovery plan as *strategic planning*. In this document, we consider strategies to be broad-scale, conceptual approaches to ecosystem recovery, such as restoring hydrologic processes within an estuary. Actions are a specific type of activity that can be used to implement a strategy, such as breaching or removing dikes within an estuary. A project is a specific measure that implements a type of action such as restoring a parcel of land within an estuary to tidal action by removing or breaching the dikes. Another example of a project is removing a bulkhead that is blocking sediment from reaching one particular beach.

The overall purpose of a strategic plan is (1) to ensure that actions and projects are conceptualized within ecological and landscape contexts, and follow from the goal of recovering ecosystem processes, (2) to target appropriate areas, processes, and habitats, and (3) to take actions that provide measurable results and can be evaluated to inform future actions. Strategic plans are essential elements for publicly funded protection or restoration actions because such plans help practitioners understand the complex functions of ecosystems and how to help them recover. In addition, they can help ensure funds are spent prudently, facilitate communications with other restoration practitioners, and document effects of completed actions by monitoring.

Rather than being based simply on opportunities, strategic planning approaches the challenges of ecosystem recovery by trying to minimize uncertainty and optimize ecological outcomes through designing projects to be as synergistic and complementary as possible. A well-crafted strategic plan should thus ensure that the actions taken will have a high probability of improving the condition of Puget Sound nearshore ecosystems. Once developed, the strategic plan should be continuously revisited, revised, and updated as the landscape changes as a result of our actions (both positive and negative) and unexpected disturbances (e.g., a severe winter storm), and as our understanding of the system derived from monitoring and research efforts increases.

A major theme of this recovery plan is the perspective that strategic planning for the nearshore must recognize the connectivity of the nearshore with other freshwater (upstream), terrestrial, shoreline, and marine ecosystems. *Recovery of the nearshore cannot be disconnected from these other segments of the landscape*. Examples of this connectivity are numerous. In river deltas, the shaping and structuring of channel habitats depends in part on the volume of freshwater inflow while the transport and delivery of sediments to these areas depends upon river and tidal hydrology. Sediments on a beach can be derived from upland habitats while organisms using nearshore habitats can depend upon food webs that connect to marine waters, uplands, tidal marshes, and rivers. Thus, the elements of a plan should include and integrate the entire freshwater–nearshore–marine gradient because it comprises tightly linked and interacting ecosystems.

The following elements are important pieces of a strategic plan for recovery of Puget Sound nearshore ecosystems. We emphasize that the following does not constitute a plan but rather the elements the NST proposes need to be included in such a plan.

1. Goals: An important part of recovery planning is the development of goals. Beyond the goal of having properly functioning nearshore ecosystems, the PSNP has not yet finalized specific goals for the strategic recovery plan. Conceptually, the goals of the strategic plan should incorporate both scientific principles and socioeconomic factors and should be formulated such that they can be directly incorporated into performance measures that can be systematically and quantitatively assessed. In addition, goals should be framed in terms of desired future conditions or desired future behaviors for the ecosystem processes, structures, and functions necessary to sustain the defined, quantified levels of goods and services we value in the system (e.g., salmon). Goals must also reflect what is realistic and recognize constraints on the system (e.g., additional people added to the landscape) that exist currently or may exist in the future. Such constraints may significantly limit assumptions about key ecosystem processes upon which the rate and outcome of recovery depends (e.g., sediment transport).
2. Conceptual model: The strategic plan will be guided by a generalized conceptual model (CM) currently under development. The primary purpose of the CM is to organize our understanding of how the nearshore ecosystems of Puget Sound are composed, organized, and operate. Nearshore ecosystems comprise various structural elements, processes, rates, fluxes, and transformations, and include air, land, water, and biology. The CM can help identify how these different components interact with each other, and how strong particular linkages might be. The CM will provide insight into how different parts of the ecosystem respond to different types of changes including stressors and restoration actions. It can thus help identify the types and locations of changes (i.e., resulting from restoration actions) needed to achieve a particular outcome (e.g., improved growth and survival of juvenile salmon); therefore, it can provide some insight into what actions might be most effective. Also, the CM will help identify what some of the key uncertainties might be in our understanding of nearshore ecosystems. The CM is being designed to be spatially explicit, which is important because the organization and functions of different units of the nearshore depend upon where they are located. The CM will be versatile enough to help us examine the effects of a strategy, an individual restoration action, or a group of actions and identify whether the expected changes

