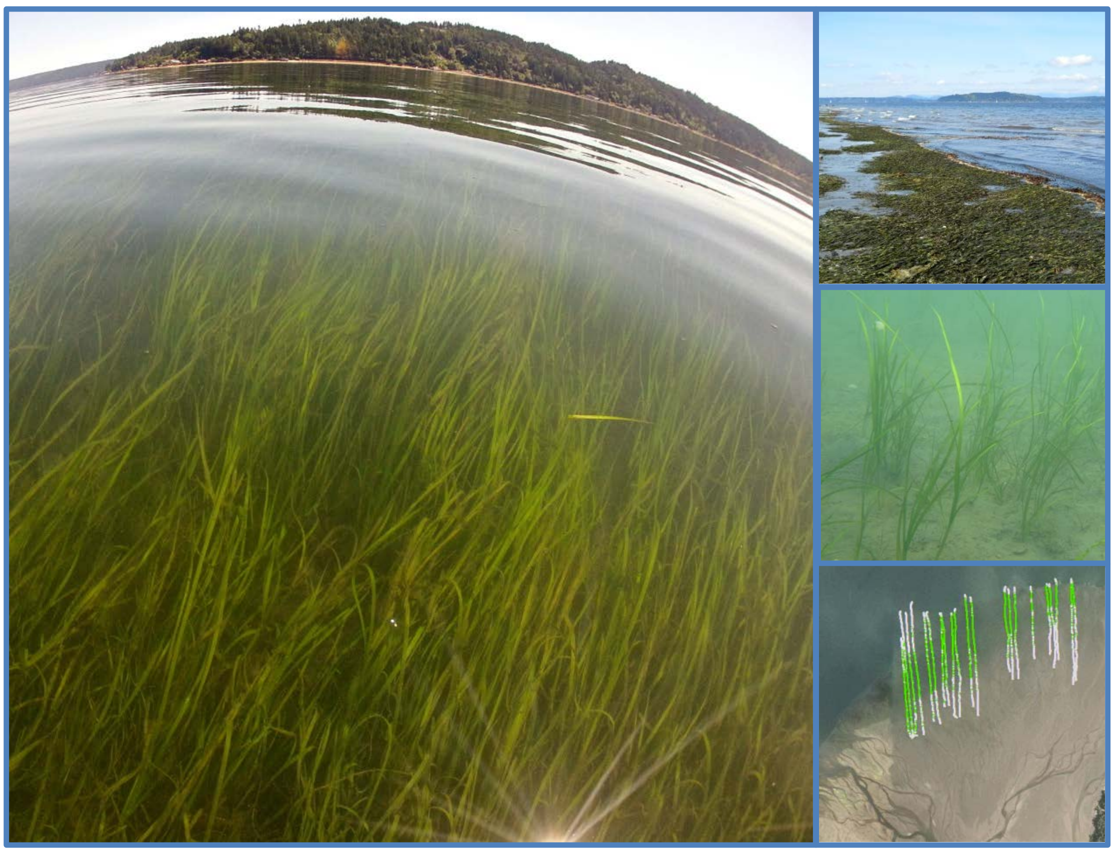
NATURAL RESOURCES

Puget Sound Eelgrass (*Zostera marina*) Recovery Strategy

February 2015



WASHINGTON STATE DEPARTMENT OF
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Acronyms

Corps	U.S. Army Corps of Engineers
DNR	Washington State Department of Natural Resources
DOE	Washington State Department of Ecology
DOH	Washington State Department of Health
EPA	United States Environmental Protection Agency
HPA	Hydraulic Project Approval
MLLW	Mean Lower Low Water
MRC	Marine Resource Committee
MRA	Marine Recovery Area
NEP	National Estuary Program
NOAA	National Oceanographic and Atmospheric Administration
OSS	On-site Septic System
PAR	Photosynthetically Active Radiation
PIC	Pollution Identification and Correction Program
PNNL	Pacific Northwest National Laboratory
PSNERP	Puget Sound Nearshore Ecosystem Restoration Project
PSP	Puget Sound Partnership
RCW	Revised Code of Washington
SMA	Shoreline Management Act
SMP	Shoreline Master Program
SVMP	Submerged Vegetation Monitoring Program
WAC	Washington Administrative Code
DFW	Washington State Department of Fish and Wildlife

1. Executive Summary

The Puget Sound Partnership established eelgrass as an indicator – or “vital sign” – of the health of Puget Sound in recognition of the regional ecosystem services it provides and its sensitivity to changes in environmental conditions. Regional population growth and land use development have contributed to historical losses of eelgrass habitats. Although soundwide estimates of eelgrass suggest stability in recent years, soundwide monitoring continues to document localized declines. A combination of anthropogenic stressors – frequently acting in concert – can adversely impact eelgrass beds. Stressors include, but are not limited to, algal blooms, overwater structures, sediment loading, shoreline armoring, and vessel moorage and anchoring. The relative magnitude of individual stressors varies spatially and temporally across sites within Puget Sound. Although a conceptual model of stressor impact pathways exists, research has been unable to isolate the primary stressors contributing to recently observed declines.

In 2011 the Puget Sound Partnership (PSP) adopted a 2020 target to increase eelgrass extent by 20 percent. The 2014/2015 Puget Sound Action Agenda tasked DNR, in collaboration with the Puget Sound Partnership, to develop a comprehensive recovery strategy to advance eelgrass recovery. DNR and PSP invited partners in local, state, and federal government, tribes, non-governmental organizations, and business groups to participate in a collaborative process to develop the recovery strategy. The interdisciplinary workgroup reviewed soundwide status trends and environmental stressors, defined overarching goals and objectives, and prioritized implementation measures to address critical stressors and support conservation and recovery. Although the plan defines implementation measures needed to advance recovery efforts, many of the priority actions may not be not feasible without additional funding.

The recovery strategy is organized by five overarching goals and nine strategic objectives:

1. **Conserve existing eelgrass habitats;**
   - Ensure existing policies, regulations, and non-regulatory programs avoid impacts to existing eelgrass beds and enforce a “no net loss” standard.
2. **Reduce environmental stressors to support natural expansion;**
   - Design new/retrofit existing in-water and over-water construction projects to avoid impacts to existing and historical eelgrass habitats.
   - Expand eelgrass compatible boater infrastructure to reduce damages to eelgrass beds as a result of recreational and commercial vessel mooring in high-use areas with extensive eelgrass habitats.
   - Reduce anthropogenic nitrogen and sediment loading – where adversely impacting eelgrass and/or contributing to violation of dissolved oxygen water quality standards – to improve marine water quality and minimize the frequency and magnitude of algal blooms and eelgrass epiphyte growth.
   - Reduce adverse impacts of shoreline armoring and conserve unarmored feeder bluffs to enhance nearshore sediment delivery and reduce beach erosion.

3. **Restore and enhance degraded or declining eelgrass beds;**
    - Utilize strategic eelgrass transplants to accelerate recolonization and expansion at sites shown to possess suitable ecological conditions.
    - Restore tidal wetlands associated with river deltas, coastal inlets, and barrier embayments to restore ecosystem processes and recapture lost linear nearshore habitat that supports eelgrass growth and expansion.
4. **Identify eelgrass research priorities; and**
    - Implement targeted research initiatives to understand the short- and long-term factors driving localized changes in eelgrass beds and inform an adaptive approach to recovery.
5. **Expand outreach and education.**
    - Target public outreach and education to foster community stewardship, individual responsibility, and collective action to benefit eelgrass conservation and recovery.

The existing scientific uncertainty behind stressor-response pathways and the reality of resource constraints make soundwide implementation of several strategic actions (e.g., nutrient reduction) infeasible and/or unadvisable at this time. The strategy provides an adaptive framework that will help advance recovery and allow managers to refine prioritization of investments as additional scientific data becomes available. It also identifies geographic focus areas to assist managers with prioritization of short-term stressor reduction efforts. Focus areas were identified based on: (1) strength of evidence of eelgrass decline or loss; (2) evidence of decline in nearshore habitat conditions; (3) recently completed and/or planned stressor abatement projects; (4) feasibility of recovery; and (5) level of site protection. Preliminary focus areas include Quartermaster Harbor, Lower Hood Canal, Purdy Spit/Henderson Bay, Fisherman Bay, and several large river deltas. These areas provide an opportunity to test stressor-response relationships, understand the reversibility of specific stressors, and if successful, help build momentum for implementing actions at a larger scale.

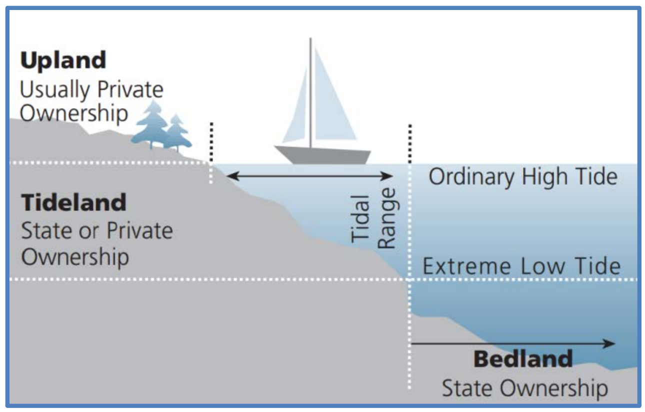
The Puget Sound eelgrass recovery strategy will help position partners to pursue funding to support eelgrass recovery during biennium budgeting cycles and future grant opportunities. It acknowledges the inability-to-date to isolate the precise causes of regional declines in eelgrass cover, yet strives to identify priority recovery actions that should be implemented as part of an adaptive approach to eelgrass management. Developing a management response to address a single stressor has the potential to contribute to large-scale recovery, but a combination of strategic actions is predicted to be a more practical strategy to advance regional recovery (Rehr et al. 2014). The workgroup identified delta restoration and reduction of anthropogenic nitrogen loading as two strategic actions with a relatively high potential to advance eelgrass recovery within Puget Sound; however, conservation of existing beds must be emphasized given the scientific uncertainty surrounding stressor-response relationships and the limited success experienced by global eelgrass restoration efforts.

2. Introduction

I. Washington Department of Natural Resources

Washington State Department of Natural Resources (DNR) manages approximately 2.6 million acres of state-owned aquatic lands, including 2.16 million acres of marine bedlands and 32,000 acres of tidelands. Excluding the Pacific Coast shoreline, DNR manages approximately 1.8 million acres of marine bedlands and tidelands within the Puget Sound, Strait of Juan de Fuca, and Strait of Georgia. Figure 1 depicts general marine ownership boundaries within Washington State. Approximately 30 percent of tidelands remain under state ownership. The remainder is privately owned. DNR manages nearly 100 percent of marine bedlands; however, a small percentage of bedlands were sold into private ownership as part of oyster tracts intended to facilitate the state's commercial shellfish industry.

Figure 1. Washington marine ownership boundaries.



DNR's proprietary management authority derives from the State's constitution, laws, and regulations.[1] DNR is directed to manage lands *"…for the benefit of the public*" in manner that provides *"…a balance of public benefits*[2] *for all citizens of the state…*" that includes: "*(1) Encouraging direct public use and access; (2) Fostering water-dependent uses*[3]*; (3) Ensuring environmental protection; and (4) Utilizing renewable resources.*" Generating revenue in a manner consistent with subsection (1) through (4) of this section is recognized as a public benefit (RCW 79.105.030).

As proprietary manager of state-owned aquatic lands, DNR is also co-manager of all resources attached or embedded within aquatic lands, including native eelgrass, *Zostera marina*. DNR's aquatic leasing program recognizes the regional ecosystem services provided by eelgrass beds and emphasizes impact avoidance during authorization of uses of state-owned aquatic lands to protect the sensitive aquatic habitat from disturbance. DNR's Aquatic Assessment and Monitoring Program evaluates the effectiveness of habitat stewardship measures applied to individual aquatic use authorizations to inform adaptive management of the resource. DNR's Nearshore Habitat Program annually monitors eelgrass throughout Puget Sound to understand site level and soundwide trends in distribution and abundance. It also manages an eelgrass

[1] Articles of Constitution (XV, XVIII, XXVII), Revised Code of Washington (RCW) 79.02, 79.105, Washington Administrative Code (WAC) 332-30.

[2] WAC 332-30-106 defines public benefit as "*…that all of the citizens of the state may derive a direct benefit from departmental actions…*"

[3] RCW 79.90.465 defines water dependent uses as those that *"…cannot logically exist in any location without water.*"

stressor-response research program to identify and understand environmental stressors contributing to locally observed declines.

