7.0 IDENTIFICATION OF RESTORATION OPTIONS

Commencement Bay was once an extensive complex of emergent marsh, mudflat, sandflat, and eelgrass habitats. Since the mid-1800s, approximately 89 percent of the intertidal mudflat and 99 percent of the emergent marsh habitat have been destroyed (DEA, 1991). These habitats functioned as nesting, nursery, and feeding habitats for invertebrates, fish, and birds. Extensive dredging has converted much of the intertidal area to deep subtidal habitats. Because of these extensive modifications, the remaining habitat is principally soft-bottom subtidal area. However, remnant patches of mudflats, emergent marshes, and vegetated shallows can still be found in Commencement Bay (Figure 7-1).

Presently, the dominant biological community that provides the base of the food web in Commencement Bay is composed of the benthic and epibenthic invertebrates associated with the soft-bottom subtidal and remaining intertidal sediments (see Section 3.0). This sediment-based food web supports higher-level consumers such as flatfish, salmonids, and birds, which are the other key biological resources found in Commencement Bay (see Section 4.0). A variety of hazardous substances have been released into the Commencement Bay environment (see Section 2.0). The release of these substances has led to the contamination of the intertidal and subtidal sediments of the bay and its associated waterways. The biota of Commencement Bay are exposed to contaminants through direct contact with contaminated sediment or through trophic interactions. Injuries in both key abiotic and biological resources of Commencement Bay, specified under Type B regulations for NRDA, have been linked to hazardous substances (see Section 5.0). The identified injuries are all ultimately linked to the presence of SOCs in the sediments of Commencement Bay.

The principal goal of the damage assessment process is to "restore, replace, or acquire the equivalent" of the injured resources. Therefore, restoration planning has been initiated. Goals for the restoration of Commencement Bay have been evolving since initiation of the damage assessment process. Restoration/mitigation goals for Commencement Bay were initially set in a September 1990 workshop (Shapiro and Associates, 1993a). While final restoration planning will need to wait until injury determination is substantially complete, preliminary restoration planning is useful in providing a broad overview of the restoration possibilities so future efforts can focus on realistic approaches in a timely and efficient manner. In August