in processes and structural components resulting from the action(s) will achieve desired goals.

3. Identification of ecosystem processes that are impaired and where they are impaired: Recovery of the nearshore ecosystems of Puget Sound requires both protecting existing processes and habitats, and repairing and restoring damaged ecosystem processes. In order to accomplish this, we need to identify what and where processes are impaired. The NST has determined that an evaluation of limiting processes is best accomplished by determining the specific relationship between the structural elements of the nearshore that have changed (e.g., shoreforms) and the mechanisms of the changes. This requires two general sources of knowledge: (1) an analysis of historical and current conditions to identify the changes that have occurred, and (2) a basic understanding of the ecosystem processes that could account for the observed changes. At this time, the NST has proposed that the ecosystem processes that are *most likely* limiting will be those involving food webs and the movements and distribution of water and sediments, and that many recovery actions will address one or more of these processes. The analyses involves the following components:

    a. Historical conditions: The historical condition of nearshore ecosystems probably provides the best template for restoration planning because it indicates where features used to occur and their natural size, shape, and connectedness to other elements of the ecosystem. The intent of the historical conditions analysis will be to quantitatively "hindcast" with the best available data the condition of the estuarine and nearshore landscapes at some point in time. (Presently, some analyses of historical conditions have been conducted by the University of Washington for some of the major estuaries of Puget Sound.) As part of this work, we need to determine how much uncertainty exists in this type of hindcasting and where data are most limited. Critical questions to be addressed in historical analyses entail defining the quantity of various types of shoreline features, their location, and their organization/arrangement. Examples of other questions that can be addressed from an analysis of historical conditions include the following:

        - What was the geomorphology?
        - What was the extent of landscape connectivity?
        - What was the extent and landscape position of discrete habitats of important organisms such as salmon?

    b. Assess current conditions: In addition to an analysis of historical conditions, an evaluation of current conditions is needed to obtain data to compare with historical conditions and assess change in ecosystem condition. This type of analysis should address the following types of questions:

        - To what degree are the various types of ecosystem features present and where are they located?
        - To what was this habitat connected?

    c. Understand ecosystem processes: As we have noted, our hypothesis is that hydrology, sediment, and food-web processes have been most affected by stressors affecting the Puget Sound nearshore. Knowledge of these processes will be critical to understanding where and what damage has occurred. Much research is needed on these key processes, especially quantitative data on rates, magnitude, scales over which the processes operate, and natural variability.

    d. Compare historical and current conditions to document changes that have occurred: Results of the change analysis will help draw inferences about what processes have likely changed. For this comparison, we will need to consider new constraints that may now exist. For example, the existence of an upstream dam will affect how water and sediment processes function. Important questions to be addressed by this analysis include the following:

        - What quantitative changes have occurred in diversity, landscape structure, and connectivity of habitats and ecosystems and why have these changes occurred?
        - What are the relative roles of anthropogenic and natural influences in these changes?
        - How have the habitats of key organisms changed over time?

4. Knowledge of critical, dependant biota: One of the expected outcomes of the strategic planning process will be a focus on the conservation of particular, valuable organisms. An obvious example of this is salmon. A strategic plan should summarize the relevant life-history requirements of these key organisms including population status, distribution, critical nearshore habitats used, and so on. This kind of description should include a determination of data gaps and research needs relative to these key organisms.