II. Puget Sound Action Agenda

The 2014/2015 Action Agenda provides a roadmap for undoing 100 years of pollution and environmental degradation within Puget Sound by 2020. The plan outlines three strategic initiatives: *Recover Shellfish Beds; Prevent Pollution from Stormwater;* and *Protect and Restore Habitat.* These focal areas prioritize where the state should direct limited resources and funding to implement priority actions and advance ecosystem recovery. Eelgrass conservation and recovery is firmly grounded within the *Protect and Restore Habitat* strategic initiative; however, it is also inherently intertwined with continued progress in both the stormwater and shellfish initiatives.

The sensitivity of eelgrass to a wide range of environmental stressors makes it an important ecological indicator of estuary health worldwide. In 2011 the Puget Sound Leadership Council adopted eelgrass acreage as a measurable indicator – or "Vital Sign" – of the biophysical conditions of Puget Sound. A 2020 Target was established to increase eelgrass area by 20 percent relatively to the 2000-2008 baseline of approximately 53,300 acres. This represents an increase of approximately 10,700 acres by 2020. Table 1 summarizes interim targets adopted to facilitate measuring progress toward the 2020 Target.

Table 1. Puget Sound Partnership eelgrass interim targets.

	2014	2016	2018	2020
PROGRESS MILESTONES	• Soundwide eelgrass area increasing or stable relative to baseline • Two or more of five regions show area stability/improvement • Within each region, fewer sites show declines compared to 2011 • Depth distribution identified	• Soundwide eelgrass area increasing 5% relative to baseline • Three or more of the five regions show area stability/improvement • Ratio of increasing to decreasing sites improves in all regions • Depth distribution of eelgrass stabilized, relative to 2014	• Soundwide eelgrass area increasing 10% relative to baseline • At least four of five regions show area stability/improvement • More increasing than decreasing sites in all regions • Depth distributions of eelgrass increasing, relative to 2016	Eelgrass extent is 120% of the area measured in the 2000-2008 baseline
OUTPUT	Recovery Target Strategy Developed	Implement a coordinated strategy to achieve 2020 target	Continue to implement coordinate strategy to achieve 2020 target	

The 2014/2015 Action Agenda calls for the implementation of a coordinated strategy to achieve the 2020 eelgrass recovery target. Two near-term actions were identified to support this effort: 1) *DNR, working in collaboration with PSP, will convene partners in state and local government, tribes, the federal agencies, BC Canada, and non-governmental and business groups to develop a broad-based strategy to achieve the 2020 eelgrass recovery target and track progress*; and 2)

DNR will identify and recommend sites that are suitable for eelgrass restoration in Puget Sound. Sites will be selected using habitat suitability analysis, hydrodynamic modeling, and eelgrass resilience to local stressors. This will include identification of sites on state-owned aquatic lands with a focus on areas with long-term protections already in place.

III. Purpose of the Recovery Strategy

The eelgrass recovery strategy provides the strategic framework for advancing native eelgrass (*Z. marina*) conservation and recovery in Puget Sound and achieving the 2020 target to increase eelgrass extent by 20 percent. The strategy was developed to outline the range of actions necessary to:

- Conserve existing eelgrass habitats;
- Reduce environmental stressors to support natural expansion;
- Restore and enhance degraded or declining eelgrass beds;
- Identify eelgrass research priorities; and
- Expand outreach and education.

Successful large-scale recovery hinges on the implementation of a suite of complementary efforts targeting a diverse range of environmental stressors. The strategy recognizes that eelgrass recovery efforts must extend beyond the range of agencies, tribes, organizations, and local governments that are involved in direct management of eelgrass beds. It must also encompass a wide-range of stakeholders that manage programs with indirect impacts to nearshore habitat conditions and/or processes that support eelgrass health and survival.

The soundwide strategy covers the south, central and north Puget Sound, Strait of Juan de Fuca, San Juan Islands, Hood Canal, and the Strait of Georgia in Washington State. It was not intended – nor feasible – to capture the inherent site-specific variation in environmental stressors impacting eelgrass populations. For example, eelgrass beds within enclosed embayments may be especially vulnerable to water quality, while sites in some well-flushed delta locations may be more vulnerable to erosion and/or burial as a result of river diking and channelization. While the range of actions necessary to support recovery will likely vary region-to-region and even site-to-site, conservation of existing beds should be prioritized at all locations.

The strategy is intended to facilitate collaboration, support new partnerships, and identify innovative opportunities to contribute to eelgrass recovery. The plan identifies actions that are necessary to achieve the recovery target; however, many of the actions may not be feasible without additional funding. The plan will help position partners to pursue funding to support eelgrass recovery during biennium budgeting cycles and future grant opportunities. The strategy acknowledges existing scientific uncertainty surrounding localized eelgrass declines, yet strives to identify priority recovery actions that can be taken as part of an adaptive approach to eelgrass management. The strategy is not intended to be a static document. Ongoing stressor-response research should continually inform reevaluation and prioritization of efforts to improve recovery success.

IV. Process Summary

Representatives from the following agencies, organizations and affiliations were invited to participate in the process.

- *Local government:* Association of Washington Cities, Association of Washington Counties, Port Townsend, Kitsap County, King County.
- *State Government:* Department of Ecology, Department of Fish and Wildlife, Department of Health, Department of Natural Resources, Puget Sound Partnership
- *Federal Government:* Army Corps of Engineers, Department of Agriculture, Environmental Protection Agency, National Oceanic & Atmospheric Administration Fisheries, Pacific Northwest National Laboratory.
- *Business and Industry:* Puget Sound Shellfish Growers, Association of Washington Business
- *Non-governmental organizations:* Puget Soundkeeper Alliance
- *Tribes:* Puget Sound Tribes, Northwest Indian Fisheries Commission
- *Academic:* Puget Sound Institute (UW-Tacoma)
- *Other:* Northwest Straits Commission

The process resulted in general consensus about eelgrass recovery objectives, priority actions, recommended pilot areas, and next steps. Over the course of five half-day meetings held between May and September 2014, participants completed the process outlined below to develop the eelgrass recovery strategy.

Review existing science and monitoring data

The group incorporated regional seagrass experts over the course of the process to inform discussions and decision-making. The first meeting included a presentation outlining why eelgrass is important, what is currently known, what scientific gaps remain, and what approaches implemented in other estuaries could be replicated in the Puget Sound region. Over the course of the process, the group also heard from experts about stormwater, public outreach and education, and eelgrass transplant suitability and modeling results.

Define and prioritize strategic objectives

The group broke down the "20% increase in eelgrass extent by 2020" goal into strategic objectives, and subsequently prioritized the objectives based on two factors: (1) How achieving the objective would contribute to overall recovery; and (2) How much value the working group could add by prioritizing the objective (e.g., where could participant resources make the most difference to recovery?). Table 2 summarizes the work group's prioritization of the recovery objectives.

Table 2. Work group prioritization of eelgrass recovery objectives.

Objective	Potential value that achieving this objective has to overall recovery			Potential value added by workgroup participants		
	High	Med	Low	High	Med	Low
Water quality / nutrient loading	11	2	0	9	1	1
Stressor research	11	0	2	8	2	0
No net loss	8	5	0	10	1	0
Tidal wetland restoration	7	5	0	0	7	3
Strategic transplants	7	2	3	8	3	0
Overwater structures / In-water construction	2	9	1	9	2	0
Mooring / anchoring	0	10	3	0	4	6
Targeted public outreach	1	9	3	0	3	8
Shoreline armoring	2	1	8	0	2	9

* Values indicate number of workgroup member votes. Not all participants voted on every objective.

Complete organizational self-assessments

After identifying strategic objectives, participants were asked to complete a self-assessment to (1) evaluate how organizational capacities may align with priority stressors, and (2) identify current and potential contributions to eelgrass recovery. Participants were asked to identify near- and long-term actions their respective organizations could implement and/or support to advance eelgrass recovery. Participants were encouraged to include ambitious objectives and actions beyond those currently funded or underway.

Identify and prioritize recovery actions

Using the results of the self-assessment exercise, DNR developed a “synthesis document” that organized potential actions by strategic objective. Participants broke into subgroups organized by discipline expertise to identify the highest priority actions for each objective. Subgroups also added detail about potential lead organization(s), resource needs, and implementation opportunities and challenges (among other factors).

Identify and prioritize focus areas for implementation

Recognizing the scientific uncertainty surrounding the relative impact of several hypothesized stressors, the workgroup identified a series of eelgrass recovery focus (or pilot) areas to provide an adaptive framework to test recovery actions at the local level. If successful, focus areas could not only advance stressor-response research, but also help build the political support necessary for implementation as part of a soundwide initiative. The group identified and prioritized areas based on:

i. Evidence of a localized eelgrass decline;
ii. Evidence of a decline in nearshore habitat conditions;
iii. Recently completed and/or planned stressor abatement programs;
iv. Feasibility of recovery; and
v. Level of site protection/conservation.

In addition to large-group meetings, members were asked to work within their agency or organization (or with other similar constituents) to review materials, provide feedback on specific topics, and identify potential eelgrass recovery commitments and priorities.

To the extent possible, the group used consensus decision-making. Consensus was reached when everyone agreed they could accept moving forward with and would support the recommendation. Where consensus was not achieved, the strategy attempts to articulate differing opinions or disagreements. The facilitation team also prepared meeting summaries capturing key discussion points, action items, and areas of agreement and disagreement related to recommendations.

3. Puget Sound Eelgrass Overview

I. Regional Ecosystem Services

Zostera marina (eelgrass) is an aquatic flowering plant found in soft-sediment intertidal and subtidal habitats. It provides numerous high-value regional ecosystem services within the shallow-water coastal ecosystem. As an ecological engineer, eelgrass enhances structural complexity of nearshore habitats and supports high levels of biodiversity. It provides nursery habitat for economically important Dungeness crab and Pacific salmon (Fernandez et al. 1993, Phillips 1984, Simenstad 1994); spawning substrate for Pacific herring (Penttila 2007); and foraging habitat for numerous water birds (Butler 1995). Eelgrass beds also improve water quality by trapping and storing particulates and nutrients (Short and Short 1984, Gacia et al. 1999, Asmus & Asmus 2000); enhance productivity and alter nutrient cycling (Hemminga and Duarte 2000); mitigate wave energy and increase shoreline stabilization (Koch et al. 2006); and serve as a globally significant carbon sink (Fourqurean et al. 2012).

The widespread distribution and acute sensitivity of eelgrass to anthropogenic stressors make it a biological indicator of ecosystem health – or a “coastal canary” (Dennison et al. 1993, Orth et al. 2006). Localized declines indicate both ecological change and a loss of the regional ecosystem services that support Puget Sound.

II. Status and Trends

DNR’s Submerged Vegetation Monitoring Program (SVMP) annually monitors eelgrass within greater Puget Sound and has estimated soundwide acreage since 2000 (Gaeckle et al. 2011). While eelgrass (*Zostera marina*) is the dominant native seagrass in Puget Sound, two species of native surfgrass (*Phyllospadix spp.*) also grow along shorelines in the Strait of Juan de Fuca and adjacent areas. The SVMP includes native surfgrass in its estimates of the status and trends in eelgrass area, but excludes non-native intertidal seagrass, *Z. japonica*.

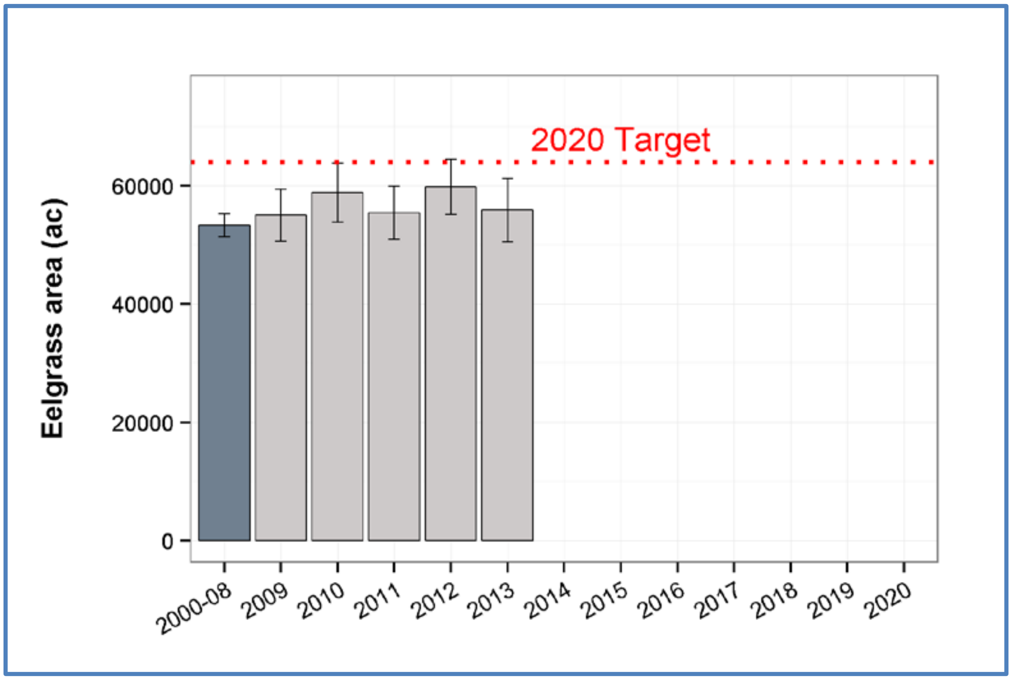
Distribution

Eelgrass is common in the intertidal and subtidal zones along the shorelines of greater Puget Sound. Nearshore geomorphology determines eelgrass bed characteristics. Eelgrass is most often found as narrow, fringing beds, but it also grows as vast meadows within embayments, near river deltas, and on shoals. The largest eelgrass beds are in Padilla and Samish bays; these make up over 25 percent of the total eelgrass area in greater Puget Sound. Many shorelines are unsuitable to eelgrass due to rocky substrate or exposure to high energy waves and currents. Eelgrass is rare in the southernmost reaches of Puget Sound (e.g. Budd Bay, Eld Inlet, Totten Inlet, Oakland Bay).

