Elliott Bay/Duwamish Restoration Program:

Intertidal Habitat Projects Monitoring Report

2015 Report

Prepared for the Elliott Bay/Duwamish Restoration Program Panel

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The Elliott Bay/Duwamish Restoration Program: Intertidal Habitat Projects Monitoring Report, 2015 Report, was prepared by the Washington Fish and Wildlife Office, U.S. Fish and Wildlife Service (USFWS), Lacey, Washington. This report was compiled and edited by Kevin Aitkin and incorporates the 2001, 2002, 2003, 2005, 2007, 2010 Intertidal Habitat Projects Monitoring Reports and findings from the 2015 field season.

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Cover photo: Hamm Creek restoration site - 20 May 2015 (USFWS).

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INTRODUCTION

This report contains monitoring data collected in 2015 and summary comparisons to data collected in 2001, 2002, 2003, 2005, 2007, and 2010 for three intertidal habitat restoration projects in the lower Duwamish River, Washington. All of the reference sites used in prior years had been altered either through enhancement plantings or converted to other habitats, so no comparisons to reference sites were possible. These data were collected as part of the Elliott Bay/Duwamish Restoration Program (EBDRP).

The EBDRP Panel was established as part of a 1991 Consent Decree between the City of Seattle, Metro (now King County Department of Natural Resources) (DNR), and natural resource trustees[1]. In 1990, a lawsuit was filed against the City of Seattle and Metro by the United States of America on behalf of the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) under its authority as a natural resource trustee provided by the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA). The lawsuit was filed to recover damages "for injury to, destruction of, and loss of natural resources resulting from releases of hazardous substances… into the environment in and around the Duwamish River and Elliott Bay, for the costs of restoring, replacing or acquiring the equivalent of the affected natural resources, and for the costs of assessing the damage to the affected natural resources" (U.S. vs. City of Seattle & Metro, 1991). Rather than engage in lengthy and costly litigation, the City of Seattle and Metro, along with the natural resource trustees, negotiated a settlement agreement to establish a program to help restore and replace natural resources of Elliott Bay and the lower Duwamish River.

The EBDRP Panel of Managers is comprised of the City of Seattle, King County DNR, and the natural resource trustees. The projects' construction and monitoring are under the sponsorship and guidance of the EBDRP Panel and follow the Intertidal Habitat Projects Monitoring Program monitoring plan (EBDRP 2000). The monitoring plan describes a 10-year project with monitoring scheduled for Years 1-3, 5, 7, and 10. Physical success and biological success criteria were identified in the monitoring plan to determine if project restoration goals are being met. Five specific criteria were identified to be monitored under the physical success criteria and eight under the biological success criteria (Table 1). Data collection methods and post-construction site monitoring schedules were followed as described in the monitoring plan unless otherwise stated. Additional reduced monitoring took place in Year 2015 due to monitoring not starting at the Kenco Marine restoration site until 2007 (Year 7). The Kenco Marine restoration site was completed at a later date.

[1] National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, Washington State Department of Ecology, the Muckleshoot Indian Tribe, and the Suquamish Tribe.

Table 1. Physical and biological success criteria monitored at the Elliott Bay/Duwamish Restoration Program sites (EBDRP 2000).

Physical Success Criteria	Biological Success Criteria
1. Intertidal Area	1. Marsh Vegetation Establishment - *Marsh vegetation area*
2. Tidal Regime	2. Marsh Vegetation Establishment - *Species composition*
3. Slope Erosion	3. Marsh Vegetation Establishment - *Plant vigor*
4. Sediment Structure**	4. Riparian Vegetation Establishment - *Areal extent/ invasive plant coverage*
5. Sediment Quality*	5. Riparian Vegetation Establishment - *Survival*
	6. Bird Use** - *Presence/absence*
	7. Fish** - *Access/presence*
	8. Invertebrate Prey Resource Production***

** for Herring's House site only - eliminated by EBDRP as a monitoring criteria in 2003.*
*** discontinued after 2005.*
**** not funded in 2015.*

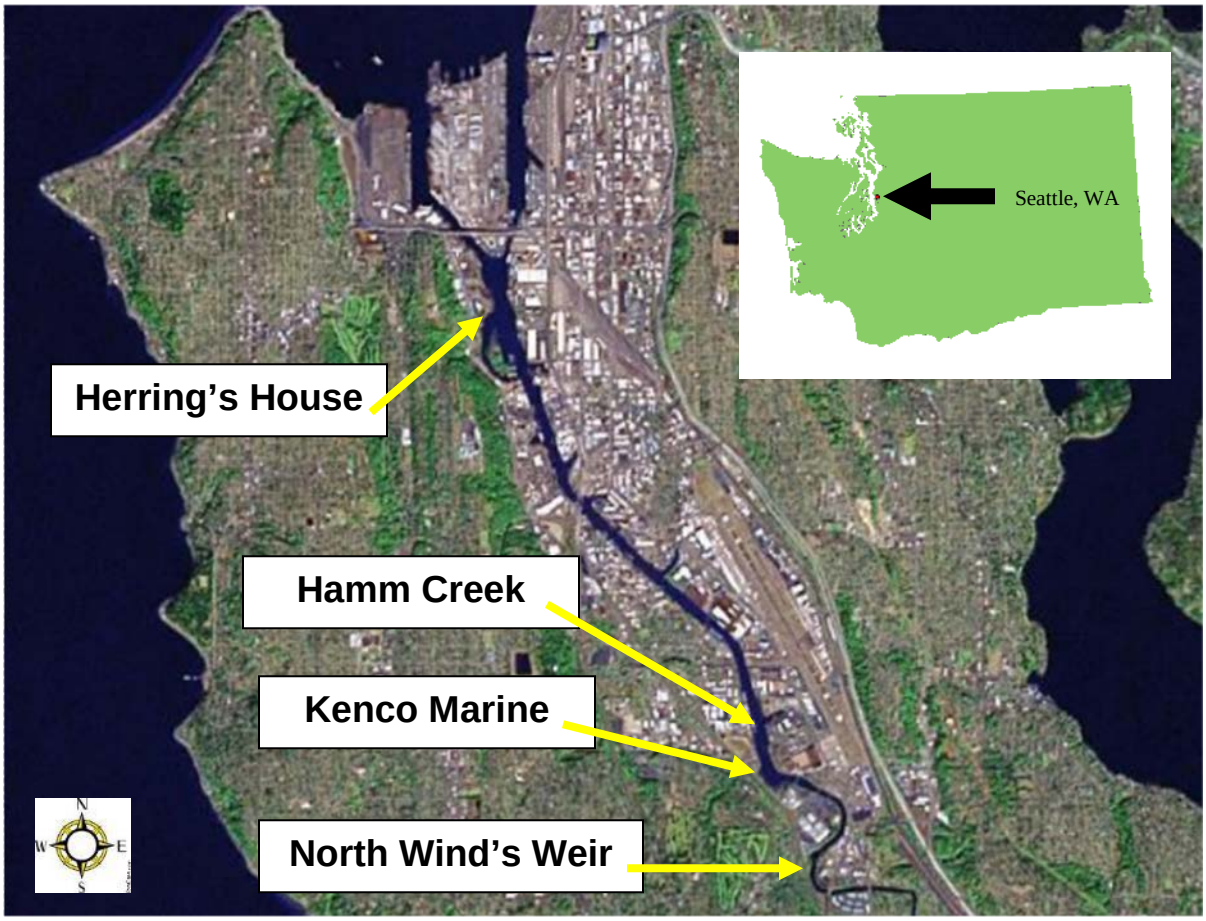

Figure 1. Location of Duwamish River restoration sites in the lower Duwamish River.

Restoration Sites

Monitoring efforts in 2015 for the EBDRP were conducted at the four restoration sites described in the monitoring plan (EBDRP 2000). Hamm Creek, Herring's House (formerly Seaboard Lumber), North Wind's Weir (formerly Cecil B. Moses Park), and Kenco Marine restoration sites are shown in Figure 1. Hamm Creek and Herring's House restoration sites were constructed in 2000 and monitoring began in 2001. Construction on the North Wind's Weir restoration site began in December 2002 and monitoring commenced in 2003. The Kenco Marine site was constructed and initially planted in 2006 with some replacement planting in 2007. The Kenco Marine site was monitored in 2007, 2010, and 2015.

Reference Sites

To gauge the success of biological criteria monitored at each restoration site, reference sites were historically selected for comparison. Due to the scarcity of 'natural' intertidal habitat remaining in the lower Duwamish River estuary, it was not possible to select reference areas containing all biological criteria to be measured. The location and number of reference areas varied for each restoration site based on the availability of similar sites and requirements for each monitoring criteria. No reference sites were sampled in 2015 due to most sites having been altered for habitat restoration. The remaining sites, last used as reference sites for macroinvertebrate sampling in 2010, were not sampled in 2015 due to a lack of funding for macroinvertebrate sampling in 2015.