5. Identifying spatially explicit strategies: Because of the extent and complexity of Puget Sound, we expect that there will be variability between regions of Puget Sound in what needs to be accomplished to improve the condition of nearshore ecosystems. For example, sediment processes may be most disrupted in one region while hydrology is the major issue in another region. Therefore, any plan to recover the condition of nearshore ecosystems will need to be spatially explicit.

6. Identifying actions: A major issue in planning recovery is determining what types of specific actions are needed. The National Research Council and others have identified four general types or categories of ecosystem recovery actions. The strategic plan for Puget Sound nearshore ecosystem

recovery will likely include some mix of these four types of actions. They are listed in order of decreasing certainty with which they can contribute to ecosystem recovery:

a. Protection: In general, by protecting portions of ecosystems with functioning natural processes, we increase our likelihood of achieving desired goals. Protection must be a key part of ecosystem recovery because minimizing further degradation of important processes and habitats is key to ensuring that restoration actions actually improve overall ecosystem conditions. Protecting processes is not necessarily synonymous with protecting habitats. Simply protecting habitats without protecting the underlying processes that create and maintain those habitats will have a low chance of contributing to ecosystem recovery. Protection can be achieved through such tactics as acquiring land, using easements, and taking regulatory actions. Areas targeted for protection will be based upon a thorough analysis of critical or vulnerable natural areas. The priority for protecting portions of the landscape will be based upon identifying critical areas in imminent risk of being converted to an alternative use. Simply protecting property because it is available for acquisition and affordable is not considered part of ecosystem recovery.

b. Restoration: We use the National Research Council (NRC) definition of restoration as "re-establishment of pre-disturbance aquatic functions and related physical, chemical, and biological characteristics." Here, we propose to focus on restoring the processes that the conditions analysis has identified as being impaired and important to the loss of historical habitat. The NRC has identified two general ways that restoration can be accomplished. First, "passive restoration" can occur by removing anthropogenic constraints and allowing the system to recover through natural design. Second, "active restoration" involves major intervention intended not only to remove ecosystem constraints but also to accelerate or supplement natural developmental processes such as sculpting desirable geomorphology or planting vegetation. Examples of restoration actions that can have a high chance of success include reconnecting isolated or fragmented portions of the landscape, recovering areas where historical habitat loss was high, and targeting processes that operate across broad scales of the nearshore.

c. Rehabilitation: Rehabilitation tactics are employed where restoration actions are not considered to be feasible and involves partially reestablishing ecosystem processes. The threshold test for policy decisions on feasibility may include such issues as availability of adequate resources and impacts on other human uses and values. Rehabilitation involves some level of maintenance to achieve project goals. We consider enhancement to be a form of rehabilitation. Given the pervasive constraints on nearshore ecosystems throughout much of Puget Sound, we expect that rehabilitation will be the focus of many actions.

d. Substitution/Creation: This is defined as the creation of an ecosystem or portion of an ecosystem where it was not historically present. This is applied in situations where other recovery options are considered to not be possible and may even involve "installation" of a typical ecosystem such as a wetland in an upland area. As with rehabilitation, the threshold test for policy decisions on feasibility may include such issues as availability of adequate resources and impacts to other human uses and values. Substitution typically involves engineering manipulations to create or enhance habitat and long-term maintenance, and it is accompanied by a great deal of uncertainty over impacts of such actions.

7. Prioritizing actions: Clearly, determining what actions to take, where to deploy them, and when they should occur will be a major challenge of strategic planning. Sequencing and prioritizing actions will depend upon the results of earlier actions and unpredicted changes occurring in the landscape. Thus, monitoring will play an important role in determining what actions are needed over time.