Trends in Total Soundwide Eelgrass Area

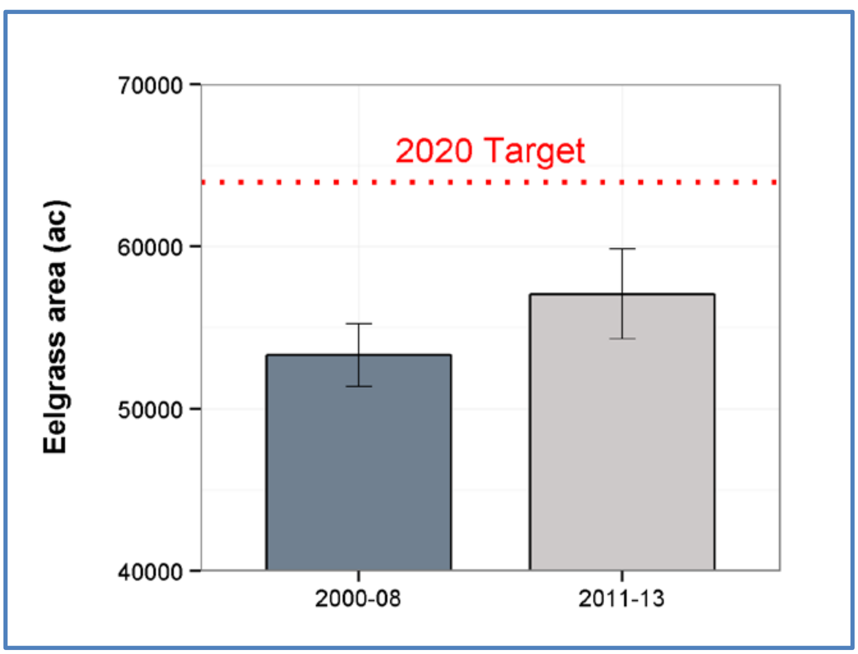
The Puget Sound Partnership adopted soundwide eelgrass acreage as a Vital Sign of the health of Puget Sound. The 2020 restoration target represents a 20 percent increase relative to the 2000-2008 baseline, which is estimated to have been 53,300 acres. Available data indicates that eelgrass within Puget Sound is not experiencing a widespread decline similar to other regions of the world (Orth et al. 2006, Short et al. 2011, Waycott et al. 2009). Puget Sound supported an estimated 55,900 acres of eelgrass in 2013 (Figure 2). Comparison of the 2011-2013 weighted average to the 2020 target shows that the target has not been met; however, the three-year weighted average suggests a seven percent increase (Figure 3).

Figure 2. Soundwide area of eelgrass relative to the 2000-2008 baseline.



* Annual points are estimated by the DNR Submerged Vegetation Monitoring Program. A 20% gain relative to the 2000-2008 baseline is shown as the 2020 target. Error bars represent standard error.

Figure 3. Weighted average of the annual soundwide eelgrass area estimates from 2011 to 2013, compared to the 2000-2008 baseline value.



* A 20% gain relative to the 2000-2008 baseline is shown as the 2020 target. Error bars represent standard error.

It is important to recognize that the eelgrass indicator was not developed to detect small changes over short periods of time. Similar to other large area status and trends indicators, uncertainty is associated with estimating changes from a sample of sites across a large geographic area. The analysis of eelgrass loss also excludes changes in eelgrass area relative to historical conditions. Although losses have been documented prior to 2000, no reliable estimates of historical soundwide eelgrass area exist for comparison purposes.

Spatial Patterns in Site-scale Changes

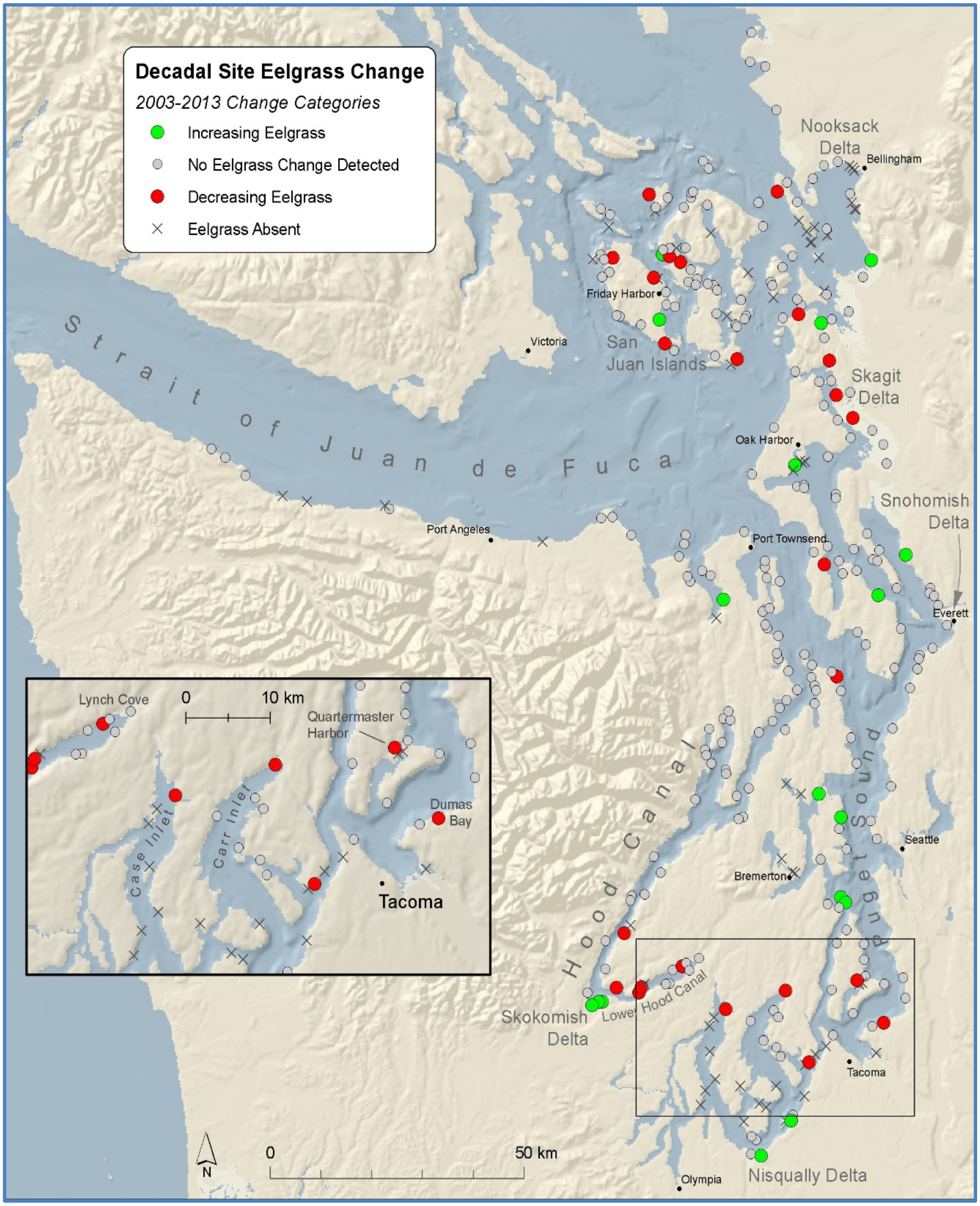
Monitoring results are used to assess long-term and recent trends at sites (Figure 4 and Figure 5). These data include both randomly selected sites and special studies. Over the last decade, clusters of declining sites are apparent (Figure 4). These declines are not correlated with the major population centers – a point that is highlighted by eelgrass increases seen in central Puget Sound. Declines are evident in poorly flushed bays and inlets in southern Hood Canal, south-central Puget Sound, and southern Puget Sound. These locations present special concern for water quality degradation due to restricted circulation and long water residence times (Short 2014, Khangaonkar et al. 2012). The San Juan Islands experienced notable declines over the same time period as lower Hood Canal and lower Puget Sound, despite regional differences in environmental conditions.

It is important to note that many individual sites did not reflect the broader basin-scale trends, which underscores the importance of local – in addition to regional – factors that can influence eelgrass condition. One important local factor could be river delta condition. In contrast to general patterns of loss in both lower Hood Canal and southern Puget Sound, decadal increases were observed at sites adjacent to large river delta restoration projects (see next section). Decadal declines were observed adjacent to the Skagit River delta, which has been identified as a restoration priority.

Recent monitoring (2010-2013) suggests a general pattern of eelgrass expansion, with fewer sites showing evidence of decline (Figure 5). The large spatial extent of these increases suggests regional conditions may play an important role. The factors contributing to recent increases at sites near Lynch Cove in lower Hood Canal remain unconfirmed; however, improved water quality could be playing a role. In 2012, the opening of the Belfair Wastewater & Water Reclamation Facility provided centralized wastewater collection and reclamation that supported decommissioning approximately 200 septic systems. Additional phases are planned to add more connections to the sewer system (Harris & Assoc. 2012). Recent increases have not been large enough offset the long-term decline at the site level (Figure 4).

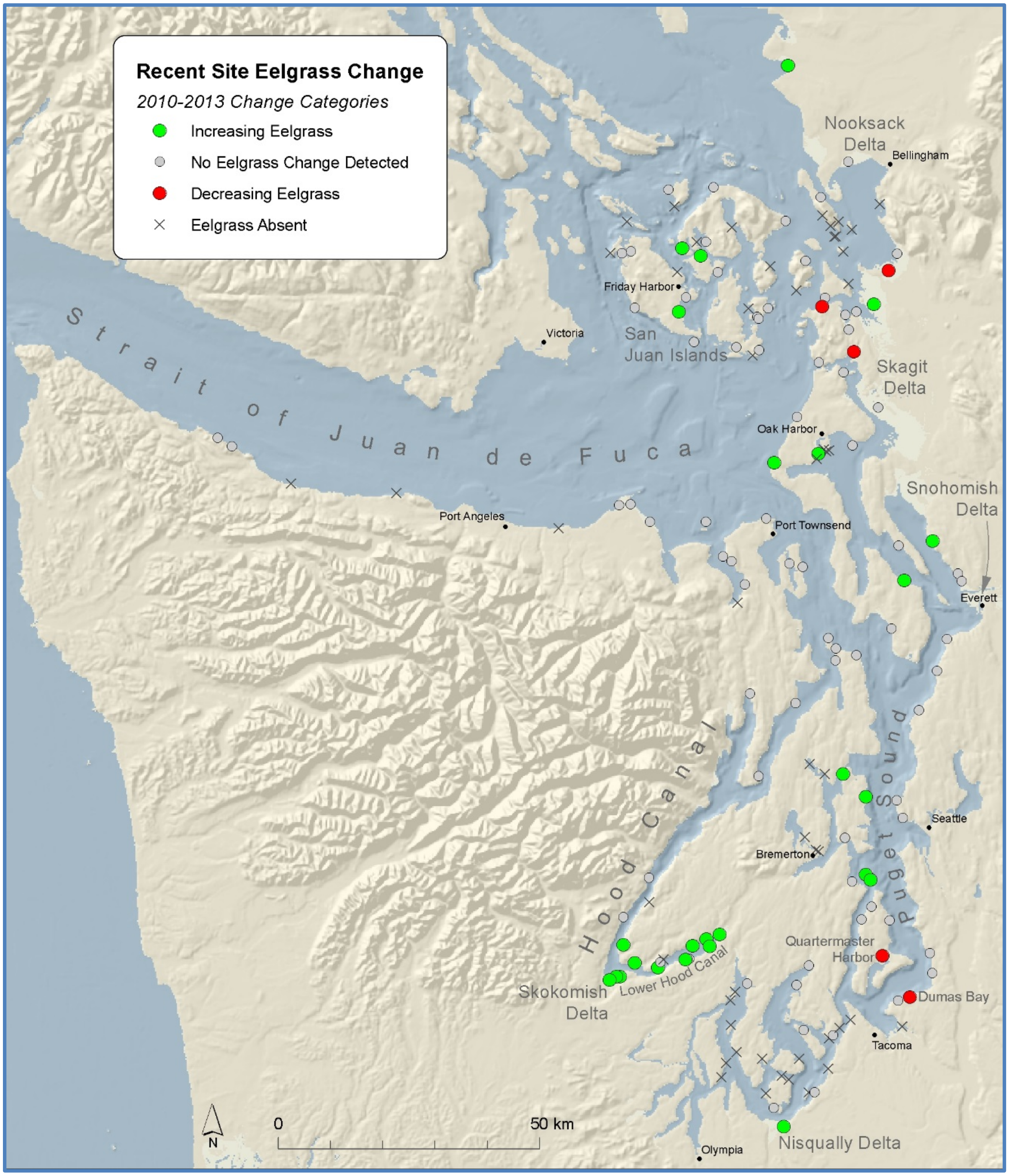
Sites in the southern reaches of Puget Sound did not experience the number of recent eelgrass gains observed in other areas. The only increasing site is located at the Nisqually River delta, a major restoration site. Ongoing decreases are evident at Quartermaster Harbor and Dumas Bay, sites that that have experience long-term losses. Given the large distance of these areas from oceanic flushing and relative long water residence times, these areas are of special concern for water quality degradation.