<u>Hamm Creek, Kenco Marine, and North Wind's Weir</u>

The Hamm Creek, Kenco Marine, and North Wind's Weir restoration sites are located at approximately river miles 5.5, 6.5, and 7, respectively, and shared the same reference site. The reference site, a small marsh on the eastern bank of the Duwamish River across from North Wind's Weir, was used as a reference site for marsh vegetation until 2010 (Figure 2). This same site also served as the macro-invertebrate reference site for North Wind's Weir and Kenco Marine. This site was altered for habitat restoration and is no longer viable for use as a reference site (Figure 3). The Hamm Creek reference site for macroinvertebrates is a small fringe marsh located along the Duwamish River shoreline adjacent to the restoration site (Figure 4). This was the only reference site sampled in 2010. No reference sites were sampled in 2015.

<u>Herring's House</u>

The Herring's House reference site previously used for comparison of marsh vegetation was eliminated from the monitoring program beginning in 2007, due to independent enhancement actions that occurred at the site (Figure 5). This site, a small area of naturally occurring Lyngby's sedge (*Carex lyngbyei*) and bulrush (*Scirpus validus*) located just upstream of the Herring's House restoration site, was used in 2010 as a reference site for the macroinvertebrate sampling. No reference sites were sampled in 2015.

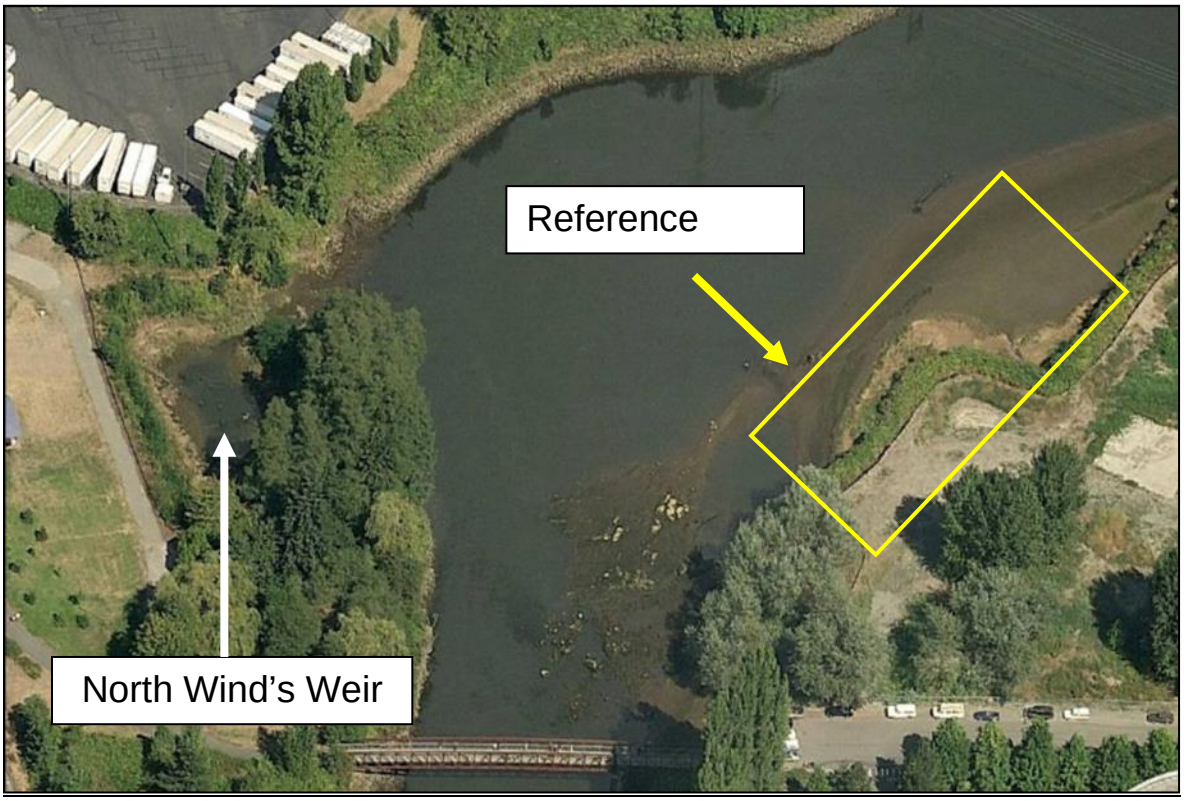

Figure 2. Location of reference sites for Hamm Creek, Kenco Marine, and North Wind's Weir.

Figure 3. Restored former reference sites for Hamm Creek, Kenco Marine, and North Wind's Weir (22 April 2011).

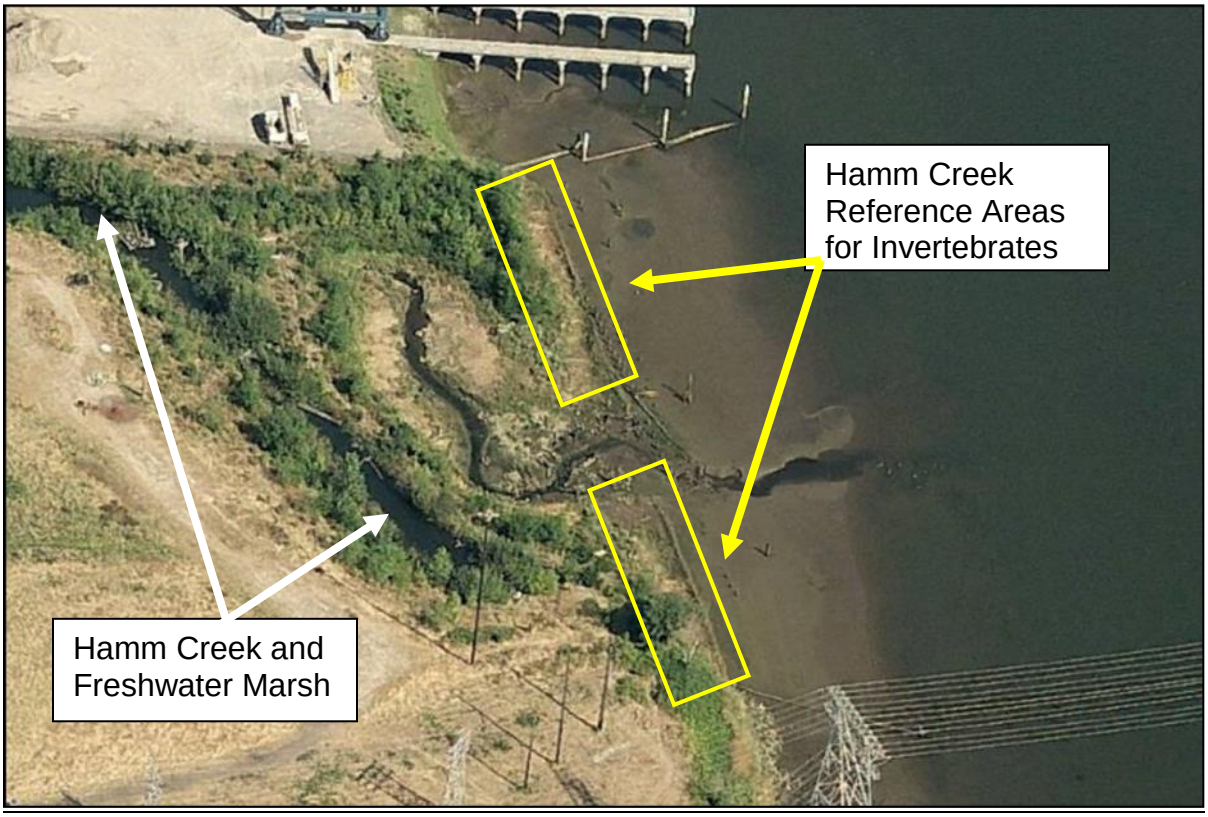

Figure 4. Location of invertebrate reference sites for Hamm Creek.