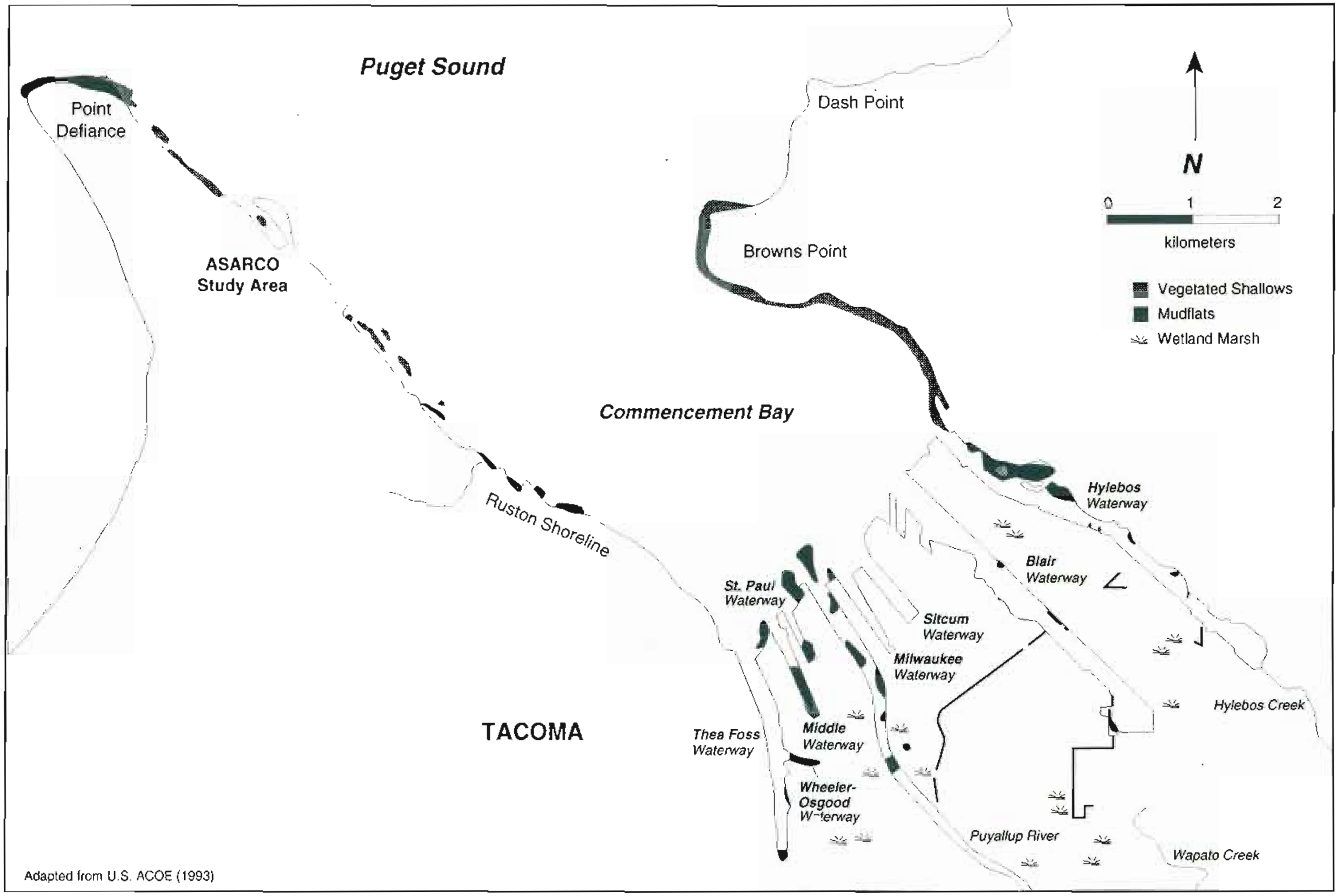

Figure 7-1. Special aquatic sites in 1988.

1992, the Coordinating Committee's Restoration Panel adopted working-draft restoration goals and principles for the damage assessment process.

More recently, in connection with the implementation of the natural resource damages settlement with the Port of Tacoma, the Trustees have determined to develop a programmatic Environmental Impact Statement (EIS) for restoration planning in Commencement Bay. While the focus of that exercise will be planning for restoration projects to be developed using damages paid by the Port of Tacoma, it will also be broad enough to potentially encompass any NRDA-related restoration efforts the Trustees may undertake. Consequently, the Trustees have decided to move all restoration planning being done for the damage assessment process under the EIS umbrella.

This section briefly summarizes the status of the Restoration Panel's work, while keeping in mind that restoration planning efforts are ongoing and are of a broader scope than the restoration projects that ultimately may be determined by the Trustees to be appropriate for the NRDA restoration process. This section also identifies areas where further documentation, coordination, or data collection may be necessary or helpful to integrate the preliminary and comprehensive restoration planning into the NRDA process. Appendix H presents a compilation and review of existing geographic information systems (GIS) data sources pertinent to restoration planning. Appendix I presents a listing of GIS coverages available from U.S. EPA.

7.1 RESTORATION PANEL GOALS AND PRINCIPLES

The following Commencement Bay restoration goals and principles are taken from the current working draft submitted to the Coordinating Committee by the Restoration Panel:

Goals

- Provide a diversity of sustainable habitat types and species within the Commencement Bay ecosystem to enhance fish and wildlife resources.
- Provide alternatives for those natural resources that will not recover without efforts above and beyond regulatory requirements for source control, sediment cleanup, and habitat restoration (e.g., certain fish and wildlife species, water quality).