Figure 4. Site changes in eelgrass area assessed over a ten year data record (2003-2013).



* Results represent conditions from earlier in the data record at sites not sampled during recent years

Figure 5. Recent site changes in eelgrass area (2010-2013).



*Not all sites were sampled during the 2010-2013 time period.

Eelgrass Adjacent to River Deltas

Notable increases in eelgrass area occurred at two river deltas following major restoration projects: the Skokomish River delta in southern Hood Canal and the Nisqually River delta in southern Puget Sound. Eelgrass gains at these deltas contrast sharply with nearby sites (Figure 4).

Along the Skokomish River delta, three sites have gained approximately 200 acres of eelgrass, some of the largest site-level increases measured by the SVMP monitoring program. The eelgrass increases were first noted in 2010, following restoration work that was initiated in 2006 to remove dikes and restore tidal wetlands and distributary channels. Subsequent increases in eelgrass area were observed in 2013.

At the eastern portion of the Nisqually River delta, eelgrass area decreased between 2004 and 2007, followed by a major increase observed in 2012 and stability in 2013. These increases followed completion of the largest dike removal effort in the Pacific Northwest in 2009 (http://nisquallydeltarestoration.org). The current status of the western portion of the delta has not been sampled recently.

In contrast to the observed increases at two river deltas, monitoring results show a decadal decline in eelgrass at the Skagit River delta, which has been identified as a priority for future restoration. Research has shown that most of the fluvial sediment delivered to the delta is currently exported offshore by channelized dike complexes. This has led to fragmentation of the eelgrass beds and degradation of other valued nearshore components (Grossman, 2013).

The observed trends in eelgrass area at deltas suggest a link between river delta restoration and eelgrass recovery. Planned and ongoing projects at major deltas throughout Puget Sound provide an opportunity to understand the mechanisms influencing changes in eelgrass condition. These projects may result in important synergistic benefits to both eelgrass and juvenile salmon, which are known to rely on delta habitat.

III. Management & Regulatory Framework

Eelgrass conservation is a management priority reflected through a network of local, state, and federal programs. Management is driven by a combination of statutory mandates and agency rulemakings which contain specific guidance related to eelgrass habitats. The following programs manage or regulate activities with direct physical impacts to eelgrass; numerous, other programs may have indirect impacts (e.g., water quality) on habitat suitability.

Department of Ecology Shorelands & Environmental Assistance

The Shoreline Management Act (SMA) provides the regulatory framework for managing, accessing, and protecting shorelines of the state by regulating shoreline use and development. Three principle policy concepts within the SMA include: (1) accommodating preferred uses; (2) ensuring environmental protection; and (3) promoting public access. Although implemented by locally developed shoreline master programs (SMP), Ecology's Shorelands & Environmental Assistance Program provides oversight at the state level. The SMA mandates that local SMP goals, policies, and regulations ensure "no net loss" of ecological function. Eelgrass is defined as a "critical saltwater habitat" that requires higher levels of protection due to its ecological importance. SMP guidelines identify eelgrass as a potential indicator of "no net loss," but highlight the limitation that multiple factors can affect "growth and sustainability."

Department of Natural Resources Aquatic Leasing

DNR is proprietary manager of 2.6 million acres of state-owned aquatic lands, including nearly all Puget Sound bedlands and approximately 30 percent of tidelands. It is also co-manager of all resources – including eelgrass – attached and embedded to state-owned aquatic lands. Development and most uses of state-owned aquatic lands require agency authorization. DNR can issue a lease, easement, or right of entry agreement depending on the nature of the activity and exclusivity of use required. DNR has management authority to condition or deny aquatic lands authorizations to ensure compatibility with eelgrass habitats. DNR applies site specific habitat stewardship measures to avoid and minimize impacts to eelgrass habitats. DNR has no management authority over land use activities on private tidelands. In some locations, Ports have been delegated management authority of state-owned aquatic lands under port management agreements.

Department of Fish & Wildlife Hydraulic Project Approval

The Hydraulic Project Approval (HPA) program is intended to minimize project specific impacts to fish and fish habitat resulting from in-water construction projects that "use, divert, obstruct, or change the natural flow or bed" of waters of the state. *Z. marina* is identified as a "saltwater habitat of special concern" that provides essential functions in the developmental life history of fish. WDFW has the regulatory authority to condition or deny permits on the basis of adverse impacts to fish habitat, including eelgrass. WDFW must ensure "no net loss" of the productive capability of fish habitat (WAC 220-110-280). The agency applies the mitigation sequence (avoid, minimize and then mitigate) to all projects located within or adjacent to eelgrass habitats.

US Army Corps Section 404 Clean Water Act

The 404 program protects the chemical, physical, and biological integrity of waters of the United States by regulating discharges of dredge or fill material. Discharges contributing to a significant degradation are specifically prohibited except for navigation or anchorage considerations. Eelgrass is defined as a "special aquatic site" and adverse impacts are considered to significantly degrade waters of the United States. A 1990 Memorandum established the goal of "no net loss" for aquatic resources. The agency applies the mitigation sequence to avoid and minimize impacts to aquatic resources. Impacts to eelgrass require NOAA Fisheries consultation under the Magnuson-Stevens Fishery Conservation and Management Act and the Endangered Species Act. Compensatory mitigation is required for all unavoidable impacts to eelgrass beds.

IV. Environmental Stressors

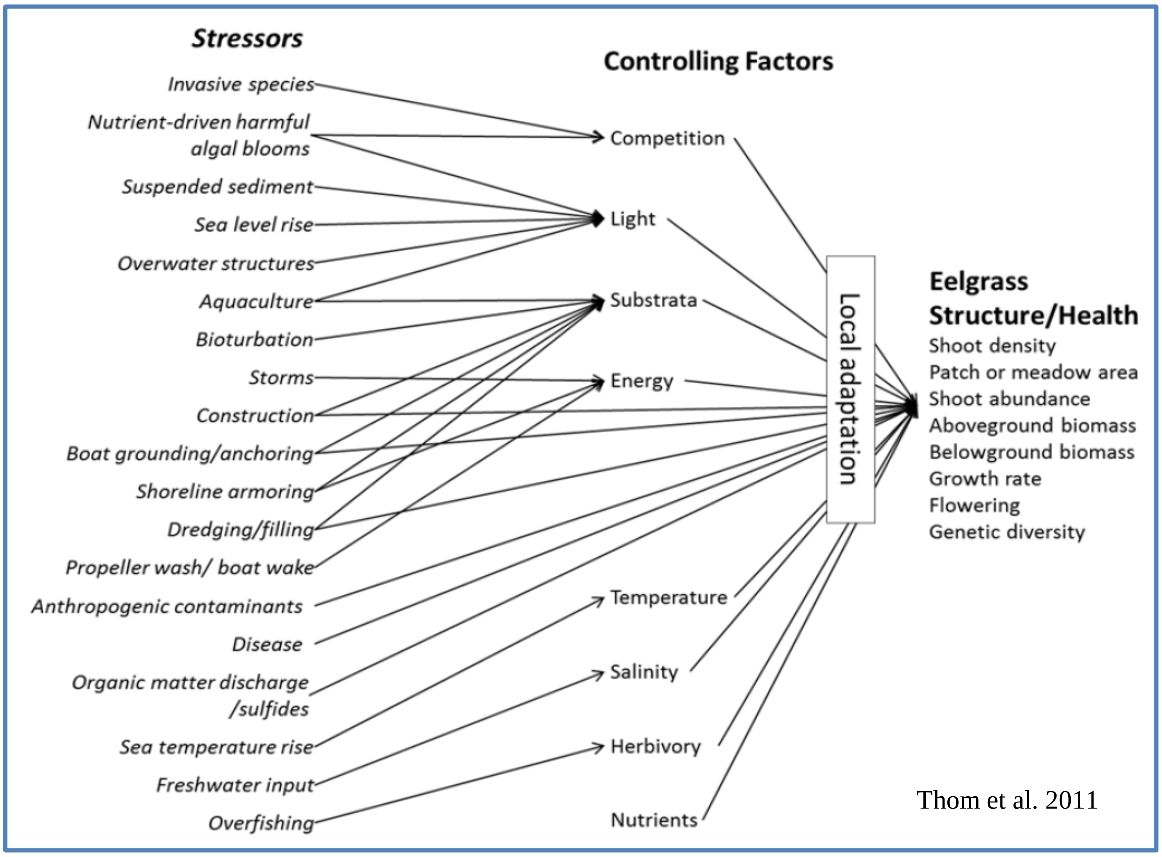
A variety of environmental stressors impact eelgrass growth and distribution within Puget Sound. The relative magnitude of impact on eelgrass beds is inherently linked to spatial and temporal variation in stressor intensity. Two recent research efforts have attempted to synthesize available information on eelgrass stressors in Puget Sound. Thom and colleagues' *Eelgrass Stressors (Zostera marina L.) in Puget Sound* (2011) provided a technical summary and comprehensive ranking of individual stressors. Figure 6 outlines a conceptual model summarizing how individual stressors impact eelgrass structure and health. Short's *Nitrogen as an Eelgrass Stressor in Puget Sound* (2014) provides an in-depth review and evaluation of nitrogen loading as a regionally-important environmental stressor within Puget Sound.

The following represents a brief summary of priority eelgrass stressors and the associated impact pathways in Puget Sound. Stressors are presented in alphabetical order and do not reflect a prioritization by level of impact. Refer to the two reports discussed above for a more comprehensive review of regional environmental stressors (Thom et al. 2011, Short 2014).

Aquaculture

The expansion of aquaculture can result in competition for space with eelgrass and mechanical harvest techniques have direct physical impacts on individual plants when conducted within existing eelgrass beds. The magnitude of impacts is spatially and temporally variable and depends on the species being cultivated and the specific aquaculture methods employed (Rumrill and Poulton 2004, Burkholder and Shumway 2011). Both positive and negative impacts to seagrass have been documented as a result of aquaculture activities (Tallis et al. 2009). Additional research is underway to support development and refinement of best management practices within Puget Sound.

Figure 6. Eelgrass stressor conceptual model.



Climate Change

Both sea temperature and sea-level rise could have significant impacts on regional eelgrass populations. Elevated temperatures directly affect eelgrass productivity and respiration. Extended periods of high temperatures can reduce eelgrass growth and survival. Although impacts are possible throughout Puget Sound, shallow embayments with poor tidal flushing are most vulnerable (Thom et al. 2011). Sea-level is also projected to rise in response to a global increase in air temperature. Increasing water depth will likely result in the loss of eelgrass along the deepest edge of existing beds in response to declining light levels. Eelgrass may shift shoreward in response to sea-level rise; however, shoreline armoring in many places will restrict inland movement leaving existing beds vulnerable to the "coastal squeeze."

Disease

Eelgrass wasting disease epidemics have resulted in widespread population declines in *Z. marina* in certain geographic areas, including Atlantic coastlines in North America and Europe. Eelgrass wasting disease has been confirmed in several embayments in the San Juan Archipelago; however, its role in recently observed declines remains poorly understood (Groner et al. 2014). Although the opportunistic host pathogen – *Labyrinthula zosterae* – is found throughout Puget Sound eelgrass populations, the specific risk factors associated with observed epidemics remain unknown (Thom et al. 2011). It is possible that changes in salinity or temperature associated with climate change could increase the vulnerability of eelgrass populations.