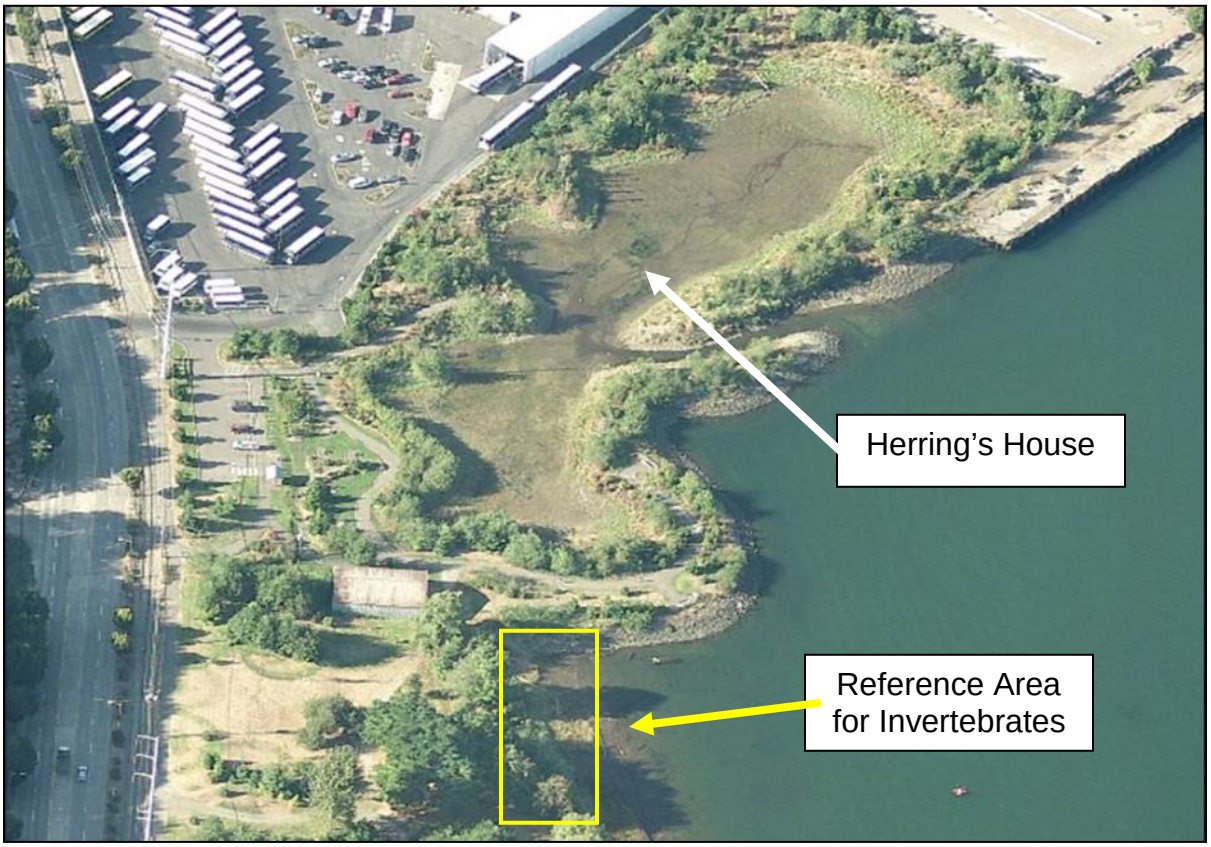

Figure 5. Location of invertebrate reference sites for Herring's House.

PHYSICAL CHARACTERISTICS

Intertidal Area (Physical Success Criterion 1)

Total restored area between an elevation of +12.0 ft. Mean Low Low Water (MLLW) and -2.0 ft. MLLW will be at least 90% of the target intertidal elevation for each site. Target intertidal area for the Hamm Creek is 4,047 m^2 (1.0 acre), Herring's House is 8,094 m^2 (2.0 acres), and North Wind's Weir is 4,047 m^2 (1.0 acre) (EBDRP 2000).

With the approval of the EBDRP Panel, monitoring for intertidal area was discontinued in 2015. Previously collected data indicated that all four sites have been stable since construction (USFWS 2012). While the Herring's House site met its numerical target, Hamm Creek and North Wind's Weir did not meet their respective numerical targets. A numerical target was never determined for the Kenco Marine site, but was determined to be stable in the previous monitoring period (USFWS 2012).

Tidal Regime (Physical Success Criterion 2)

Tidal amplitude, as determined by both timing and elevation of high and low tide events, is equivalent inside and outside of the project area (EBDRP 2000).

With the approval of the EBDRP Panel, monitoring for tidal regime was discontinued in 2005. Previously collected data indicated that tidal exchange between the restoration sites and Duwamish River estuary was unimpeded (USFWS 2004).

Slope Erosion (Physical Success Criterion 3)

No evidence of erosion that threatens property, infrastructure, or is otherwise unacceptable, is observed after a period of initial site stabilization (EBDRP 2000).

With the approval of the EBDRP Panel, monitoring of slope erosion at the Herrings House site was discontinued in 2015. Monitoring at the Hamm Creek, Kenco Marine, and North Wind's Weir sites did take place in 2015.

Methods

During site visits, visual inspections were made and photographs taken to detect any obvious bank erosion.

Results

Major erosion occurred at the Hamm Creek restoration site during winter storm events in 2006/2007. In addition, beaver dams along the creek had caused water to back up and create a new creek channel cutting through the berm that previously separated the freshwater and saltwater marshes (USFWS 2012). The site appears to be stabilizing, but the majority of the flow is now passing through the new channel that was created in 2006/2007 (Figures 6 and 7). The original main channel appears to flow only during high water events. No signs of erosion were seen at the Kenco Marine site (Figure 8). The North Wind's Weir site has remained stable since construction was completed (Figure 9).

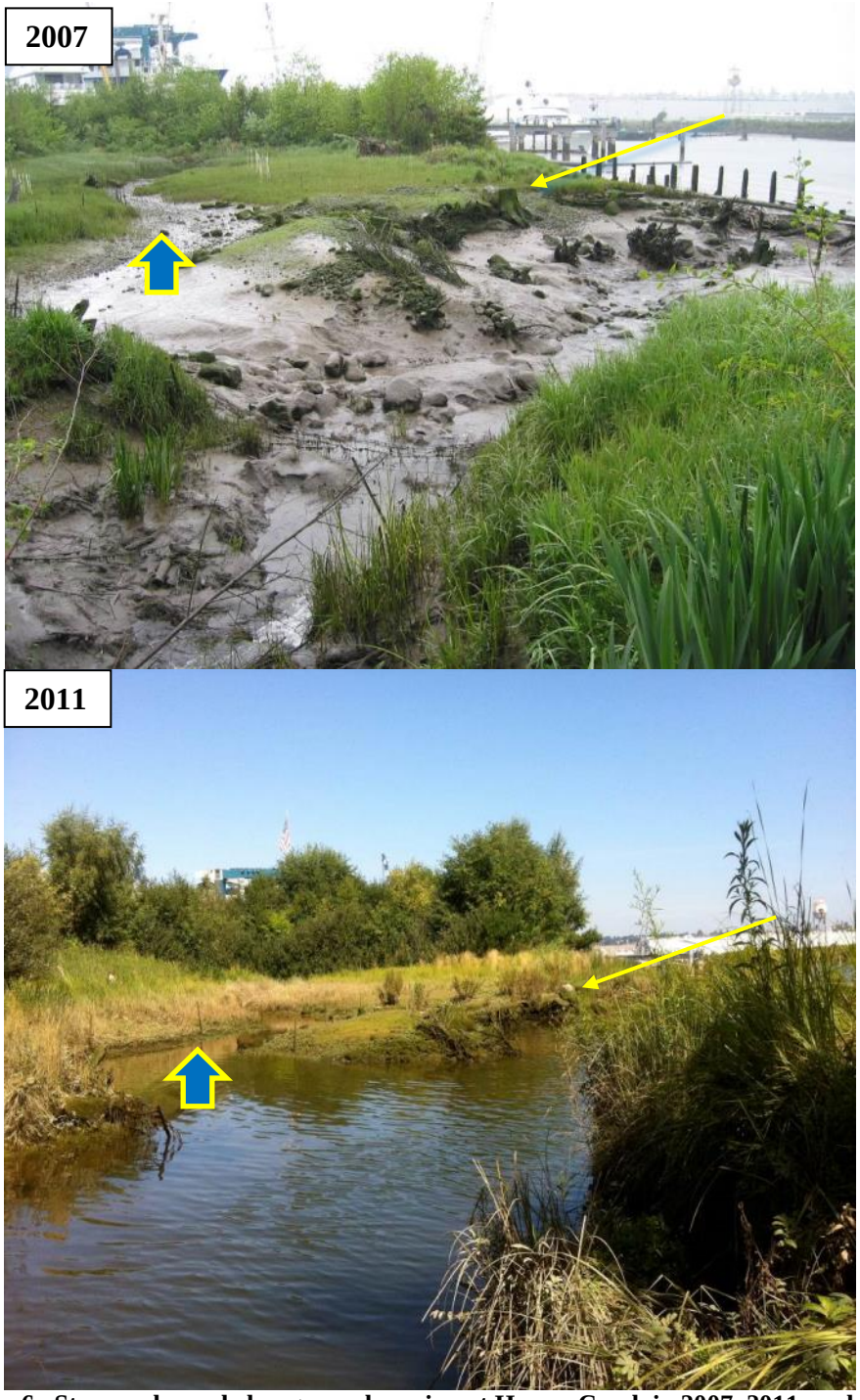

Figure 6. **Stream channel changes and erosion at Hamm Creek in 2007, 2011, and 2015. (Yellow arrow indicates same stump in all four photos and the blue arrow indicates the mouth of the original main channel)** (continued on next page)

Figure 6 (continued). Stream channel changes and erosion at Hamm Creek in 2007, 2011, and 2015. (Yellow arrow indicates same stump in all four photos and the blue arrow indicates the mouth of the original main channel)

Figure 7. Source of original main channel for Hamm Creek referenced in Figure 6 (indicated by blue arrow). The yellow arrow indicates present flow of water through former "freshwater wetland" (20 May 2015)

Figure 8. The Kenco Marine restoration site (14 July 2015)

Figure 9. The North Wind's Weir restoration site (14 July 2015)

Discussion
The Kenco Marine and North Wind's Weir sites appear to be stable. Hamm Creek appears to be stabilizing with time, but channel incision continues to take place. The Hamm Creek stream channel remains in the "new" channel it cut during the winter of 2006/2007.