   Proposing actions without a strategic plan and the information to support this plan increases the likelihood that recovery goals will not be met, that resources will not be well spent, and that we will do more harm than good. However, the degraded condition of Puget Sound nearshore ecosystems and many of the associated biological resources argues for taking some immediate action. We propose that initiating carefully targeted protection and restoration projects can address both of these concerns. These types of projects should have a high probability of achieving expected ecological benefits, have a low risk of doing harm, and have a high likelihood of providing knowledge that is needed to enhance our ability to restore Puget Sound nearshore ecosystems. Accordingly, projects that incorporate experimental approaches to adaptive management with intensive monitoring, hypothesis testing, and scientific investigation are strongly supported. The NST is in the process of identifying major information needs that can be used to help develop such projects.

8. Performance measures: Performance measures will be needed that directly relate to goals and monitoring efforts. Optimally, performance measures should be focused on processes, but insight into responses of habitats and species to process-level changes may be obtained from other types of performance measures that target these structural and functional elements. Examples of performance measures include residence-time estimates of juvenile salmon, growth or survival rates of salmon, sedimentation rates, change in recruitment of wood to shorelines, and change in the amount of a specific habitat type.

9. Adaptive management: Strategic planning for recovering nearshore ecosystems requires using an adaptive management approach. Adaptive management, a key component of PSNP, is a process whereby research and monitoring make it possible for certain projects and activities to proceed, despite some uncertainty and risk regarding their consequences. Adaptive management incorporates uncertainty about the system being managed and is a mechanism to increase our understanding by taking restoration actions. The overall intent of this process is to (1) ensure project success, (2) reduce the risk and uncertainty associated with future actions, and (3) gain knowledge. *All* restoration projects should be designed and approached as experiments to evaluate ecosystem response to our actions. The emphasis should be on high-quality scientific and technical assessments of ecosystem responses to the restoration actions. Key elements and principles of adaptive management relating to recovery of ecosystems are available from a variety of sources and so are not repeated here.

10. Monitoring: A well-developed and detailed monitoring plan is critical to ecosystem recovery planning. Monitoring designs are intended to provide high-quality data on nearshore ecosystems of Puget Sound, including how they work, how they respond to changes (our actions), and how well we can predict what is going to happen. Most importantly though, they represent a way to learn how to do a better job of restoring nearshore ecosystems.

In general, three types of monitoring can be identified. *Implementation monitoring* focuses on determining whether a specific project was designed and built as proposed and so is usually focused at the scale of an individual project. *Effectiveness monitoring* seeks to determine if the expected outcomes of a project or group of projects have been achieved. Effectiveness monitoring typically focuses on structural or functional features of the landscape. *Validation monitoring* is conducted to examine cause-and-effect relationships between specific resource conditions that result from recovery actions and the process these actions were focused on. It is usually conducted at large scales (e.g., regional or ecosystem-wide). In general, while all three types of monitoring are needed, the focus of the strategic plan is on validation monitoring. But all three are intended to provide information that will be used as part of the adaptive management process.

Recovery actions should be viewed as a way to test hypotheses or answer specific questions. Thus, monitoring should be focused on goals and objectives of the recovery plan and include measurable performance criteria that are relevant to the specific questions being asked. Pre-project assessments are critical and the use of reference sites will be a key component.

Criteria for Developing and Selecting Nearshore Ecosystem Recovery Projects

Here we provide a set of criteria for developing and evaluating nearshore restoration projects. We recommend that initiating carefully targeted protection and restoration projects is possible while strategic planning occurs, if these efforts (1) have a high probability of achieving expected ecological benefits, (2) have a low risk of doing harm, and (3) have a high likelihood of providing knowledge needed to enhance our ability to restore Puget Sound nearshore ecosystems. Such projects can test approaches to restoration, address key scientific uncertainties, develop new methods, and test key assumptions. Our intent here is not to propose a system to facilitate comparisons of projects but rather to suggest a system that can be used to evaluate each project or group of projects on its own merits. We have framed this guidance in the form of a series of questions:

1. **Does the project have clearly stated goals and objectives and are they appropriate for ecosystem recovery?** Each project should have clearly stated goals that help define the expected benefits of the project and what we expect to learn. A primary purpose of projects undertaken will be to enhance our understanding about how to recover nearshore ecosystems of Puget Sound. In addition, each project should address the causes of ecosystem degradation rather than the symptoms and should contribute to the recovery of nearshore ecosystems of Puget Sound.