Dredge & Fill

Dredge and fill projects can result in direct physical disturbance and mortality to existing eelgrass beds. Modifications to nearshore depth contours and wave energy can effectively prevent recolonization. Dredging can also have short-term implications for water quality. Historically, dredging to accommodate commerce and navigation and filling tidelands to support agriculture and land use development contributed to loss of eelgrass beds. Periodic maintenance dredging around ports and marinas can have reoccurring impacts on certain eelgrass populations.

In-water Construction

Construction in and around eelgrass beds can result in direct removal, burial, and/or physical damage that results in plant mortality. Construction activities can also temporarily elevate turbidity and reduce light transmission. Common construction activities include piling, overwater-structure, underwater cable, outfall, and breakwater installation. In-water construction should increase with regional population growth.

Moorage & Anchoring

Vessel moorage and anchoring in sensitive habitats can damage eelgrass beds and contribute to habitat fragmentation. Although impacts from individual vessels are localized, collective impacts in high-use areas can contribute to significant scaring of eelgrass beds. Traditional moorings utilize large anchor blocks and weighted chains. As the vessel swings with the tide changes, chain drag across the substrate can uproot plants and leave a visible circular scar in an eelgrass bed. Vessel moorage in eelgrass habitats can also contribute to shading of eelgrass. Vessel use and moorage is anticipated to increase with regional population growth.

Nutrient Driven Algal Blooms

Anthropogenic nutrient loading into the nearshore environment can stimulate phytoplankton and macroalgae blooms which can increase turbidity and reduce the maximum depth of light transmission (Burkholder et al. 2007). The deposition of large masses of macroalgae can also reduce recruitment success (Thom et al. 2011). During summer-fall periods nearshore systems can become nitrogen-limited, increasing the vulnerability to nutrient loading. Geographic locations with restricted circulation and longer residence times (e.g., embayments) are likely more susceptible to anthropogenic nutrients (Khangaonkar et al. 2012). Although the decline of eelgrass as a result of anthropogenic nitrogen loading is well-documented in international literature, further research is necessary to understand the magnitude of impacts and relationship to observed eelgrass declines within Puget Sound (Short 2014). Nitrogen loading is projected to increase with regional population growth assuming water treatment technology remains unchanged (Roberts et al. 2014).

Organic Matter Deposition/Sediment Hydrogen Sulfide

The deposition and subsequent decomposition of organic matter can create anaerobic conditions within sediment porewater and contribute to elevated levels of hydrogen sulfide within nearshore sediments. Initial studies have shown that hydrogen sulfide concentrations found in some San Juan Islands embayments that have experienced declines and local extinctions are high enough to significantly reduce *Z. marina* seedling survival (Dooley et al. 2013). Further research is needed to understand the potential role of porewater hydrogen sulfide concentration in locally observed declines and/or preventing re-colonization.

Overwater Structures

The construction of overwater structures can have direct physical impacts on eelgrass beds and contribute to long-term shading of nearshore habitats. When built above or adjacent to eelgrass beds, overwater structures can reduce light transmission and plant growth, contribute to localized mortality, and/or increase regional habitat fragmentation. The relative magnitude of impact on light transmission depends on structure height, orientation, width, number of pilings, percent grating, and functional open space (Jones & Stokes 2006). The acreage of overwater structures is anticipated to increase with population growth and economic development.

Sediment Loading

Sediment loading reduces water clarity and can stress eelgrass growth by reducing available photosynthetic light. Although the major source of sediment loading is river discharge, stormwater runoff and discharges can also contribute to elevated turbidity. Further study is needed to understand the relationship to locally observed eelgrass declines. Historic channelization of rivers and deltas to support land use development and agriculture can also focus/increase sediment delivery contributing to the burial and/or fragmentation of nearshore eelgrass habitats (Czuba et al. 2011, Grossman et al. 2011). Numerous river deltas have been channelized within Puget Sound; however, efforts are underway to restore deltas and tidal wetlands to reestablish natural levels of sediment delivery and storage.

Shoreline Armoring

Shoreline armoring can disrupt natural sediment delivery and transport within the nearshore ecosystem and contribute to substrata changes. Increased wave turbulence from reflected waves can also increase erosion and elevate local water turbidity. Although shoreline hardening has been shown to correlate with a reduction in submerged aquatic vegetation in other regions

(Landry et al. 2013, Patrick and Weller 2013), only anecdotal evidence of similar effects exist within Puget Sound. Additional research is needed to understand the magnitude of impacts within Puget Sound and/or relationship to observed declines (Short 2014, Thom et al. 2011). Shoreline armoring is increasing at a rate of approximately 1 mile per year within Puget Sound (PSP 2013); additional armoring is anticipated in response to sea-level rise.

4. Strategic Action Plan

The following actions provide a strategic framework for advancing eelgrass recovery in Puget Sound. Management actions are organized within the overarching goals of conservation, stressor reduction, restoration, research priorities, and education and outreach. Each objective includes near-term priorities as well as additional supporting actions. Near-term priorities were identified by the work group as critical first steps in recovery and/or low hanging fruit that will help build momentum moving forward. Implementation leads are identified for all near-term priorities. References in [brackets] refer to related objectives and near-term actions within the 2014/2015 Puget Sound Action Agenda.

I. Conservation

<u>No net loss:</u> Ensure existing policies, regulations, and non-regulatory programs avoid impacts to existing eelgrass beds and enforce "no net loss[4]" standard.

The conservation of existing eelgrass beds is fundamental to long-term recovery. Policies and regulations must emphasize the protection of existing eelgrass beds to ensure land use development does not contribute to incremental losses that undermine regional investments in recovery. Researchers have largely been unable to isolate the relative magnitude of impact individual environmental stressors are having on eelgrass beds experiencing declines. The inability to pinpoint the stressors driving locally observed declines complicates prioritization of stressor abatement efforts and highlights the uncertainty surrounding large-scale restoration. Given the high financial costs and low success rates associated with eelgrass restoration efforts worldwide, impact avoidance should be prioritized moving forward. Future costs for restoration will likely far outweigh the current cost for protection.

Near-term Priorities for Advancing Conservation and Recovery

a. Adopt and implement an Aquatic Lands Habitat Conservation Plan to ensure leasing activities on state-owned aquatic lands do not adversely impact eelgrass habitats (DNR).

[4] The SMP Guidelines establish the standard of "no net loss" of shoreline ecological functions as a framework for implementing shoreline master programs (SMP). WAC 172-32-186(8) directs SMPs to "include policies and regulations designed to achieve no net loss of those ecological functions." The "no net loss" standards is designed to prevent new impacts to ecological functions resulting from new development. Both protection and restoration are necessary to achieve "no net loss." Restoration activities may also result in improvements to shoreline ecological functions over time. SMP Handbook Chapter 4 available at http://www.ecy.wa.gov/programs/sea/shorelines/smp/Handbook/index.html.

b. Ensure diverse stakeholder involvement in the Hydraulic Code update process to incorporate best available science, improve regulatory consistency, and strengthen protections for eelgrass habitats (DFW). **[B1.3.1 & B1.3.2]**

c. Support finalization and implementation of Shoreline Master Program updates to strengthen protections for eelgrass habitats and apply no net loss principles during shoreline project review (DOE).**[B1.2 et seq.]**

Supporting Actions

d. Convene an interagency workgroup to develop Puget Sound eelgrass mitigation guidance to increase consistency and predictability between local, state, and federal permits and use authorizations.

e. Develop and maintain a mitigation database to track level of success achieved by compensatory mitigation projects to ensure mitigation sequencing does not cumulatively undermine "no net loss" standards for eelgrass habitats.

f. Evaluate opportunities to expand the network of aquatic reserves within Puget Sound to advance conservation and recovery of regional eelgrass habitats.

II. Stressor Reduction

Significant progress towards the 20 percent more eelgrass by 2020 goal depends on the extent to which management programs can address priority stressors linked to regional eelgrass declines. Alleviating environmental stressors not only supports conservation, but also is critical to stimulating natural recovery in areas that have experienced localized losses and increasing transplant success. Several stressors hypothesized to contribute to Puget Sound declines are identified as existing priorities – or Vital Signs of ecosystem health – within the Puget Sound Action Agenda. Ongoing implementation of near term actions and other recovery efforts related to these priorities (e.g., water quality, delta restoration, etc.) should convey parallel benefits to eelgrass recovery.

<u>Overwater Structures & In-water Construction</u>: Design new/retrofit existing in-water and over-water construction projects to avoid impacts to existing and historical eelgrass habitats.

Overwater structures increase light attenuation within nearshore habitats, reducing light availability for eelgrass growth and survival. Impact avoidance during construction of new structures should be prioritized. The magnitude of recovery anticipated from improving management is bound by the spatial distribution of existing structures within Puget Sound. DNR estimates 200 hectares of cumulative eelgrass loss associated with existing overwater structures (assuming total loss) within the eelgrass depth band within Puget Sound (DNR, unpublished data). Two-hundred hectares represents approximately one-fifth of the 20 percent more target; however, complete recovery in response to structure retrofits is not practical. Retrofit costs may be difficult for property owners to absorb and load bearing commercial structures may not be suitable for increased light transmission. Further, numerous factors (e.g., habitat fragmentation, historic dredge and fill, etc.) will influence recolonization and recovery potential surrounding overwater structures.

Near-term Priorities for Action

a. Leverage collective regulatory and proprietary authorities and political capital to avoid new construction within, over, and/or immediately adjacent to eelgrass habitats where potential adverse impacts are identified (DNR, DFW).**[B2.1.2]**

b. Require all new overwater structures to meet light transmission design standards necessary to support eelgrass growth and survival as supported by the best available science (DFW, DNR).

Supporting Actions

c. Encourage and provide incentives (e.g., technical assistance, streamlined permitting, etc.) to property owners to retrofit pre-existing overwater structures to comply with light transmission and construction design standards as structures approach the end of their functional lifespan.**[B2.1.1]**

d. Develop and distribute overwater structure design guidelines for state-owned aquatic lands that are consistent with the proposed Aquatic Lands Habitat Conservation Plan commitments necessary to maintain an incidental take permit under the Endangered Species Act.**[B2.1.3]**

e. Increase enforcement capacity to address unpermitted, unauthorized, and/or derelict structures with adverse impacts to eelgrass habitats. **[B1.3 et seq.]**

f. Leverage the Clean Marina Program to promote best management practices and encourage environmentally friendly retrofits at marinas throughout Puget Sound.

Vessel Mooring & Anchoring: Expand eelgrass compatible boater infrastructure to reduce damages to eelgrass beds as a result of recreational and commercial vessel mooring in high-use areas with extensive eelgrass habitats.

Improperly sited or designed mooring buoys and vessel anchoring can scour, shade, fragment, and increase eelgrass bed vulnerability to disturbances. Localized impacts are frequently concentrated within embayments with high densities of moored vessels. It is difficult to quantify a potential eelgrass response from improving management of vessel moorage and anchoring. Although the overall contribution towards the 20 percent more goal is anticipated to be relatively small, it should not discount the ecological importance of restoring eelgrass in small, isolated embayments. Local input is essential to identifying and prioritizing areas where existing moorage conflicts with eelgrass habitats.

Near-term Priorities for Action

a. Leverage collaborative partnerships to improve mooring buoy management (e.g., management plans, relocation, retrofits, derelict removal, and outreach) in embayments where vessels moorage is located within or adjacent to eelgrass habitats (DNR, MRCs, Local Governments, Tribes).

b. Require all new and replacement mooring buoys to avoid eelgrass habitats and utilize helical anchor/midline float configurations to avoid impacts to eelgrass habitats (DNR, DFW).

Supporting Actions

c. Expand network of voluntary no anchor zones to reduce adverse impacts to eelgrass habitats as a result of temporary vessel mooring. Aligning shellfish protection and eelgrass conservation priorities may provide additional opportunities to leverage limited resources and increase stakeholder support.

Figure 7. Quartermaster Harbor Mooring Buoy Plan.