Herring's House, North Wind's Weir, and Kenco Marine meet Physical Success Criterion 3. The Hamm Creek site has been a very dynamic site since completion. The majority of the site appears stable, though there is channel incision. Due to the channel incision it does not yet meet Physical Success Criterion 3.

Sediment Structure (Physical Success Criterion 4)
Over time, sites will accumulate fine-grained material and organic matter. This would be evidenced by a decrease in mean grain size, and an increase in organic carbon in surface sediments (EBDRP 2000).

With the approval of the EBDRP Panel, monitoring of sediment structure was discontinued after 2005 (USFWS 2012).

Sediment Quality (Physical Success Criterion 5*)*
No evidence of contamination due to sediment transport or on-site migration of upland contaminants to groundwater or aquatic areas (Herring's House only) (EBDRP 2000).

Originally, the monitoring plan allocated funds for the installation of three groundwater monitoring wells at the Herring's House site to evaluate the success of Criterion 5. Following discussions with their cooperators in 2003, the EBDRP Panel decided not to install monitoring wells at the Herring's House site; therefore, this criterion was not implemented.

BIOLOGICAL CHARACTERISTICS

Marsh Vegetation Establishment (Biological Success Criteria 1-3)
The areal extent of vegetation should be stable or increasing (Criterion 1), species composition of native wetland plants should be comparable to appropriate reference sites (Criterion 2) and plant vigor should be comparable to appropriate reference sites (Criterion 3) (EBDRP 2000).

Methods
Total Areal Extent (Criterion 1)
There are two sections to this criterion, total areal extent of the marsh and total area of individual marsh vegetation patches measuring only Lyngby's sedge and bulrush.

Total Areal Extent
Areal extent of marsh vegetation was surveyed only at the Kenco Marine restoration site in 2015. Following the border between riparian and marsh vegetation, the extent of marsh vegetation was mapped by walking a continuous line along the perimeter of the marsh vegetation area using a Trimble[2] Geo7X Global Positioning System (GPS) (±1-3 meter precision for each point with differential correction). The area of the resulting polygon was calculated using GIS/ArcView software. The Hamm

[2]For informational purposes only. In all instances, use of brand names in this report does not constitute endorsement by the U.S. Government.

Creek and Herring's House restoration sites met Biological Success Criterion 1 for areal extent in 2005 (USFWS 2006). The North Winds Weir restoration site met Biological Success Criterion 1 for areal extent in 2011 (USFWS 2012). With the approval of the EBDRP Panel, monitoring of these three restoration sites and associated reference sites for this criterion were discontinued in 2007 (USFWS 2008).

Marsh Vegetation Patches
For 2015, individual marsh vegetation patches (Lyngby's sedge and bulrush) were measured for each site by walking a continuous line along the perimeter of the marsh vegetation patch area using GPS (±1-3 meter precision for each point with differential correction). The area of the resulting polygon was calculated using GIS/ArcView software. The polygons ranged from 977.51 m^2 to 4.15 m^2 in size. This method was also used in 2001. The patches for each respective restoration site were summed to get the total area of marsh vegetation patches for each site.

Note: One uncorrected patch (out of 3 patches) measurement was used in the total area for North Wind's Weir because the GPS file had been corrupted and was unable to be corrected.

An alternate method (the direct measurement method) had been used in the past because the areas of some vegetation patches were too small to be effectively measured with GPS equipment due to resolution limitations. This method entails the measurement of each patch to the nearest 0.1 meter using a measuring tape to determine total area. This method was used in 2002, 2003, 2005, 2007, and 2010 (USFWS 2012). Riparian and marsh vegetation species observed at the restoration and reference sites are included in Appendix 1.

Species Composition (Criterion 2)
With the approval of the EBDRP Panel, Species Composition was not measured in 2015.

Plant Vigor (Criterion 3)
With the approval of the EBDRP Panel, Plant Vigor was not measured in 2015.

Results
Areal Extent (Criterion 1)
Total Areal Extent
Kenco Marine was the only site that was surveyed for marsh areal extent in 2015. The area was 0.06 acres in 2007, no data was taken in 2010, and 0.18 acres in 2015.

Marsh Vegetation Patches
The total area of marsh vegetation patches (Lyngby's sedge and bulrush) was estimated for the restoration sites (Table 2).

Table 2. Total area of marsh vegetation patches (Lyngby's sedge and bulrush) at the restoration sites by survey year.

	Marsh vegetation patches in m^2					
Site	**2002**	**2003**	**2005**	**2007**	**2010**	**2015**
Hamm Creek	1051	1014	1038	760	609	961
North Wind's Weir	-	182	469	413	341	347
Kenco Marine	-	-	-	16	103	542
Herring's House	279	395	587	723	549	1913

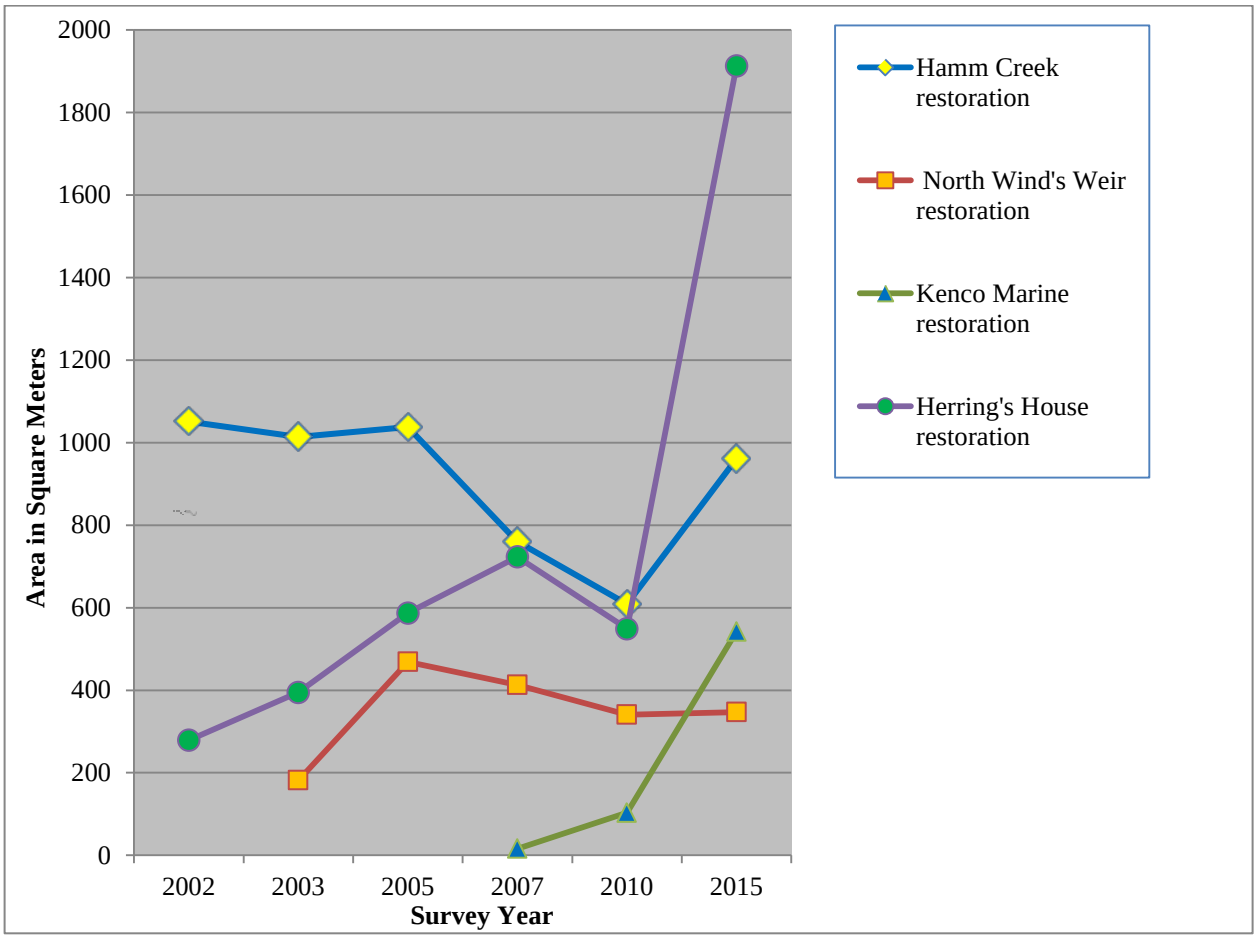

Figure 10. Comparison of the total area of marsh vegetation patches (Lyngby's sedge and bulrush) at the restoration sites by survey year.