- Meet the statutory objective of restoring, replacing, or acquiring the equivalent of natural resources injured or destroyed as a result of the release of hazardous substances.

Principles

- Provide a functioning and sustainable ecosystem encompassing the industrialized urban estuary of the Commencement Bay environment, where selected habitats and species of fish and wildlife are enhanced beyond existing conditions. The ecosystem need not be pristine, but must contain the functional elements of a healthy ecosystem, support a diversity of habitats and species indigenous to the area, and be environmentally and economically sustainable.

- Set priorities for restoration projects in accordance with sound restoration planning. First, focus on habitat, especially habitat that provides functional benefits to injured natural resources. In general, if functioning and diverse habitats similar to naturally occurring habitats are provided, the appropriate species will follow. Preserve existing threatened habitats, while enhancing existing habitats and creating new habitats. Second, consider recovery plans for selected species and natural resources of concern where habitat restoration and preservation alone are insufficient to allow for their recovery. Third, consider providing for public access (where compatible).

- Integrate restoration efforts with other planning and regulatory efforts in Commencement Bay to promote successful habitat protection and enhancement (e.g., look for opportunities for enhancing air, water, and sediment quality as part of Ecology's source control efforts and U.S. EPA's sediment cleanup efforts).

- Implement restoration strategies that will increase the likelihood of successful projects. In general, take a "landscape ecology" approach to habitat restoration projects by integrating the projects into their surrounding environments. Consider establishing a "greenbelt" through Commencement Bay for movement and use by species. Require performance criteria and monitoring and contingency plans for restoration projects. Apply knowledge gained from restoration projects in phases. Provide opportunities for innovative projects and technologies and for assessing the feasibility of some restoration methods before applying them full-scale.

- Protect habitat restoration and preservation sites in perpetuity. Use available options to protect habitat sites, including the use of different acquisition tools (e.g., fee title, deed restrictions, conservation easements) and recipient organizations (e.g., natural resource agencies, nonprofit nature conservancies with special expertise in managing natural habitats).

- Involve the public in restoration planning and implementation. Successful restoration of Commencement Bay depends upon broad public support for the restoration effort and involvement in restoration decision-making, work, monitoring, and management. Encourage public stewardship of restoration projects and existing natural habitats through education and public involvement activities.

- Fund restoration projects through the resolution of natural resource damages, augmented where appropriate by other available sources of funds, property, or services. Leverage restoration funds, where possible, to accomplish restoration projects. Consider non-monetary sources, such as land.

7.2 IDENTIFICATION OF RESTORATION OPTIONS

The areal extent of habitat disruption in Commencement Bay has been well studied and documented. A very brief review of the extent of the loss of nearshore and subareal wetlands indicates that 98.6 percent of the intertidal wetland habitat in the Puyallup River estuary and Commencement Bay has been lost (Bortelson et al., 1980). DEA (1991) reported in 1988 that 98.5 percent of the emergent marsh and 90.8 percent of the mudflat area have been lost from pre-development levels. Bortelson et al. (1980) estimated that 100 percent of the pristine subareal wetlands, those areas located landward of the general saltwater shoreline and not including the intertidal wetlands, have been lost in Commencement Bay.

While the general type of aquatic site targeted for restoration at each of the potential restoration sites within Commencement Bay has been reasonably identified and addressed in the Cumulative Impact Study (U.S. ACOE, 1993), the techniques and strategies that might be employed at each of these sites have been discussed and evaluated only in a general way. In part, the limited detail reflects a lack of site-specific data necessary for project-level restoration designs and strategies. Because of the uncertainties in the final direction of the effort, it is appropriate to wait until further into the restoration planning process to spend the time and expense of obtaining these site-specific data. However, a great deal of information already exists about the techniques and strategies that are most commonly used in the restoration of aquatic sites of interest, such as those in Commencement Bay.