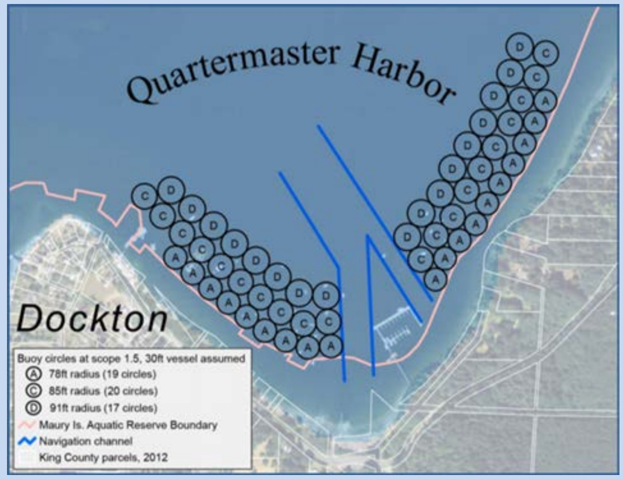


Image: Quartermaster Harbor Mooring Buoy Management Plan (2013)

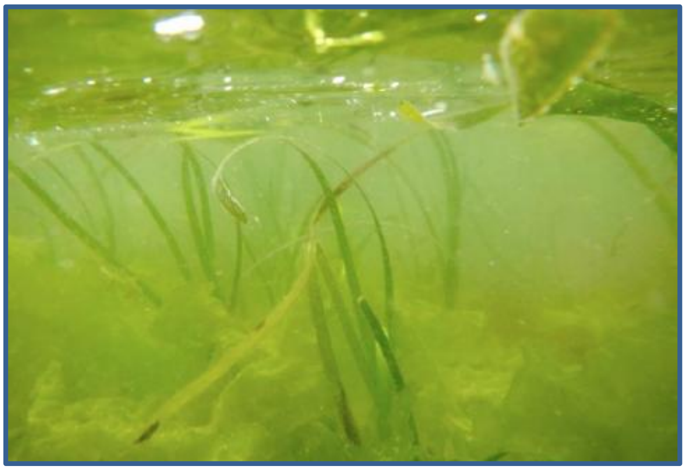
The Quartermaster Harbor Mooring Buoy Management Plan provides vessel moorage opportunities in a manner that ensures navigational safety and avoids adverse impacts to aquatic vegetation. Recommendations included designating buoy fields, monitoring impacts to eelgrass habitats, requiring embedded anchors with mid-line floats for all authorized buoys, and removing abandoned/derelict buoys.

Water Quality/Nutrient Loading: Reduce anthropogenic nitrogen and sediment loading – where adversely impacting eelgrass and/or contributing to violation of dissolved oxygen water quality standards – to improve marine water quality and minimize the frequency and magnitude of algal blooms and eelgrass epiphyte growth.

Nearshore nitrogen enrichment and sediment loading associated with population growth and land use development can contribute to phytoplankton and macroalgae blooms, epiphyte growth, and turbidity, collectively reducing light availability for eelgrass growth (Burkholder et. al. 2007). Although oceanic influx is the dominant source of nutrient loading within Puget Sound, it does not negate the potential impacts of anthropogenic inputs at specific locations, or during particular periods of time. Restricted embayments with reduced circulation and longer water residence times are most vulnerable to cultural eutrophication (Khangaonkar et al. 2012) and should be prioritized for nutrient source identification and control efforts; however, modeling indicates that distant nitrogen sources (e.g., central sound point sources) are also contributing to depletion of dissolved oxygen below regulatory levels in several southern Puget Sound inlets (Ahmed et al. 2014).

Nitrogen enrichment is widely recognized as a stressor responsible for significant eelgrass declines worldwide. Several states have elected to adopt numeric nutrient limits – in addition to dissolved oxygen standards – to ensure protection of aquatic life (e.g., seagrass) in response to cultural eutrophication. The connection to locally observed declines and the magnitude of regional impact with Puget Sound has not been confirmed. Isolating the impact on the nearshore ecosystem is complicated by the high magnitude of marine nitrogen inputs, as compared to watershed sources, and large tidal exchange within the system. Given the uncertainty surrounding regional impacts, enhanced regulatory control of nitrogen loading based on impacts to eelgrass is not advisable at this time. However, eelgrass may experience localized benefits from regulation of sources of nitrogen loading driven by dissolved oxygen water quality standards.

Figure 8. Dumas Bay algal bloom, summer 2013.



Voluntary/grant-based nutrient source identification and control should be emphasized not only as a recovery action, but also a proactive conservation measure to address potential increases in anthropogenic inputs associated with projected regional population growth. A reduction in nitrogen loading could drive local expansion of eelgrass beds – particularly along the deep edge – if local water clarity can be improved. Quantifying a potential response to various nitrogen load reduction scenarios is impossible given the unknown magnitude of impact under existing conditions.

Marine water quality has been identified as a “Vital Sign” for Puget Sound recovery. The 2013 State of the Sound reports that the marine water condition index has continued to decline since 1999.

Near-term Priorities for Action

a. Implement a coordinated approach to identify and reduce the impacts of outfalls on state-owned aquatic lands by avoiding eelgrass habitats, evaluating methods of alternative and advanced treatment where feasible, and requiring sediment and natural resource assessments prior to (re)authorization and/or permitting (DNR, DOE).**[B3.1.2 & C6.2]**

b. Fund local or watershed-based grants to implement nitrogen source identification and control, Pollution Identification and Control (PIC) programs, and low impact development stormwater retrofits in embayments and inlets with restricted circulation and long water residence times. Leveraging the existing PIC framework and methodology to expand nitrogen testing and provide technical assistance and/or incentives to address sources of nitrogen pollution may provide cost-effective opportunities within identified focus areas (Chapter 5) (DOE, DOH). **[C2.3 et seq.; C3.1 et seq.; C3.2 et seq.; C.5.1 et seq; C5.3 et seq.; C7.1 et seq.; & C9.4 et seq.]**

c. Upgrade existing wastewater treatment plants to advanced nutrient-removal technology as facilities reach operational capacity if they are shown to contribute to violation of dissolved oxygen water quality standards (DOE). **[C6.3]**

Supporting Actions

d. Develop standards and guidance for applying onsite septic systems (OSS) nitrogen removal technologies to reduce nearshore nitrogen loading. Advance OSS inspections to meet the 95 percent current inspection target within marine recovery areas as identified in the Action Agenda and correct all identified failures. **[C5.1.3 & C5.3 et seq.]**

e. Secure designation of marine inland waters of Puget Sound as a No Discharge Zone to protect marine water quality from vessel sewage discharges. **[C1.5 et seq.]**

f. Evaluate opportunities to leverage shellfish restoration to enhance local water quality and advance regional eelgrass recovery efforts.**[C7.3.4]**

<u>Shoreline Armoring</u>: **Reduce adverse impacts of shoreline armoring and conserve unarmored feeder bluffs to enhance nearshore sediment delivery and reduce beach erosion.**

Approximately 27 percent of Puget Sound shorelines is armored, with approximately one mile of additional armor installed annually (Schlenger et al. 2011). Shoreline armoring interrupts sediment supply from adjacent feeder bluffs, increases wave reflectivity and beach erosion, and can lead to localized increases in turbidity. Armor removal contributes to the restoration of nearshore processes that support eelgrass growth and survival. Although hypothetical impact pathways have been identified, the magnitude of impacts on eelgrass beds has not been confirmed. As a result, it is not possible to isolate the potential contribution of armor removal to the 20 percent more by 2020 target.

Shoreline armor has been identified as a “Vital Sign” for Puget Sound recovery. The 2013 State of the Sound reported that despite a constant increase in shoreline armor removal, new armoring continues to outpace removal. Parallel efforts are underway to prevent and remove shoreline armoring.

Near-term Priorities for Action

a. Leverage federal, state, and local government authorities and tribe and non-governmental organization support to prevent shoreline armoring along feeder bluffs and incentivize armor removal on undeveloped properties or where erosion is not a significant concern (DFW). **[B2.1.1 & B2.3 et seq.]**

b. Promote soft-shore stabilization alternatives and develop a social marketing framework to overcome perceived societal barriers to pursuing removal of or foregoing traditional shoreline armoring (DFW). **[B2.3 et seq.]**

Supporting Actions

c. Support continued implementation of Puget Sound Action Agenda Near Term Actions related to the *shoreline armoring* recovery target. Parallel investments to achieve a net reduction in soundwide shoreline armoring are anticipated to benefit eelgrass conservation and recovery. **[B2.2 et seq. & B2.3 et seq.]**

III. Restoration

Tidal Wetland Restoration: Restore tidal wetlands associated with river deltas, coastal inlets, and barrier embayments to restore ecosystem processes and recapture lost linear nearshore habitat that supports eelgrass growth and expansion.

Tidal barriers (e.g., dikes, levees, road crossings) have contributed the loss of 59 percent of historic wetlands associated with large river deltas and coastal embayments within Puget Sound (Schlenger et al. 2011). This has discouraged distributary channel formation and altered historic sediment supply and delivery to nearshore ecosystems. Recent research conducted by USGS has shown channelization of flow and sediment discharge from the North and South Forks of the Skagit River are contributing to fragmentation of eelgrass beds. Similar impacts have been observed along other river deltas (Grossman pers. comm.). Delta restoration has the potential to support natural expansion of significant acreage of eelgrass habitat, while also conveying parallel benefits to salmon recovery and coastal resilience. DNR's Submerged Vegetation Monitoring Program has observed expansion of eelgrass following large scale-delta restoration efforts in the Skokomish and Nisqually systems. Preliminary estimates have identified up to 1000 hectares of potential eelgrass recovery – or 23 percent of the 20 percent more target – may be possible with the restoration of the Skagit River delta (Grossman 2013).

Figure 9. Eelgrass response to the restoration of the Skokomish river delta.

Photo: Ecology Coastal Atlas (2006)

DNR is monitoring eelgrass response to a multi-phase Skokomish delta restoration effort. The delta was diked and filled in the mid-1900's to support agriculture, recreation, and development. Projects-to-date have restored over 300 acres of tidal wetlands, re-establishing natural sediment transport and storage within the estuary. DNR has documented a corresponding expansion of eelgrass with the completion of Phases I (2007) and II (2011). Eelgrass increased by more than 100 percent – or 63 ha – from 2005 to 2010 and an additional 10 percent – or 12 ha – from 2010 to 2013. Phase IIIA should be completed in 2014 and additional phases are proposed for funding.

Estuarine wetland restoration within large river deltas is identified as a "Vital Sign" for Puget Sound recovery. The 2013 State of the Sound reported 2,260 acres of estuarine wetlands – or approximately 31 percent of 2020 target – have been restored since 2006. Efforts are underway to identify and prioritize opportunities for continued estuary restoration work throughout Puget Sound.

Near-term Priorities for Action

a. Support continued progress towards the Puget Sound Partnership's Interim Targets and 10-year salmon recovery goals for estuarine wetland restoration within large river deltas. Preliminary monitoring of the Nisqually and Skokomish deltas has shown significant eelgrass expansion following restoration efforts (PSP). **[A6.1 et seq. & B2.2]]**

b. Implement process-based restoration strategies for coastal beaches, embayments, and river deltas as identified by the Puget Sound Nearshore Ecosystem Restoration Project and emerging Delta Restoration Consortium to reestablish intertidal and nearshore habitats capable of supporting eelgrass (DFW and PSP). **[B2.2 et seq.]**

c. Implement Floodplains by Design restoration projects throughout Puget Sound to restore estuaries and marine nearshore habitats, reconnect rivers to historic floodplains, reduce erosive flows, and increase upstream sediment storage capacity (DOE). [**A5.2 et seq. & A5.4 et seq.]**

Supporting Actions

d. Secure funding to monitor eelgrass response to tidal wetland restoration projects in order to identify ecological associations between various habitat types, inform education and outreach messaging, and support future habitat conservation and recovery.

Strategic Transplants: **Utilize strategic eelgrass transplants to accelerate recolonization and expansion at sites shown to possess suitable ecological conditions.**

Transplanting supports and accelerates eelgrass recovery where ecological conditions are suitable for eelgrass growth and survival. Donor plants are harvested from nearby healthy beds and transplanted to suitable sites using degradable anchors. Although the cost of transplanting (~$100,000 per acre) will limit the overall contribution towards the 20 percent more by 2020 target, natural expansion – through vegetative growth and sexual reproduction – can colonize areas much larger than the original transplant footprint. A Puget Sound transplant site suitability model was recently developed to enhance success of regional transplanting efforts (Thom et al. 2014). Up to 15 acres of transplants are currently targeted through 2016.

Near-term Priorities for Action

a. Conduct eelgrass transplants to stimulate colonization and recovery at sites identified as potential habitat by the transplant site selection model and subsequently confirmed as viable habitat by successful pilot eelgrass plantings. Permits for initial restoration projects at Joemma State Park, Port Gamble Bay, Wescott Bay, and Zangle Cove must be secured by winter 2015 to execute funds prior to grant deadlines (DNR, PNNL). [B2.4.2]

b. Monitor transplant success and donor bed recovery after transplant harvest to improve best practices related to eelgrass restoration and avoid adverse impacts to existing eelgrass beds that are the source of transplant material (DNR, PNNL).

c. Identify opportunities to incorporate strategic eelgrass transplants into large-scale process-based nearshore restoration projects identified through the Puget Sound Nearshore Ecosystem Restoration Project or similar ecosystem restoration prioritization efforts. Initial opportunities have been identified in concert with Elwha, Skokomish and Nisqually restoration efforts (DNR, PNNL). **[B2.2 et seq.]**

Supporting Actions

d. Convene local, state, federal and tribal partners to evaluate opportunities to reduce barriers and streamline permitting requirements for eelgrass restoration within Puget Sound. **[A6.1.2]**

e. Coordinate with Puget Sound Ecosystem Monitoring Program to incorporate historical herring spawn data into prioritization of sites for eelgrass restoration. Sites with parallel declines in herring spawn and eelgrass should be prioritized for restoration (e.g., Quartermaster Harbor).

f. Evaluate opportunities to leverage synergies between native shellfish and eelgrass restoration efforts to enhance long-term success.