Discussion

Areal Extent (Criterion 1)

Total Areal Extent

The areal extent of marsh vegetation at the Kenco Marine restoration site was 0.18 acre in 2015 and 0.06 acre in 2007. There was a threefold increase in the marsh areal extent in 8 years.

Marsh Vegetation Patches

The total area of marsh vegetation patches (Lyngby's sedge and bulrush) was measured for the restoration sites (Table 2). A different set of data observers, than in the past, took data in 2015. Data was also taken differently than in the recent past (see methods).

The Hamm Creek, Kenco Marine, and Herring's House restoration sites all had substantial increases in their total marsh vegetation patches (Figure 10). This could be due to the maturing of these sites. It could also be due to using a different method of measuring this variable (GPS versus the direct measuring method referenced above). The 2015 total marsh vegetation patches at the North Wind's Weir restoration site was almost identical to the 2010 data.

The areal extent of vegetation should be stable or increasing (Criterion 1).

The Kenco Marine restoration site showed a threefold increase in the marsh total areal extent in 8 years and therefore met Biological Success Criterion 1. At this time (2015), Hamm Creek, Kenco Marine, and

Herring's House restoration sites all have substantial increases in their total marsh vegetation patches (Figure 10) from 2010. Therefore, all three sites meet Biological Success Criterion 1 for marsh vegetation patches. The North Wind's Weir site also appears to be stable at this time (Figure 10); therefore it also meets Biological Success Criterion 1 for marsh vegetation patches.

Riparian Vegetation (Biological Success Criteria 4 and 5)

The areal extent of vegetation should be stable or increasing over time, and cover not less than 90% of the upland vegetated area of each project site at the end of 10 years, and invasive plant coverage should be minimal (Criterion 4). Survival of riparian plantings in each cover class (herb, shrub, and tree) should be at least 75% at the end of 3 years (Criterion 5) (EBDRP 2000).

Methods

Areal Extent/Percent Cover/Invasives (Criterion 4)

To estimate the areal extent of upland riparian vegetation, the perimeters of riparian vegetation at each site were mapped using the Trimble[3] Geo7X Global Positioning System (GPS) (±1-3 meter precision for each point with differential correction). The area of the resulting polygon was calculated using GIS/ArcView software in the same manner as for areal extent of marsh vegetation. With the approval of the EBDRP Panel, measuring areal extent of upland riparian vegetation was discontinued in 2015 at the Hamm Creek and Herring's House restoration sites. Areal extent of upland riparian vegetation was only measured at the North Wind's Weir and Kenco Marine restoration sites in 2015.

To assess the percent cover of herbaceous, shrub, and tree layers, surveys were conducted in the riparian vegetation zone along transects established in 2001 for Hamm Creek and Herring's House restoration sites (USFWS 2012). Vegetation transects at the North Wind's Weir site were established in 2003 (USFWS 2012). Vegetation transects at the Kenco Marine site were established in 2007 (USFWS 2012). The first sample plot of each transect was located at a random distance (1-9 meters) from the starting point and subsequent plots were placed along that transect using that determined interval. The herbaceous layer was sampled using a 0.25 m^2 quadrat and the shrub and tree layers were sampled using a 3-meter radius circular plot. Percent cover was visually estimated to the nearest 5 percent for each species. Anything less than 5 percent was recorded as 2.5 percent.

For each site, mean percent cover values were calculated for all layers. For each layer per site, the values were calculated by calculating the mean of the cover values of all species per plot. The mean of all plots were then calculated per transect. Finally, the mean of all transects were calculated per site. Because each layer's estimate was independent of the other vegetation layers and the size of herbaceous sample plots was smaller than the other layers, percent cover cannot be summed across layers.

Nonnative invasive species were sampled as a layer using a 3-meter radius circular plot. Percent cover was visually estimated to the nearest 5 percent for each species. Anything less than 5 percent was recorded as 2.5 percent. For each site, mean percent cover values were calculated as with the other vegetation layers. The monitoring plan (EBDRP 2000) identified three nonnative species of special concern as target species: Himalayan blackberry (*Rubus discolor*), Scot's broom (*Cytisus scoparius*), and Japanese knotweed (*Polygonum cuspidatum*). Two of these species (Himalayan blackberry and Scot's broom) were encountered at the sites. Other nonnative species were present and were included in the all nonnative percent cover estimates in each plot.

[3]For informational purposes only. In all instances, use of brand names in this report does not constitute endorsement by the U.S. Government.

Note: The "percent cover" may have been incorrectly calculated throughout the study. Total or absolute percent cover cannot be calculated by assigning a percent cover value to individual species, because species percent cover may or may not overlap (Schulz et al. 2009). Total or absolute percent cover can take values between 0 and 100 percent. Combined percent cover is the sum of the cover values for different plant species (Wilson 2009). Combined percent cover can take values that exceed 100 percent (Wilson 2009). Therefore, it appears this study has been measuring "combined cover" throughout the study.

Survival (Criterion 5)
With the approval of the EBDRP Panel, survival of shrubs and trees was not measured in 2015.

Results
Areal Extent/Percent Cover/Invasives (Criterion 4)
The total areal extent of riparian vegetation at each restoration site was estimated and is provided in Table 3. The areal extent of riparian vegetation increased at both the North Wind's Weir and Kenco Marine restoration sites when compared to past data (Table 3).

Because of routine maintenance and invasive species control at the restoration sites, interpretation of vegetation coverage data must be considered carefully. Other entities (e.g., King County Parks, Seattle City Parks, and People for Puget Sound) have spent much effort controlling nonnative plants, removing dead trees and shrubs, and planting new vegetation in the riparian areas. These actions are beneficial and necessary to the long-term health of the site. However, it is important to consider these actions when interpreting our results. The results show the status of the restoration sites at a single point in time and are not a measure of natural succession over time.

Table 3. Estimates of riparian areal extent at restoration sites by survey year.

	Riparian areal extent in m^2 (acres)						
Site Name	**2001**	**2002**	**2003**	**2005**	**2007**	**2011**	**2015**
Hamm Creek	2,104 (0.5)	2,648 (0.7)	3,049 (0.8)	3,237 (0.8)	2,478 (0.6)	3,260 (0.8)	-
North Wind's Weir	-	-	1,285 (0.3)	1,261 (0.3)	1,176 (0.3)	1,383 (0.3)	1762 (0.4)
Herring's House	9,598 (2.4)	8,706 (2.2)	9,705 (2.4)	8,912 (2.2)	8,685 (2.2)	10,056 (2.5)	-
Kenco Marine	-	-	-	-	854 (0.2)	920 (0.2)	1498 (0.4)

Percent cover data was not measured at Hamm Creek because the vegetation was too thick and too tall to gain access. Data was collected at the remaining three restoration sites. At the North Wind's Weir site, percent cover decreased for the herbaceous and shrub layers, but the tree layer increased. At the Herring's House site, percent cover increased for the tree layer, but decreased for the herbaceous and shrub layers. At Kenco Marine, percent cover decreased for the herbaceous and tree layers, but increased for the shrub layer.

Himalayan blackberry and Scot's broom were observed in the transect plots and are two of the three nonnative invasive plant species designated as target species. To date, none of the known knotweed species has been observed at any of the restoration sites. Some additional invasive species of note that

were observed include: yellow flag iris (observed at the Hamm Creek and North Wind's Weir restoration sites and herb-Robert (observed at the Herring's House restoration site). The percent cover of target species was estimated separately and also combined with other non-target species for an estimate of all nonnative species in each plot. Percent cover of the nonnative target species increased at Kenco Marine and decreased at North Wind's Weir and Herring's House. The percent cover for all nonnatives increased at Herring's House, North Wind's Weir and Kenco Marine (Table 4). Percent cover data was not measured at Hamm Creek because the vegetation was too thick and too tall to gain access. Riparian and marsh vegetation species observed at the restoration and reference sites are included in Appendix 1.

Table 4. **Independent estimates of mean percent cover for herbaceous, shrub, tree, and nonnative riparian vegetation layers at restoration sites by survey year.**

		Percent Cover of Riparian Vegetation Layers				
					Nonnative	
Site	**Year**	**Herbaceous** (0.25m^2 quadrat)	**Shrub** (3m radius plot)	**Tree** (3m radius plot)	**Target spp** (3m radius plot)	**All species** (3m radius plot)
Hamm Creek	2001	28	7	11	1.5	4
	2002	71	15	25	6	18
	2003	76	8	30	5	21
	2005	63	20	26	5	14
	2007	71	85	47	10	12
	2010	26	44	48	22	24
	2015	-	-	-	-	-
North Wind's Weir	2003	36	30	38	3	21
	2005	55	14	78	2	16
	2007	36	35	73	3	8
	2010	60	33	52	5	5
	2015	2	14	75	1	45
Herring's House	2001	44	27	26	2	5
	2002	50	16	35	4	17
	2003	56	16	57	3	18
	2005	51	11	35	8	17
	2007	75	7	54	5	6
	2010	22	15	38	8	10
	2015	6	7	63	7	42
Kenco Marine	2007	82	7	19	2	7
	2010	8	20	86	2	4
	2015	2	31	83	3	5

Discussion

Areal Extent/Percent Cover/Invasives (Criterion 4): The areal extent of vegetation should be stable or increasing over time, and cover not less than 90% of the upland vegetated area of each project site at the end of 10 years, and invasive plant coverage should be minimal (Criterion 4).