2. **Does the project have a conceptual model (CM)?** Each project should employ a conceptual model that demonstrates how the proposed action will lead to the expected outcome(s). Application of the conceptual model should identify which processes the proposed action will affect, what type of effect the action is expected have on processes, what types of structural changes are expected to occur as a result, and ultimately how this will lead to the proposed outcome. In addition, applying the CM should help identify critical uncertainties. Addressing these uncertainties would be a key part of a proposed project. The NST is building a general CM that can be broadly used by other restoration practitioners.

3. **Does the project contribute significantly to our understanding of the ecosystem or how to restore it?** At present, a critical criterion in proposing and evaluating projects is the ability to enhance our understanding about how to restore Puget Sound nearshore ecosystems. This does not mean that we support intentionally destructive, low-value, or high-risk actions simply for the sake of learning something. Accordingly, we recommend that projects incorporate extensive experimental approaches to adaptive management with intensive monitoring, hypothesis testing, and scientific investigation. An important element of this criterion is the availability of *reference sites*. Projects are preferred that can be linked to the reference sites during monitoring efforts. The NST is in the process of developing a list of major information needs that will help guide in the planning and implementation of projects.

4. **How likely is it that the project will have significant ecological benefits?** Although learning is a key element of a recovery project, there should also be a high expectation that the project will deliver ecological benefits (i.e., contribute to an improvement in the condition of nearshore ecosystems). All projects will be selected based on some combination of scientific and socioeconomic factors that relates directly to their expected benefits.

   Projects can be grouped into one of four categories based upon their potential to contribute to ecosystem recovery: protection of processes, restoration of processes, rehabilitation/enhancement, and substitution/creation. Projects that seek to protect natural processes have the least uncertainty associated with them. Clearly, for protection projects to work, sites need to be selected based upon a thorough analysis of critical or vulnerable natural areas. The priority should be to protect critical portions of the landscape (e.g., support high abundance levels of key natural resources) in imminent risk of being converted to an alternative use.

   We use the NRC definition of restoration as "reestablishment of pre-disturbance aquatic functions and related physical, chemical, and biological characteristics." Much of the uncertainty associated with restoration projects stems from our lack of experience. In general, passive restoration minimizes the uncertainty of negative ecological consequences.

   Even greater uncertainty exists with rehabilitation or actions designed to improve the condition of habitats or processes. In general, uncertainty associated with this type of action is high because of the need for continuing intervention over perhaps long time scales.

   Finally, creation or substitution has the most uncertainty associated with it because it typically involves engineering manipulations to create or enhance habitat. In addition, creation or substitution typically involves structural fixes (i.e., targeting habitats), as opposed to fixing processes.

5. **What is the landscape context of the project?** The expected benefits of any project and its ability to meet goals and objectives will depend upon the landscape context of the project. Landscape context refers to how a particular location is integrated with all other elements of the landscape, including the arrangement, size, shape, location, connectivity to other habitats, and accessibility of that habitat to biotic resources. As a result, the same type of habitat in two different locations can differ in how it functions for any plant or animal element. There is not a correct landscape context. Rather, the expected benefits of any project will depend in part upon its landscape context. Landscape attributes that need to be incorporated into the development and selection of recovery actions include the following:

a. <u>What is the scale and size of the project?</u> Two important landscape attributes are the scale and the size of the project. All actions should be of a scale and size appropriate for the objectives of the project. There is not a correct scale, only a correct scale relative to the goals and objectives of the action. While scale is probably the more important of the two factors, size of a project should be considered as well. In general, projects of a large size are more likely to have significant ecological benefits than small, disconnected, and fragmented restoration efforts.

b. <u>What is the connectivity and complexity of the project?</u> Two elements that also can contribute to the ecological benefits of a project are landscape connectivity and complexity. Connectivity refers to the linkage between one habitat and other habitats. A tidal channel complex that is near a main channel is more likely to be used by large numbers of juvenile salmon than one that is distant from major distributary channels. Areas of high complexity (e.g., emergent and forested wetlands, unarmored beaches with tributary streams) are also more likely to deliver significant ecological benefits than areas of low complexity.