Figure 10. Puget Sound eelgrass restoration.

Photo: Pacific Northwest National Lab

DNR and the Pacific Northwest National Laboratory (PNNL) are using an experimental approach to restore declining eelgrass beds on state-owned aquatic lands. Based on the results of a transplant suitability model, donor plants are selectively harvested from existing beds and transplanted to sites predicted to possess ecological conditions conducive to eelgrass growth and expansion. In 2013, initial small-scale test transplants were conducted at Westcott Bay, Joemma State Park, and Zangle Cove. Additional transplants are planned for along the Nisqually, Skokomish and Elwha deltas, Anderson Island and Port Gamble Bay through 2016.

IV. Research Priorities

<u>Stressor-Response Research:</u> Implement targeted research initiatives to understand the short- and long-term factors driving localized changes in eelgrass beds and inform an adaptive approach to recovery efforts.

Eelgrass beds have experienced declines or been completely lost in localized areas within Puget Sound. Many losses remain unexplained (Schanz et al. 2010). It is possible that observed losses within vulnerable populations may be an early indicator of a larger regional issue. Although scientists have developed conceptual models for stressor impact pathways (Thom et al. 2011), additional research is critical to understanding relative importance of and interaction between various stressors driving observed population declines. This information will allow managers to assess, prioritize, and adapt regional strategies for conservation and recovery.

Near-term Priorities for Action

a. Expand DNR eelgrass stressor response research capacity to understand and isolate contributing factors responsible for observed site-specific losses and expansion (DNR).

b. Coordinate and fund research efforts to understand the implications of anthropogenic nutrient loading on nearshore water quality, light availability, and eelgrass health in Puget Sound (DNR, DOE).

c. Establish a collaborative partnership to collect, compile, and share year-round photosynthetically active radiation (PAR) data in nearshore areas. High resolution PAR data will provide insight into how temporal and spatial ranges of light attenuation relate to regional nearshore water quality and eelgrass distribution and trends (DNR, PNNL).

Supporting Actions

d. Develop and test stormwater best management practices (BMPs) to enhance nitrogen removal as part of low impact development strategies. Certain existing BMPs may actually contribute nutrients to stormwater.

e. Assess pathways through which shoreline armoring and its removal may influence intertidal and sub-tidal habitat structure and function on both local and drift-cell scales.

f. Research the impacts of sediment hydrogen sulfide on eelgrass communities and the potential role in locally observed declines and re-colonization.

g. Research long-term implications of climate change and ocean acidification on eelgrass communities to inform an adaptive approach to conservation and recovery.

h. Maintain the Washington Marine Vegetation Atlas to provide publically accessible repository for spatial data and publication information on eelgrass in Puget Sound.

i. Support continued analysis of long-term eelgrass trends (1973-2013) at Pacific herring spawning sites to broaden the database of eelgrass occurrence and trends for use in research to understand contributing factors responsible for observed site-specific losses and expansion (NOAA, PSI).

V. Public Awareness

<u>Outreach & Education:</u> Target public outreach and education to foster community stewardship, individual responsibility, and collective action to benefit eelgrass conservation and recovery.

Strategic outreach to local governments and planners, recreational boaters, and shoreline homeowners is essential to influencing individual behavior to support responsible stewardship of eelgrass habitats. Incentive-based communications by entities who hold credibility with the target audience increase the likelihood of success. Local marine resources committees have been at the forefront of regional outreach and education efforts. Existing efforts include engaging local residents in local eelgrass surveys, developing educational shoreline signage, promoting the WSU Shore Stewards program, establishing Marine Stewardship Areas, managing voluntary no anchor zones, and supporting educational booths at regional community events.

Near-term Priorities for Action

a. Expand boater awareness campaigns to promote eelgrass-friendly boating practices. Outreach opportunities include developing an eelgrass geospatial layer within the Washington Boater application and distributing awareness fact sheets with boater registration (Puget Sound Keeper Alliance).

b. Provide targeted community outreach and messaging to enhance compliance with voluntary no-anchor zones as additional locations are identified for implementation (MRCs).

Supporting Actions

c. Increase opportunities for community involvement in local eelgrass and nearshore monitoring. Volunteer opportunities, such as the Island County Beach Watchers and Salish Sea Stewards programs increase public awareness, promote resource stewardship, and contribute valuable scientific data.

d. Develop/expand shoreline homeowner outreach program(s) that provide tips for creating a waterfront landscape that both enhances property values and promotes conservation of nearshore habitats. Local programs incentivizing green shoreline practices should be emphasized.**[D5.2.1 & D5.3.1]**

Figure 11. Jefferson County Marine Resources Committee Voluntary eelgrass protection zone

Image: Jefferson County Marine Resources Committee

In 2004, the Jefferson County Marine Resources Committee (MRC) established a voluntary no anchor zone to protect eelgrass beds from temporary vessel moorage along the Port Townsend waterfront. Now in its 11th year, the program has achieved a 98 percent rate of vessel compliance as a result of a targeted outreach campaign to vessel operators. The "Anchor Out – For Safety and For Salmon" campaign has included informative signage, eelgrass marker buoys, decals, and advertisements to the boating community. The advertisement pictured above was funded by the US EPA and PSP and appeared in a local publication. In 2014, Jefferson County MRC announced their intention to expand the voluntary no anchor zone to include an additional 36 acres south of the ferry dock.

5. Geographic Focus Areas

The large geographic scope of recovery when viewed within the context of current resource-constrained operating budgets requires managers to prioritize restoration and stressor reduction investments. The recovery workgroup identified the following focus areas based on the (1) strength of evidence of eelgrass decline or loss; (2) evidence of decline in nearshore habitat conditions; (3) recently completed and/or planned stressor abatement projects; (4) feasibility of recovery; and (5) level of site protection (Figure 12). Focus areas provide an opportunity to test the effectiveness of various strategic actions, understand the reversibility of specific stressors, and inform an adaptive approach to eelgrass management. If successful, recovery efforts within focus areas will not only increase eelgrass acreage within Puget Sound, but also advance the scientific understanding of regional eelgrass stressor-response pathways and build momentum for implementing actions at a larger scale. Recovery efforts also have the potential to improve conditions beyond eelgrass that favor ecosystem-wide recovery.

Quartermaster Harbor

Quartermaster Harbor is a shallow restricted embayment located on Vashon Island. The natural harbor is divided into an inner and outer harbor with maximum depths of approximately -6 m and -46 m mean lower low water respectively. The entire harbor is located within the DNR Maury Island Aquatic Reserve. The King County Shoreline Master Program (SMP) identifies the shoreline as predominately rural and natural designations and the waterfront is characterized by low intensity residential development. The harbor is heavily utilized for recreational boating, supporting three marinas and approximately 274 recreational mooring buoys and rafts (DNR 2013).

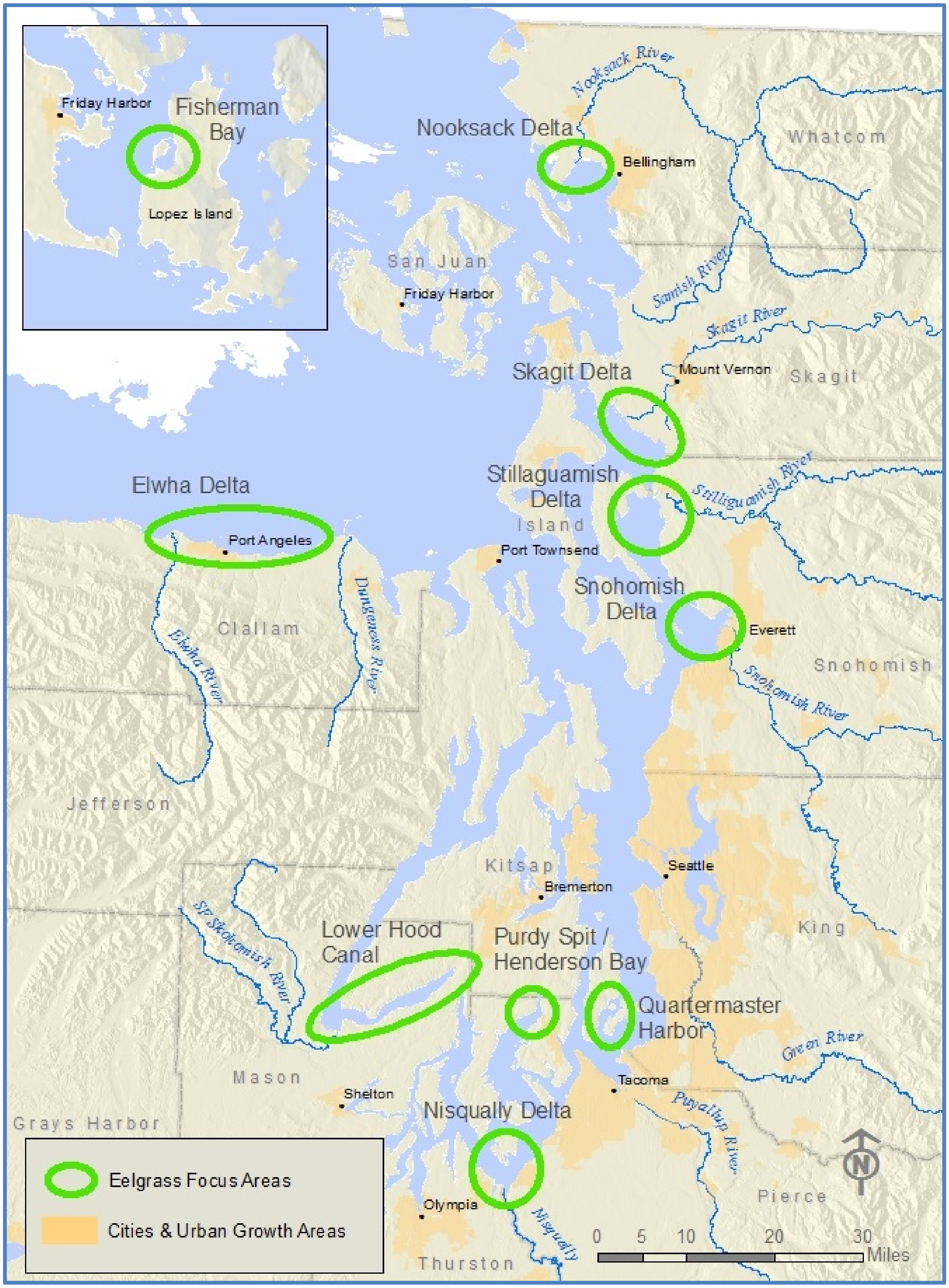
Quartermaster Harbor historically supported a near continuous band of fringing eelgrass habitat along the entire length of the embayment. Thirty years of DFW herring spawning survey data from 1981-2011 documented an ongoing decline in eelgrass, especially within the inner harbor from Burton Cove to Judd Creek where it has been completely lost (DNR 2013). A parallel decline in herring spawning biomass was also observed during this timeframe (Stick & Lindquist 2009). The DNR SVMP has surveyed 11 sites within Quartermaster Harbor; however, surveys have only been repeated at three sites. The Burton Cove site in the head of the inner harbor has declined from an estimated 2 acres in 2004 to a fraction of an acre in 2013. Two sites adjacent to the entrance of the outer harbor have shown no detectable change (DNR, unpublished data).

Local water quality issues have received growing attention and remain a management priority. Several commercial shellfish growing areas have been closed in response to high fecal coliform bacteria levels and portions of the harbor have been designated as a Marine Recovery Area (MRA) to address problems associated with OSS. King County has received several National Estuary Program (NEP) grant awards to implement a local PIC program. Marine waters within the embayment are also listed on the 303(d) list of impaired water for low dissolved oxygen levels. Although marine inputs are the dominant source of nitrogen, the role of anthropogenic nitrogen loading in contributing to low dissolved oxygen and harmful algal blooms remains uncertain (King County 2014).