U.S. ACOE (1990) identified three types of special aquatic habitats that currently exist or historically existed in Commencement Bay: mudflats, vegetated shallows, and wetlands.

Mudflats are broad, flat intertidal areas typically devoid of vascular plants or macroalgae. Vegetated shallows are permanently or periodically inundated areas that support rooted or attached aquatic vegetation, such as eelgrass and macroalgae. Wetlands areas, which begin in the intertidal zone and extend landward, support vegetation adapted for life in saturated soils (Shapiro and Associates, 1993a). The following sections briefly describe each of the three special habitat types and discuss the attributes that make the habitats critical to the Commencement Bay system.

7.2.1 Mudflats

Mudflats are typically located above mean lower low water and usually are exposed or inundated at least once per day due to tides. Acre for acre, these areas exhibit low annual net primary productivity when compared to other special aquatic site habitats. In Commencement Bay, however, the primary productivity of mudflats may be important because of their relative abundance compared to either vegetated shallows or emergent marsh, and because spring peaks in primary productivity correspond to microalgal blooms. Mudflats can support extensive populations of invertebrates, an important food source for mammals, waterfowl, demersal fish, and salmonids. Mudflats may also support commercially important shellfish. Important functions performed by mudflats include (Shapiro and Associates, 1993a):

- Providing nesting, nursery, and feeding habitats for invertebrates and fish
- Serving as acclimation zones for outmigrating salmonid stocks
- Providing feeding and resting habitats for birds and mammals
- Nutrient cycling
- Protecting shorelines from erosion
- Dissipating storm surge runoff

7.2.2 Vegetated Shallows

Vegetated shallows are located in nearshore areas. Although typically these areas are permanently inundated, portions of the habitat may be exposed during extremely low tides. Eel grass or attached macroalgae make up the dominant vegetation of this habitat type. The primary productivity of vegetated shallows can be high, contributing substantially to the detritus-based food web. This habitat also provides food and shelter for a variety of fish and invertebrate species. Waterfowl use the plants and animals that live in the habitat as sources of food. Vegetated shallows also play an important role in the nutrient cycling between sediments and water. The roots and rhizomes bind the substrate, protecting the bottom from erosion, and the leaves slow currents and increase deposition of fine sediments and organic matter. Important ecological functions of eelgrass habitats include (Shapiro and Associates, 1993a):

- High primary production
- Food and feeding pathways
- Shelter
- Habitat stabilization
- Nutrient recycling

7.2.3 Wetlands

Wetlands in Commencement Bay include tidal, brackish, and freshwater marshes. Tidal marsh extends from the upper 0.6 m of the intertidal zone to more than 3 m above mean sea level. A tidal marsh can include both salt and brackish marsh. Important ecological functions of wetlands include (Shapiro and Associates, 1993a):

- Groundwater discharge and recharge
- Flood storage and desynchronization
- Shoreline anchoring and dissipation of erosive forces
- Sediment trapping, nutrient retention, and removal
- Food chain support
- Habitat for fish and wildlife

Saltmarsh areas are net exporters of detritus to nearshore and intertidal communities. Detrital material contributes to the food chain of juvenile salmon and invertebrates. Vegetation is consumed directly by shorebirds and waterfowl.

Brackish marshes are found in tidal areas with extensive freshwater influence. Although situated in the tidal zone, saltwater infusions are minimal and generally limited to low freshwater flow situations that occur in late summer. Brackish marshes exhibit high rates of primary productivity (Shapiro and Associates, 1993a).

7.3 RESTORATION EXAMPLES PERTINENT TO COMMENCEMENT BAY

The following section presents several examples of restoration projects that might be undertaken in Commencement Bay to restore and enhance the bay's special aquatic habitats. The examples provided are not intended to provide an exhaustive review of restoration possibilities, but rather provide discrete examples of restoration projects that have been conducted in the Pacific Northwest.