Areal extent of upland riparian vegetation was only measured at the North Wind's Weir and Kenco Marine restoration sites in 2015. As previously noted, the areal extent of riparian vegetation increased at both restoration sites. The riparian areal extent for both North Wind's Weir and Kenco Marine restoration sites met Criterion 4 for areal extent in 2015.

There are no vegetation coverage goals given in the monitoring plan (EBDRP 2000) for Year 15, and no monitoring was planned post Year 10. Vegetation coverage goals for Year 10 are given in the monitoring plan (EBDRP 2000). The herbaceous layer goal is that the percentage may decline as other layers mature, provided not more than 10% bare ground by Year 10 (EBDRP 2000). All restoration sites, except Hamm Creek because data was not taken at that site, had greater than 10 percent bare ground in the herbaceous layer and therefore did not meet the projected Year 10 goal in Year 15 (see Table 4). The shrub layer goal is expected to be greater than 80 percent by year 10 (EBDRP 2000). The shrub layers at all sites (except Hamm Creek because data was not taken at that site), did not meet the projected Year 10 goal in Year 15 (see Table 4). The projected goal for the tree layer is 70 percent coverage by Year 10 (EBDRP 2000). The percent cover of trees at Herring's House (63%) did not meet the projected Year 10 goal in Year 15 (see Table 4). The percent cover of trees at North Wind's Weir (75%) and Kenco Marine (83%) did meet the projected Year 10 goal in Year 15 (see Table 4). Anecdotally, the Hamm Creek restoration site also met the projected Year 10 goal in Year 15, due to the fact that the vegetation was too thick and too tall to even gain access to measure the percent cover.

Note: In 2015, the Hamm Creek and Herring's House restoration sites were in Year 15 of the monitoring project timeline. North Wind's Weir was in Year 13 and Kenco Marine was in Year 9 of the monitoring project timeline.

Two of the three nonnative invasive species identified as target species, Himalayan blackberry and Scot's broom, were present at the sites. The percent coverage of these target species at the sites measured ranged from 1 to 7 percent. Many other nonnative species were also present at the sites. When all nonnative species in the surveys were included, the estimated percent cover of nonnative species at the restoration sites measured ranges between 5 and 45 percent. This is probably due to the important and extensive work done by other entities to remove nonnative and invasive species at the sites. The extensive work to control nonnative species provides evidence that continued maintenance of the sites is important to preserve and provide the best habitat possible.

The goal for Biological Success Criterion 4 (nonnative species) is less than 20 percent nonnative species by Year 10 (EBDRP 2000). This goal was only met at the Kenco Marine restoration site (5%). The goal was not met at North Wind's Weir (45%) or Herring's House (42%). Nonnative percent cover for Hamm Creek could not be determined because the vegetation was too thick and tall to gain access.

Bird Use (Biological Success Criterion 6)
Use of the restoration sites and the area within 50 meters of the site by indigenous/native bird species should be comparable to that of the appropriate reference sites (EBDRP 2000).

With the approval of the EBDRP Panel, none of the sites were monitored for bird use after 2007. However, from the data collected in previous years, the number of bird species observed at the restoration sites appeared to be more comparable to numbers seen at the reference sites with each successive year. Therefore, the restoration sites meet Biological Success Criterion 6.

Fish Presence/Access (Biological Success Criterion 7)
Estuarine fishes will access the project sites. Juvenile salmonid presence within the project sites should be comparable to that of appropriate reference sites at the end of ten years (EBDRP 2000).

With the approval of the EBDRP Panel, none of the sites were monitored for fish presence/access after 2007. The capture of salmonids and non-salmonids in all previous years indicates that the restoration

sites are accessible to these fishes and juvenile salmonid presence is comparable to the appropriate reference sites. Therefore, the restoration sites meet Biological Success Criterion 7.

Invertebrate Prey Resource Production (Biological Success Criteria 8)
Production of invertebrate prey taxa known to be important to juvenile salmonids should be comparable to that of appropriate reference sites at the end of ten years (EBDRP 2000).

With the approval of the EBDRP Panel, the invertebrate monitoring was discontinued in 2015.

SUMMARY

The status of restoration sites in meeting the Physical and Biological Success Criteria are summarized by criterion and the status by survey year in Table 5 and Table 6. The monitoring plan, EBDRP (2000), allows for adaptive management of monitoring at the sites as outlined in the following statements: *"Elimination of Monitoring Tasks. It is possible that in the future, the Elliott Bay / Duwamish Restoration Program Panel might reach consensus that specific success criteria have been met, and that associated monitoring tasks could cease. Similarly, it could be determined that a monitoring task was not returning useful information, and therefore not worth the expense of continuation."* Monitoring tasks and results were evaluated based on these statements and options are given for adapting monitoring activities to reflect the current status of the sites.

PHYSICAL CHARACTERISTICS

Intertidal Area (Physical Success Criterion 1)
Total restored area between an elevation of +12.0 ft. Mean Low Low Water (MLLW) and -2.0 ft. MLLW will be at least 90% of the target intertidal elevation for each site. Target intertidal area for the Hamm Creek is 4,047 m^2 (1.0 acre), Herring's House is 8,094 m^2 (2.0 acres), and North Wind's Weir is 4,047 m^2 (1.0 acre) (EBDRP 2000).

With the approval of the EBDRP Panel, monitoring for intertidal area was discontinued in 2015.

Tidal Regime (Physical Success Criterion 2)
Tidal amplitude, as determined by both timing and elevation of high and low tide events, is equivalent inside and outside of the project area (EBDRP 2000).

With the approval of the EBDRP Panel, monitoring for tidal regime was discontinued in 2005.

Slope Erosion (Physical Success Criterion 3)
No evidence of erosion that threatens property, infrastructure, or is otherwise unacceptable, is observed after a period of initial site stabilization (EBDRP 2000).

With the approval of the EBDRP Panel, monitoring of slope erosion at the Herrings House site was discontinued in 2015, but did meet Criterion 3 in 2010. The Kenco Marine and North Wind's Weir sites appear to be stable and met Criterion 3 in 2015. Hamm Creek appears to be stabilizing with time, but channel incision continues to take place, therefore the Hamm Creek site did not meet Criterion 3 in 2015.

Table 5. Success of Hamm Creek and Herring's House restoration sites to meet physical and biological criteria targets by monitoring task and survey year (2001 – 2015).

			Hamm Creek							Herring's House						
	Task	**Target**	**01**	**02**	**03**	**05**	**07**	**10**	**15**	**01**	**02**	**03**	**05**	**07**	**10**	**15**
Physical Criteria (1-3)																
1	**Intertidal Area**	numerical target	N	N	N	N	.	.	.	Y	Y	Y	Y	.	.	.
2	**Tidal Regime** (years 1 & 5 only)	site equivalent with river	Y	Y	.	.	.	.	.	Y	Y	.	.	.	.	.
3	**Slope Erosion**	minimal erosion	N[1]	N	N	N	N	N	N	N[1]	Y	Y	Y	Y	Y	.
Biological Criteria (1-8)																
	Marsh															
1	areal extent	stable or increasing size	.	N[1]	N	Y	.	.	.	.	N[1]	Y	Y	.	.	.
1	patch size	stable or increasing size	.	N[1]	Y	Y	N	N	Y	.	N[1]	Y	Y	Y	N	Y
2	species composition	compare to reference site	N	N	N[2]	N[2]	Y	.	.	N	N	N[2]	N[2]	N[2]	.	.
3	plant vigor / shoot height	compare to reference site	N	N	N[2]	N[2]	N	.	.	N	N	N[2]	N[2]	N[2]	.	.
3	plant vigor / shoot density	compare to reference site	N	N	N[2]	N[2]	N	.	.	N	N	N[2]	N[2]	N[2]	.	.
	Riparian															
4	areal extent	stable or increasing size	Y	Y	Y	Y	N	Y	.	Y	Y	Y	Y	Y	Y	.
4	% cover by layer	numerical target / layer	N[1]	N	N	N	Y	Y[4]	NM	N[1]	N	N	N	Y[3]	N	N
5	survival (yrs. 1-3 only)	> 75% survival	Y	Y	Y	.	.	.	.	Y	Y	Y	.	.	.	.
	Birds															
6	presence/absence	compare to reference site	Y	Y	Y	Y	.	.	.	Y	Y	Y	Y	.	.	.
	Fish															
7	presence/absence	compare to reference site	Y	Y	Y	Y	.	.	.	Y	Y	Y	Y	.	.	.
	Inverts															
8	presence/absence	compare to reference site	N	N	N	N	Y	.	.	N	N	N	N	N[3]	.	.