6. **Does the action incorporate habitats important to key biota?** An objective of a project may be to restore a specific biotic component of the ecosystem such as salmon or forage fishes. Projects that seek to accomplish this should recognize and integrate the specific needs and requirements of the species into their approach. If a goal is salmon conservation, for example, then the project should recognize the need to support sustainable habitats important to these species.

7. **Is the project part of a portfolio of recovery actions**? The NST plans to employ an approach to implementing restoration projects that involves developing and applying portfolios of recovery actions. Each group or portfolio consists of a blend of different types of actions (e.g., protection and restoration) targeted throughout the landscape. A portfolio of actions can involve only actions in the nearshore or it could involve an integrated suite of actions across freshwater and nearshore ecosystems. Although such an approach has yet to be fully evaluated and developed, it has several potential advantages useful for ecosystem recovery, including increasing our chances of detecting a response to the actions at large spatial and temporal scales. For a portfolio, monitoring would be focused on individual projects as well as on detecting the overall effect of the portfolio's actions on the landscape.

8. **What are the relationships between uncertainty, risk, expected ecological benefits, and potential learning, and have they been thoroughly evaluated and considered?** The uncertainty and risk associated with each project must be considered simultaneously with the information, knowledge, and benefits expected from the project. *Uncertainty* is the likelihood or probability the project will meet its stated goals while *risk* is the chance the project will cause damage to the ecosystem or have unforeseen negative effects. Actions targeted at one ecosystem should not damage processes important to another ecosystem. Various factors contribute to risk and uncertainty, such as whether appropriate controlling factors can be easily reestablished and whether stressors can be easily abated or eliminated.

   No clear-cut way exists to weigh risk, uncertainty, value of learning, and anticipated ecological benefits of each project although at this time, the NST places a high value on learning. Conceptually, the ideal project would clearly be one that is of low risk, high amount of certainty (i.e., low uncertainty), high value of learning, and high expected benefits (position A in the following table).

Risk	Uncertainty					Value of Learning
		High	Medium	Low		
	High				Low	
	Medium				Medium	
	Low			A	High	
		Low	Medium	High		
	Expected Ecological Benefits					

   As the uncertainty associated with an action increases, additional justifications are needed to support the project—for example, does it have low risk of causing harm or does it address an important information need. If the probability of success is low, then the risks associated with the project should also be low and the potential benefits high. A project with a high amount of uncertainty should only be considered when the potential benefits are very high and risks are low. High-risk actions should be considered only as experiments with intensive monitoring and evaluation and not as demonstrations of approaches that will become institutionalized.

9. **What are the costs of the project relative to other factors?** Project costs relative to such factors as risk, uncertainty, and the expected benefits should be considered. For example, a costly project may be acceptable if expected benefits are significant or risk and uncertainty are low. Although the NST recognizes that some projects may require multiple sources of funds, project success should not be contingent upon finding future sources of funding to "finish the project" once it has been initiated. Maintenance, contingency, and monitoring costs all should be considered in overall project costs. Although projects should be sustainable in the sense that they should not require upkeep, there may nevertheless be maintenance or contingency costs associated with a project.

10. **Is the project sustainable within the context of the expected natural evolution of the target ecosystem?** Where possible, the natural evolution of the project should be

explicit and expected, and it should not require significant long-term upkeep and maintenance.