7.3.1 Restoration Examples for Mudflats

Three restoration examples are available for mudflat sites. In the first example, the Port of Seattle and the Muckleshoot Indian Tribe agreed in 1988 to test the construction of littoral mudflat "terraces" on rip-rap stabilized shoreline in the Duwamish River estuary. The habitat enhancement potential of this design was measured by pre-construction and post-construction monitoring of epibenthic crustacean prey of juvenile salmon. Simenstad and Thom (1993) report that visual examination of the completed terraces in August 1990 indicated that benthic infauna were colonizing, shorebirds had frequented the constructed flats, and that accretion, rather than erosion, of sediments was occurring. However, foraging by juvenile salmon on the flats has not been verified. Simenstad and Thom (1993) argue that projects such as this one along the Duwamish River may have some advantages as restoration projects because the habitat being restored historically persisted on the site, as mudflats did and continue to in Commencement Bay. However, the authors caution that important processes that may now be absent or seriously degraded, such as sedimentation or longshore transport, may plague the long-term stability of the target habitat, and continued modifications may be necessary.

As a second example in 1988, a 17-acre area in the St. Paul Waterway offshore from the Tacoma Kraft Mill was capped with clean sediment. In conjunction with this action, more than 6 acres of new intertidal habitat were reconstructed over the portion of the cap along the shoreline. A 1991 monitoring report found that the new habitat was inhabited by diverse biological communities of benthic and epibenthic organisms as well as algae (Parametrix, 1991a). Transitory use of the site by birds, fishes, and large predatory crustaceans has also been documented. Chemical monitoring of surface sediments generally indicated that continued contamination was not occurring.

As a third example, at a functionally related site along the southeastern shore of the Middle Waterway, the Middle Waterway Shore Restoration Project is to be constructed nearly entirely on filled tideflats to enhance the estuarine habitat.

Many of the potential approaches to site restoration identified for Commencement Bay include the possibility of mudflat enhancement or restoration. The lessons learned from the design and testing of the Duwamish River, St. Paul Waterway, and Middle Waterway projects should be incorporated into future restoration planning for the bay, particularly where targeted habitat includes support for invertebrates, mammals, waterfowl, shorebirds, demersal fish, and salmonids.

7.3.2 Restoration Example for Vegetated Shallows

Eelgrass habitat restoration will likely be an important component of a comprehensive restoration program for Commencement Bay because of the many important ecological functions this habitat provides, primarily its importance to the detritus-based food web of the nearshore environment. Fortunately, reasonable guidance exists on the feasibility of eelgrass restoration and creation in the Pacific Northwest. Thom (1990) provides an excellent review of eelgrass transplanting projects with recommendations that will be useful in site selection, evaluation, and the design of restoration projects in Commencement Bay. While Thom concluded that 11 of the 17 projects reviewed were a success because the eelgrass survived and flourished in at least part of the site, he indicates that only two large-scale and long-term projects provided adequate documentation of functional success. He recommended that herring spawning, as well as the densities of animal populations in the sediment or on the surface of the sediment or eelgrass leaves, might serve as functional performance evaluation criteria. Clearly, there can be no guarantees of achieving a designated level of habitat functions in restored eelgrass projects. However, while important to remember when establishing mitigation goals, this should not deter the design and implementation of small-scale, carefully planned eelgrass projects with their potential high productivity and habitat values.

7.3.3 Restoration Example For Wetlands

The first example involves the creation of wetlands using a strategy of breaching dikes along a waterway to allow flooding of historical lowlands. In a recent article, Simenstad and Thom

(1993) cite two examples of the dike breaching strategy for restoring estuarine wetland habitat: the Salmon River estuary, located in coastal Oregon, and the Elk River estuary, in Grays Harbor on the Washington coast.