N[1] First year of data; no comparison possible
N[2] Reference site compromised by disturbance
N[3] Herring's House site does have an abundance of nereid polychaetes, a known prey of juvenile Chinook salmon.
Y[3] Yes for herbaceous and tree (No for shrub layer)
Y[4] Yes for herbaceous (No for shrub and tree layers)
NM - not measured

Table 6. Success of North Wind's Weir and Kenco Marine restoration sites to meet physical and biological criteria targets by monitoring task and survey year (2001 – 2015).

	Task	Target	North Wind's Weir							Kenco Marine						
			01	02	03	05	07	10	15	01	02	03	05	07	10	15
Physical Criteria (1-3)																
1	**Intertidal Area**	numerical target	.	.	N	N	.	.	.	.	.	.	.	N	.	.
2	**Tidal Regime** (years 1 & 5 only)	site equivalent with river	.	.	Y	.	.	.	.	.	.	.	.	.	.	.
3	**Slope Erosion**	minimal erosion	.	.	N[1]	Y	Y	Y	Y	.	.	.	.	Y	Y	Y
Biological Criteria (1-8)																
	Marsh															
1	areal extent	stable or increasing size	.	.	N[1]	Y	Y	Y	.	.	.	.	.	N[1]	Y	Y
1	patch size	stable or increasing size	.	.	N[1]	Y	Y	N	Y	.	.	.	.	N[1]	Y	Y
2	species composition	compare to reference site	.	.	N[2]	N[2]	Y	.	.	.	.	.	.	N[1]	.	.
3	plant vigor / shoot height	compare to reference site	.	.	N[2]	N[2]	N	.	.	.	.	.	.	N[1]	.	.
3	plant vigor / shoot density	compare to reference site	.	.	N[2]	N[2]	N	.	.	.	.	.	.	N[1]	.	.
	Riparian															
4	areal extent	stable or increasing size	.	.	Y	Y	N	Y	Y	.	.	.	.	N[1]	Y	Y
4	% cover by layer	numerical target / layer	.	.	N[1]	N	Y	Y[3]	Y[5]	.	.	.	.	N[1]	Y[5]	Y[5]
5	survival (yrs. 1-3 only)	> 75% survival	.	.	Y	.	.	.	.	.	.	.	.	N[1]	Y	.
	Birds															
6	presence/absence	compare to reference site	.	.	Y	Y	.	.	.	.	.	.	.	.	.	.
	Fish															
7	presence/absence	compare to reference site	.	.	Y	Y	.	.	.	.	.	.	.	.	.	.
	Inverts															
8	presence/absence	compare to reference site	.	.	N	N	Y	.	.	.	.	.	.	Y	.	.

N[1] First year of data; no comparison possible
N[2] Reference site compromised by disturbance
Y[3] Yes for herbaceous and tree (No for shrub)
Y[5] Yes for tree (No for herbaceous and shrub)

Sediment Structure (Physical Success Criterion 4)
Over time, sites will accumulate fine-grained material and organic matter. This would be evidenced by a decrease in mean grain size, and an increase in organic carbon in surface sediments (EBDRP 2000).

With the approval of the EBDRP Panel, monitoring of sediment structure was discontinued after 2005.

Sediment Quality (Physical Success Criterion 5)
No evidence of contamination due to sediment transport or on-site migration of upland contaminants to groundwater or aquatic areas (Herring's House only) (EBDRP 2000).

Originally, the monitoring plan allocated funds for the installation of three groundwater monitoring wells at the Herring's House site to evaluate the success of Physical Success Criterion 5. Following discussions with their cooperators in 2003, the EBDRP Panel decided not to install monitoring wells at the Herring's House site; therefore, this criterion was not implemented.

BIOLOGICAL CHARACTERISTICS

Marsh Vegetation Establishment (Biological Success Criteria 1-3)
The areal extent of vegetation should be stable or increasing (Criterion 1), species composition of native wetland plants should be comparable to appropriate reference sites (Criterion 2) and plant vigor should be comparable to appropriate reference sites (Criterion 3) (EBDRP 2000). ***Due to the discontinuation of monitoring reference sites, it is difficult to ascertain whether criterion 2 and 3 have been met for 2010 or 2015.***

<u>Areal Extent – (Criterion 1)</u>
With the approval of the EBDRP Panel, areal extent of marsh vegetation was only collected at the Kenco Marine site. Criterion 1 was met at this site in 2015. Hamm Creek, Kenco Marine, and Herring's House restoration sites all had substantial increases in their total marsh vegetation patches from 2010. Therefore, all three sites met Biological Success Criterion 1 for marsh vegetation patches. The North Wind's Weir site appears to be stable at this time; therefore it also has met Biological Success Criterion 1 for marsh vegetation patches.

<u>Species Composition – (Criterion 2)</u>
With the approval of the EBDRP Panel, monitoring for plant vigor was discontinued in 2015.

<u>Plant Vigor – (Criterion 3)</u>
With the approval of the EBDRP Panel, monitoring for plant vigor was discontinued in 2015.

Riparian Vegetation (Biological Success Criteria 4 and 5)
The areal extent of vegetation should be stable or increasing over time, and cover not less than 90% of the upland vegetated area of each project site at the end of 10 years, and invasive plant coverage should be minimal (Criterion 4). Survival of riparian plantings in each cover class (herb, shrub, and tree) should be at least 75% at the end of 3 years (Criterion 5) (EBDRP 2000).

<u>Areal Extent/Percent Cover/Invasives – (Criterion 4)</u>
Areal extent of upland riparian vegetation was only measured at the North Wind's Weir and Kenco Marine restoration sites in 2015. The areal extent of riparian vegetation increased at both restoration sites. The riparian areal extent for both North Wind's Weir and Kenco Marine restoration sites met Criterion 4 for areal extent.

There are no vegetation coverage goals given in the monitoring plan for Year 15, and no monitoring was planned post Year 10. All restoration sites, except Hamm Creek (data not collected), had greater than 10 percent bare ground in the herbaceous layer and therefore did not meet the projected goal. The shrub layers at all sites, except Hamm Creek (data not collected), did not meet the projected goal. The percent cover of trees at Herring's House did not meet the projected goal. The percent cover of trees at North Wind's Weir and Kenco Marine did meet the projected goal. Anecdotally, the Hamm Creek restoration site also met the projected goal for tree cover, due to the fact that the vegetation was too thick and tall to gain access to measure percent cover.

The goal for Biological Success Criterion 4 (nonnative species) is less than 20 percent nonnative species. This goal was only met at the Kenco Marine restoration site (5%). The goal was not met at North Wind's Weir (45%) or Herring's House (42%). Nonnative percent cover for Hamm Creek could not be determined because vegetation was too thick and tall to gain access.

<u>Survival – (Criterion 5)</u>
Riparian plant survival surveys were scheduled for Years 1-3 only. Monitoring during the first 3 years indicated all restoration sites had at least 75 percent survival plantings in each cover class (herb, shrub, trees). Biological Success Criteria 5 has been met and monitoring tasks ceased after Year 3 for all sites with the exception of the Kenco Marine site which met Criterion 5 in 2010 (USFWS 2012).

Bird Use (Biological Success Criterion 6)
Use of the restoration sites and the area within 50 meters of the site by indigenous/native bird species should be comparable to that of the appropriate reference sites (EBDRP 2000).

With the approval of the EBDRP Panel, it was agreed that biological Success Criterion 6 for bird use had been met and bird use monitoring was concluded following the 2005 monitoring.

Fish Presence/Access (Biological Success Criterion 7)
Estuarine fishes will access the project sites. Juvenile salmonid presence within the project sites should be comparable to that of appropriate reference sites at the end of ten years (EBDRP 2000).

Biological Success Criterion 7 for fish access/presence was determined to have been met following the 2005 monitoring season, and with the approval of the EBDRP Panel fish access/presence monitoring was concluded following the 2005 monitoring season.

Invertebrate Prey Resource Production (Biological Success Criteria 8)
Production of invertebrate prey taxa known to be important to juvenile salmonids should be comparable to that of appropriate reference sites at the end of ten years (EBDRP 2000).

With the approval of the EBDRP Panel, the invertebrate monitoring was discontinued in 2015.

RECOMMENDATIONS

Recommendations provided in the previous four monitoring reports remain appropriate to repeat in this year's report and are highlighted below. Common themes or recommendations of importance are italicized and underlined.

Review of Recommendations from the past four reports:

2003 Report:

RECOMMENDATIONS

- **General recommendations for cooperative action at the sites:** In addition to the monitoring activities being conducted as part of the Elliott Bay/Duwamish Restoration Program (EBDRP), other monitoring, restoration, and construction activities are being conducted near or on the restoration and reference sites. These activities are being conducted by a variety of different entities in the Duwamish River Estuary and include volunteer monitoring, research, and management of the sites. *We recommend that the EBDRP Panel include a discussion in one of their meetings on ways to ensure more effective coordination with the various entities working in the area.* A process should be identified a minimum of 3 months prior to the start of the 2005 monitoring activities for the EBDRP.