Lower Hood Canal

Hood Canal is a deep and narrow L-shaped fjord that separates the Olympic and Kitsap peninsulas. The lower Hood Canal extends from the Skokomish delta to Lynch Cove. It supports

Figure 12. Puget Sound eelgrass focus areas



regionally important commercial shellfish growing areas and provides opportunities for recreational shellfish harvest. The proposed Mason County SMP update designates the majority of the shoreline as Residential and Urban Commercial. Single-family residential development is the predominant land use along lower Hood Canal and has resulted in extensive shoreline modification (e.g., bulkheads, docks, floats, etc.). Depending on the reach, approximately 34 to 76 percent of the shoreline has been armored to prevent erosion (Mason County 2012). Residential occupancy is seasonal, increasing significantly during the summer months.

Lower Hood Canal supports a combination of narrow fringe habitat and larger continuous eelgrass flats. Fringe habitat extends along the majority of shorelines with extensive shallow flats located along Lynch Cove and the Skokomish delta. The DNR SVMP has sampled 13 sites in the regions. Long-term trends from the early 2000s through 2013 have documented eelgrass decline at five fringe habitat sites, representing a decline of an estimated 16 acres. During this same time, three sites along the Skokomish River delta have gained approximately 200 acres of eelgrass. Short-term data since 2010 has shown increases at seven fringe sites, three sites at the Skokomish delta and one site at the flats site in Lynch Cove. There have been no statistically significant declines since 2010 (DNR, unpublished data).

The Hood Canal's sensitivity to water quality impairment has been the focus of extensive research and driven significant regional investment to reduce sources of pollution. Portions of lower Hood Canal are listed on the 303(d) list of impaired waters for both dissolved oxygen and fecal coliform bacteria. The entire shoreline has also been designed as a MRA to help address potential pollution sources from on-site septic systems. The Hood Canal Coordinating Council received NEP PIC funds to develop and implement a regional PIC program to address and prevent closures of commercial shellfish areas. The 2012 completion of Belfair waste water and water reclamation facility also helped to reduce nutrient and bacteria inputs into Lynch Cove and contributed to upgrading 280 acres of commercial shellfish beds from "prohibited" to "approved" classification.

EPA and DOE recently concluded that marine input is the dominant source of nitrogen and anthropogenic nitrogen loading has "no effect" on low dissolved oxygen levels and episodic fish kills in central Hood Canal; however, the report does not represent a comprehensive assessment of potential impacts as a result of human-derived nutrient inputs and did not attempt to analyze potential impacts on the nearshore biological communities. The report also did not rule out that nitrogen loading has contributed to violations of dissolved oxygen water quality standards in Lynch Cove (Cope & Roberts 2013).

Purdy Spit / Henderson Bay

Purdy Spit is a barrier spit that separates Henderson Bay from Burley Lagoon, a small barrier estuary. Burley Lagoon and Henderson Bay are regionally important shellfish growing areas and currently supports commercial aquaculture operations and recreational beach harvest opportunities. The Pierce County SMP designates the Burley Lagoon and Henderson Bay as predominately Rural Residential (east shore), Urban, and Conservancy (west shore) shorelines. Henderson Bay shorelines are characterized by rural residential development with higher densities surrounding Burley Lagoon. Residential development has contributed to moderate levels of shoreline modification, predominately in the form of rip-rap and concrete bulkheads

(Pierce County 2009). The construction of State Route 302 across the Purdy Spit has also likely altered historic tidal exchange and patterns of sediment transport and deposition.

Henderson Bay supports extensive beds of fringing eelgrass beds from the mouth of Burley Lagoon to Glen Cove (Pierce County 2009). The DNR SVMP has sampled two sites in Henderson Bay. The SVMP program has surveyed the south end of Purdy Spit annually since 2000. Eelgrass has declined from an estimated 15 acres in 2003 to an estimated 6.5 acres in 2013. Since 2010, no short-term trend has been detected. No detectable change has been observed at the site near the Allen Point further down the eastern shoreline of Henderson Bay since it was first sampled in 2008.

Henderson Bay is sensitive to water quality impairment due to the length of the embayment and the relatively long water-residence times. Henderson Bay and Burley Lagoon are listed on the 303(d) list of impaired waters for both dissolved oxygen and fecal coliform bacteria. Human-derived nutrient loads are causing greater than 0.2 mg/L decreases in minimum dissolved oxygen concentrations in Henderson Bay (Ahmed et al. 2014). A 2011 review of status and trends in fecal coliform pollution ranked Burley Lagoon and Henderson Bay as the 3rd and 13th most highly impacted shellfish growing areas, respectively within Puget Sound (DOH 2012). Pierce County has received National Estuary Program and Department of Ecology Centennial Grant funding for PIC projects located within Burley Lagoon and the Henderson Bay to identify sources of fecal pollution and help fund repair of failing OSS.

Fisherman Bay

Fisherman Bay is a natural harbor on the west side of Lopez Island in San Juan County. Shoreline environment designations include a mixture of residential-rural-farm, rural residential, rural and urban. Current land use is characterized primarily by small lot residential development. Development has contributed to numerous shoreline modifications including bulkheads, overwater structures, and the second highest concentration of mooring buoys in the county. In 2012, there were approximately 160 mooring buoys and four marinas within the bay (San Juan Co. 2012).

Fisherman Bay has experienced a dramatic decline in eelgrass beds. The decline corresponded with the widespread decline of eelgrass observed in a number of small embayments within the San Juan Archipelago between 1995 and 2004. Fisherman Bay eelgrass declined from an estimated 34 acres in 1995 to 24 acres in 2004 (PSAT 2007). Several embayments, including Westcott and Nelson Bay also experienced localized extinctions during this timeframe. Although the DNR SVMP sampled Fisherman Bay in 2010, sufficient data is not available to access more recent trends in distribution and abundance. The reduced genetic structure and diversity of the local eelgrass population may increase its vulnerability to future declines (Wyllie-Echeverria et al. 2010). A seagrass wasting disease outbreak was confirmed in the summer of 2014 (Wyllie-Echeverria, pers. obs.).

Wetland removal, ditching of uplands freshwater sources, and construction of a county road along the tombolo have contributed to local water quality degradation and accumulation of fine sediments (San Juan Co. 2012). San Juan County Public Works recently selected Fisherman Bay as one of six focus areas for a three-year pilot stormwater monitoring program to identify sources of pollution (e.g., fecal and nutrients) to marine waters. Fisherman Bay is listed as a waterbody of concern for low dissolved oxygen levels and there is local interest in improving tidal circulation within the bay. It has been suggested that retrofitting the county road along the tombolo could improve hydrodynamics and geomorphic processes within the bay.

Puget Sound River Deltas

River deltas are an interface between marine and upland ecosystems, supporting high levels of biological productivity and providing important habitat for a variety of species, including chum and chinook salmon, Dungeness crabs and marine birds. Researchers have identified 16 large river deltas within Puget Sound that historically accounted for approximately 90 percent of tidal wetlands within the region (Fresh et al. 2011, Collins and Sheikh 2005). Sediment delivery and transport pathways within these systems play an important role in the formation, maintenance, and composition of nearshore intertidal and subtidal habitats, including eelgrass flats that are frequently associated with Puget Sound deltas (Jay and Simenstad 1996, Grossman et al. 2011).

The construction of tidal barriers, dikes, and levees to support agricultural production and land use development has significantly modified Puget Sound deltas. Large deltas have lost approximately 55.5 percent of tidal wetlands and 176 kilometers of shoreline (Fresh et al. 2011). The loss of natural distributary channels and modification of sediment transport is likely impacting the high-quality eelgrass flats that frequently grow along the margins of numerous river deltas. Recent research shows the channelization of the Skagit River contributed to a transition from a calm to energetic nearshore environment and coarsening of the nearshore substrate. Increased water velocities and concentrated sediment discharges appear to eroding and burying eelgrass beds contributing to the fragmentation of habitat (Grossman 2011). Another study estimated that dam construction and water diversion in the Skokomish watershed contributed to a decline in sediment transport capacity, a net erosion of the outer delta, and an approximately 17 percent reduction in eelgrass (Jay and Simenstad 1996).

The large-scale restoration of the Skokomish delta has highlighted the potential for a significant eelgrass response to restoration of tidal wetlands, distributary channels, and natural sediment delivery-transport processes. The first and second phases of the project were completed in 2007 and 2011 respectively, contributing to the restoration of over 300 acres of tidal wetlands. DNR SVMP monitoring has measured a gain of approximately 200 acres of eelgrass since the onset of the multi-phase restoration project (DNR SVMP, unpublished data). The gain is the largest observed during DNR's SVMP program and represents approximately 2 percent of the 2020 recovery target. Additional phases are underway or have been conceptually designed for pursuing future funding.

Significant public and political support exists for restoring deltas due to their importance to juvenile salmon and role in rebuilding depressed chinook populations. The Puget Sound Partnership identified estuarine wetland restoration within large river deltas a as a "Vital Sign" of ecosystem health and adopted a target of restoring 7,380 acres by 2020. As of 2012, 2,260 acres had been restored and additional projects are currently underway and/or proposed for funding in the Skagit, Stillaguamish, Snohomish, Skokomish, Nooksack, Nisqually, and Elwha River deltas. PSNERP's tentatively selected restoration plan includes six projects within the Skagit, Snohomish, and Nooksack deltas for congressional authorization to fund further design and construction as a partnership with the U.S Army Corps of Engineers.

The extent of historical modification (e.g., acreage of tidal wetland loss) and the feasibility of restoration (e.g., conflicts with existing development) will ultimately contribute to potential delta-specific eelgrass responses that can be anticipated within each system. DNR is working to secure funding to monitor eelgrass response to large-scale restoration projects to help isolate and understand the physical and biological mechanisms driving change. Deltas highlighted as "focus areas" in Figure 8 represent areas where significant restoration efforts are underway or anticipated – additional opportunities may be identified in the future. Funding has been secured to conduct eelgrass transplants within several deltas, including the Skokomish, Nisqually and Elwha deltas to accelerate natural colonization and expansion. Additional transplant opportunities may be identified as delta restoration projects are completed.

6. Conclusion

The 20 percent more eelgrass by 2020 recovery target is an aspirational goal for restoring the health of Puget Sound. This document outlines a strategic framework for resource managers to address the diverse set of environmental stressors with potential adverse impacts on eelgrass growth and survival. Numerous state and federal agencies, local governments, tribes, and stakeholders are actively involved in regional eelgrass management. The scope of influence extends even farther if one considers the breadth of environmental stressors that indirectly affect nearshore habitat conditions and the ecosystem processes that support eelgrass habitats. Several important environmental stressors originate above mean high tide and relevant management structures and regulatory frameworks are not set up to prioritize concerns related to eelgrass recovery. A comprehensive recovery effort transcends the traditional partners who are involved in eelgrass management. Eelgrass recovery will require effective communication, close coordination, and innovative partnerships among a diverse set of partners to be successful.

Soundwide recovery hinges on the ability to restore environmental conditions and ecosystem processes conducive to natural eelgrass recolonization and expansion. DNR's SVMP has observed large recent expansions of eelgrass beds at several sites adjacent to large scale delta restoration efforts. Strategic transplants, although locally important to supporting recolonization and expansion of eelgrass, will not lead to large-scale recovery. The combination and magnitude of environmental stressors varies spatially and temporally throughout Puget Sound. The range of stressors affecting eelgrass within an isolated embayment can differ substantially from those along an exposed river delta. Although this strategy attempts to provide a comprehensive approach to regional eelgrass recovery, resource managers must acknowledge regional variations and tailor their approach to the sub-region or even embayment scale to maximize return on investment. Not all identified management actions are appropriate for implementation in all geographic locations. Local participation and input will be essential to effective implementation.

This recovery strategy is not intended to be a static document. It provides a framework for recovery that can – and should – be periodically reevaluated and adapted based on lessons learned from successful and unsuccessful stressor-reduction efforts. The plan acknowledges existing scientific uncertainty surrounding the factors contributing to localized eelgrass declines, but emphasizes that delaying action could contribute to additional declines and substantially raise future recovery costs. Numerous actions identified in this plan remain unfunded or are not currently financially and/or politically feasible for implementing at a soundwide scale. The plan identifies focus areas to provide an opportunity to test the effectiveness of strategic actions at a feasible scale. These areas provide an opportunity to restore lost or degraded eelgrass habitat, improve our understanding of stressor-response pathways, and build the political momentum necessary for implementation at a larger scale. Forming focused recovery workgroups that bring in local stakeholders and partners that are active in these areas will be critical to success.

Resource managers, tribes, and stakeholders must emphasize conservation of existing eelgrass beds as a management priority essential to long-term recovery. Projected regional population and economic growth is likely to increase pressure, both direct and indirect, on the nearshore environment. Eelgrass restoration has proven expensive and to-date has demonstrated mixed levels of success – not just regionally, but globally. Failure to avoid ongoing incremental adverse to existing eelgrass habitat could undermine recovery investments.

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