Simenstad and Thom (1993) stated that while neither example provided "any evidence for enhanced fish and wildlife function of breached dike estuarine wetlands, other examples from the region indicate that juvenile salmon accessing similarly restored slough habitats appeared to obtain adequate and representative prey, rear longer and grow larger." The authors point out that both examples illustrate the importance of carefully assessing a site's tidal gradient, historical level of subsidence, drainage patterns, and need for modifications over the course of the project to better ensure the desired recovery trajectory (Simenstad and Thom, 1993).

The dike breaching strategy is particularly important in evaluating restoration options for Commencement Bay because of the extensive dike system connected to the Puyallup River. A restoration project in the Puyallup River estuary, referred to as the Gog-le-hi-te (i.e., Lincoln Avenue wetland), used dike breaching as part of a project to restore an estuarine wetland-upland complex at the site of a former solid waste landfill. Simenstad and Thom (1993) report that studies over the 5 years since the breach of the dike indicated:

- Rapidly expanding benthic infauna, epibenthic crustacean, fish, and avifauna populations composed of progressively more estuarine species
- Extensive retreat of the area of planted sedge vegetation, but increased shoot density and net production over the whole brackish habitat of the system
- Substantial sedimentation on the littoral flats and in the tidal channels
- Use of the wetland system as a sink for some organic matter and a source of inorganic matter
- Extensive use of the site by juvenile salmon

The project's comprehensive monitoring program has produced useful data for future restoration planning in Commencement Bay. Particularly useful may be the management and long-term modification questions that have arisen concerning the project. For example, the authors question whether sedimentation should be allowed to continue at the site, since it could one day preclude juvenile salmon residence for longer than brief tidal cycles.

Many of the potential restoration sites described in the Cumulative Impact Study mention the possibility of restoring wetland and riparian habitat adjacent to the Puyallup River through dike breaching. While more research is needed to determine the major factors controlling access to, and utilization of, enhanced or restored estuarine habitats by a variety of target species, the relative success of the Gog-le-hi-te project should provide valuable guidance for other dike breaching projects and similar restoration strategies in the future.

7.4 FUNCTIONAL APPROACH TO RESTORATION

The key resources identified in Section 3.0 of this report provide further assistance in the evaluation of appropriate restoration options for the NRDA and the comprehensive restoration plan for Commencement Bay. The four identified key resource groups (commercially or recreationally harvested resources, resources that are important links in supporting the ecosystem, resources that are important elements of nonconsumptive uses, and resources that are endangered or threatened), with their documented ecological, economical, and social value, can serve to better prioritize where time and money will be spent to link injured resources to appropriate restoration. Restoration projects with habitat replacement value for one or more of these key resources should have high importance in any ranking scheme. Species assemblages associated with various ecotypes, such as riparian, subtidal, mudflat, sandflat, emergent marsh, and gravel/cobble, have been adapted to Commencement Bay by the Restoration Panel and are a good source of information for linking these key resources with their habitats. The restoration panel report and the Cumulative Impact Study contain valuable information for this linkage.

An issue relevant to nearly all the restoration goals in Commencement Bay relates to the meaning of "successful" habitat restoration. Restoration projects should be designed, monitored, and evaluated in terms of fundamental functions and services provided by the habitat. One approach, the Estuarine Habitat Assessment Protocol, stresses monitoring habitats to identify and quantify the attributes of the habitat that directly affect the function (Simenstad et al., 1991). The approach strives to gather functional information that can be used to develop increasingly more successful mitigation and restoration projects in an adaptive manner. The design of this protocol involves:

- Categorizing the basic estuarine wetland and associated habitats in the region
- Identifying of fish and wildlife assemblages considered representative of these habitats
- Classifying hierarchically all the functions that habitats provide to fish and wildlife assemblages
- Identifying attributes for the functions of reproduction, feeding and foraging, and refuge from predation and for physiological adaptation to identify the functional attributes as well as their requirements

Employing the concept of functional habitat restoration using information gathered under this protocol, as well as in other studies, holds promise for a more sustainable and ecologically sound restoration of Commencement Bay habitats.

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