11. **Does the project have clear performance measures?** Each project must have explicit performance measures that directly relate to the project goals. Examples of acceptable performance measures include growth rates or survival rates of salmon, sedimentation rates, changes in recruitment of wood to shorelines, and changes in the amount of a specific habitat type.
12. **Does the project have a rigorous monitoring plan?** All projects must have a scientifically rigorous monitoring plan that focuses on evaluating whether the goals and objectives of the project have been met. At a minimum, we expect such plans to evaluate project implementation (implementation monitoring) and whether the expected results were realized (performance monitoring). Monitoring, goals, and performance measures of each project all should be directly related and integrated.
13. **Does the project have an adaptive management and contingency plan?** Not everything will go as expected with each project. There may be delays or funding shortfalls or other problems with the project. Each project should include an adaptive management approach that allows for contingency planning. A contingency plan is a demonstration that project proponents have planned beyond the first shovel full of earth that is moved. While we recognize that not everything can be anticipated, we nevertheless believe that this type of approach can help lead to better and more successful projects.
14. **Do partnerships exist among communities, organizations, and agencies who may be involved in the project and who own the land?** Clearly, local community support and participation can be important to the success of any action taken. Thus, we believe additional considerations in project selection should include the amount of local support for the project, linkages to local watershed or recovery groups' goals and objectives, linkages to ongoing restoration efforts, and availability of local sponsors. A non-scientific consideration in any project is land ownership. In general, actions taken on public lands are preferable because of the increased certainty that the land can be accessed over time.

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PSNERP and the Nearshore Partnership

The **Puget Sound Nearshore Ecosystem Restoration Project** (PSNERP) was formally initiated as a General Investigation (GI) Feasibility Study in September 2001 through a cost-share agreement between the U.S. Army Corps of Engineers and the State of Washington, represented by the Washington Department of Fish and Wildlife. This agreement describes our joint interests and responsibilities to complete a feasibility study to

> "…*evaluate significant ecosystem degradation in the Puget Sound Basin; to formulate, evaluate, and screen potential solutions to these problems; and to recommend a series of actions and projects that have a federal interest and are supported by a local entity willing to provide the necessary items of local cooperation.*"

The current Work Plan describing our approach to completing this study can be found at:

http://pugetsoundnearshore.org/documents/StrategicWorkPlanfinal.pdf

Since that time, PSNERP has attracted considerable attention and support from a diverse group of individuals and organizations interested and involved in improving the health of Puget Sound nearshore ecosystems and the biological, cultural, and economic resources they support. The **Puget Sound Nearshore Partnership** is the name we have chosen to describe this growing and diverse group, and the work we will collectively undertake that ultimately supports the goals of PSNERP, but is beyond the scope of the GI Study. Collaborating with the Puget Sound Action Team, the Nearshore Partnership seeks to implement portions of their Work Plan pertaining to nearshore habitat restoration issues. We understand that the mission of PSNERP remains at the core of our partnership. However restoration projects, information transfer, scientific studies, and other activities can and should occur to advance our understanding, and ultimately, the health of the Puget Sound nearshore beyond the original focus and scope of the ongoing GI Study. As of the date of publication for this Technical Report, our partnership includes participation by the following entities:

Interagency Committee for Outdoor Recreation

King Conservation District

King County

National Wildlife Federation

NOAA Fisheries

Northwest Indian Fisheries Commission

People for Puget Sound

Pierce County

Puget Sound Action Team

Salmon Recovery Funding Board

Taylor Shellfish Company

The Nature Conservancy

U.S. Army Corps of Engineers

U.S. Environmental Protection Agency

U.S. Geological Survey

U.S. Fish and Wildlife Service

University of Washington

Washington Department of Ecology

Washington Department of Fish and Wildlife

Washington Department of Natural Resources

Washington Public Ports Association

Washington Sea Grant

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PUGET SOUND
NEARSHORE
PARTNERSHIP

RESTORING OUR
ECOSYSTEM HEALTH