- **Loss of vegetation reference sites:** The EBDRP Panel needs to discuss the continued monitoring of the reference sites a minimum of 3 months prior to the start of the 2005 monitoring activities. The Herring's House vegetation reference site was planted and fenced this year by another entity. The additional plantings of *Carex* and *Scirpus* species will impede our ability to distinguish future expansion of the original vegetation patches from the new plantings. The Hamm Creek and North Wind's Weir vegetation reference site is scheduled for construction activity from the restoration of the adjoining uplands of the site by the U.S. Army Corps of Engineers. Because of these alterations to the reference site, the EBDRP Panel needs to decide if they want to continue the monitoring of these sites or identify new reference sites.

- **Immediate action needed:** *A focused, coordinated effort to control nonnative vegetation is needed at the restoration sites.* Of particular concern is the presence of perennial pepperweed, which has been observed at two sites. Control of seed production of this Class B noxious weed (WSNWCB 2016) is required in King County, and may be a recurring problem due to the presence of this plant on adjacent property. Himalayan blackberry and Scot's broom have also been identified as problematic because of their spread.

2005 Report:

GENERAL RECOMMENDATIONS

Coordination needed: In addition to the EBDRP monitoring activities, other monitoring, research, vegetation management, restoration, and construction activities were being conducted near or on the restoration and reference sites. These activities are being conducted in the Duwamish River estuary by a variety of different entities and volunteer groups. More effective coordination with the various entities working in the area is needed to aide information exchange and decrease overlap of effort or possible conflicting activities. *We recommend to the EBDRP Panel that a primary contact be selected*

to coordinate all activities at the EBDRP sites. The contact person would maintain communication and coordination with the representative for each site's landowner (or responsible entity), each entity known to be working at the site, and the EBDRP Panel.

Vegetation maintenance: Success of the restoration sites in partially meeting vegetation goals appears to be due to removal of nonnative and invasive species by other entities and volunteers. A significant effort has been applied to controlling invasive species, planting additional vegetation, replacing dead plants, removing trash and debris, and constructing erosion control measures. *Continued site stewardship is expected to remain a vital part of maintaining valuable restored habitats at the sites.* With many different entities working on site maintenance, it is difficult to quantify the effort and resources needed to accomplish this work. Quantifying the effort devoted to the sites by maintenance crews, volunteer organizations, and others would aide in assessing restoration success and current status of the site. *We recommend to the Panel that a process be developed to improve coordination between monitoring and site stewardship activities enabling increased complementary efforts.* The capacity of the land management entity and volunteer groups to support continued site stewardship should be evaluated and any gaps identified. *If unallocated funds are available, the Panel may need to consider directing these resources towards support of future site stewardship activities.*

Change in monitoring design for future projects: The monitoring plan states that one goal of the program is to provide "a useful tool to others interested in estimating habitat restoration project monitoring costs" (EBDRP 2000). *The original design of the monitoring plan (EBDRP 2000) was not sufficient to provide adequate sample sizes to effectively evaluate success of monitoring criteria and the plan underestimated the costs associated with many of the monitoring tasks in this project.* Large standard errors were detected after analysis of the data from the first few years of the project. Increasing sample sizes could lower the standard error; however, large increases in sample sizes could not be implemented due to budgetary constraints. For future efforts we recommend that fewer criteria be monitored with more intensity. Concentrating funds and effort on a few important criteria would enable the statistical evaluation of criterion success and provide more reliable conclusions. This would also aide restoration projects in remaining within the limited budgets often associated with monitoring projects.

2007 Report:

RECOMMENDATIONS

Coordination

Other activities including: monitoring and research efforts, vegetation management, restoration and construction activities on or near the four restoration sites and their associated reference sites continue to compromise, at least in part, the ability of this monitoring effort to generate the intended information originally set forth by the EBDRP Panel in 2000. For example, well-intentioned restoration and vegetation management activities on the current restoration and reference sites typically are not coordinated with this monitoring effort or considered prior to their implementation. *As noted in previous years, effective coordination using a primary contact was recommended as one option for information exchange and to decrease the potential for overlap of effort or conflicting activities at these sites. The EBDRP Panel should consider from this point forward the usefulness of the data currently collected by this monitoring program and make the necessary changes to best utilize this effort for 2010 and beyond.* We believe the time to begin these discussions is well in advance of the next monitoring period and with the Panel's approval, we will provide a more detailed set of recommendations on how to best collect the most meaningful information with regard to the four restoration sites.

Site Stewardship

Success of the restoration sites in partially meeting vegetation goals continues to be attributed to, at least in part, the removal of nonnative and invasive species by other entities and volunteers. A significant effort has been applied to controlling invasive species, planting additional vegetation, replacing dead plants, removing trash and debris, and constructing erosion control measures. *Continued site stewardship remains a vital part of maintaining valuable restored habitats at these sites.* However, with many different entities working on site maintenance, it is difficult to quantify the effort and resources expended. Quantifying the effort devoted to the sites by maintenance crews, volunteer organizations, and others would help in assessing the level of effort being placed towards the success of the restoration sites. *We continue to support the development of a process that improves coordination between monitoring and site stewardship activities enabling increased complementary efforts and overall site success.* The capacity of the land management entity and volunteer groups to support continued site stewardship needs to be evaluated and any gaps resolved.

Unallocated and/or additional funds should be directed towards supporting site stewardship activities with a specific focus on controlling invasives. Hamm Creek for example, should be evaluated for its extent of invasives such as the common water reed (*Phragmities communis*), and yellow flag iris (*Iris pseudacorus*) while populations of these species are still relatively small and manageable. Common water reed was listed in the EBDRP monitoring plan as an invasive species of special concern.

As mentioned in the report, other invasive species were noted during the 2007 monitoring event besides the four invasive plant species of special concern listed in the EBDRP monitoring plan. These species included yellow flag iris and perennial pepperweed (*Lepidium latifolium*). Yellow flag iris is listed as a Class C noxious weed and perennial pepperweed is listed as a Class B weed in Washington State (WSNWCB 2016). It will be critical for future success of these sites to control occurrences of these invasives while they are relatively small in number and while control methods have a negligible impact on site restoration efforts.

Monitoring Changes

The monitoring plan states that one goal of the program is to provide "a useful tool to others interested in estimating habitat restoration project monitoring costs" (EBDRP 2000). *The original design of the monitoring plan (EBDRP 2000) was not sufficient to provide adequate sample sizes to effectively evaluate success of monitoring criteria and the plan underestimated the costs associated with many of the monitoring tasks in this project.* Large standard errors were detected after analysis of the data from the first few years of the project. We noted in our previous reports that increasing sample sizes could lower the standard error but recognized large increases in sample sizes would not be within the budget framework originally conceived for this effort. Therefore, by concentrating funds on fewer criteria to monitor with more intensity during 2007, we have established a better prospect of reaching more reliable conclusions with better statistical evaluation when appropriate.

In addition, we believe the time period in which to collect the data with regards to vegetation should be re-evaluated. Collecting data for riparian vegetation at the same time as marsh vegetation may not take into account the differences in growing season for each vegetation type and therefore may not be returning the best result for the data collected. We are currently evaluating this with regard to Biological Success Criteria 5 for riparian plant survival for the newly constructed Kenco Marine site.

We also advocate the use of aerial photography for each site and believe this information would contribute in a more meaningful way in the overall determination of how well the sites have done from year to year both in physical attributes as well as biological. Photographic comparisons are often

useful in determining larger scale alterations or successional progressions over time.

2010 Report:

RECOMMENDATIONS

In conjunction with the submission and approval of this report by the EBDRP Panel, we would like to begin discussions on concluding the monitoring effort and producing a comprehensive final monitoring report in 2015. *We would like the EBDRP Panel to consider the usefulness of the data currently being collected by this monitoring program and ways to best utilize remaining funds prior to the next monitoring period presently scheduled for 2015.* Some new objectives to consider in 2015 are producing a final summary report of all the monitoring years since 2000, changing the monitoring protocol for the last year of data collection, and developing a stewardship program for the monitored sites.

Coordination

As in previous years, other activities including: monitoring and research efforts, vegetation management, restoration and construction activities on or near the four restoration sites and their associated reference sites continue to compromise, at least in part, the ability of this monitoring effort to generate the intended information originally set forth by the EBDRP Panel in 2000. For example, well - intentioned restoration and vegetation management activities on the current restoration and reference sites typically are not coordinated with this monitoring effort. *As noted in previous years, effective coordination using a primary contact was recommended as one option for information exchange and to decrease the potential for overlap of effort or conflicting activities at these sites.*

Monitoring Changes

We also continue to advocate the use of aerial photography for each site. We believe this information would contribute in a meaningful way to the overall determination of how well the sites have done from year to year both in physical and biological attributes. Photographic comparisons are often useful in determining larger scale alterations or successional progressions over time and may be useful in the transition towards a future site stewardship program.

Site Stewardship

We continue to recognize that the success of the restoration sites in partially meeting vegetation goals is attributable to, at least in part, the removal of nonnative and invasive species by other entities and volunteers. A significant effort is evident in controlling invasive species, planting additional vegetation, replacing dead plants, removing trash and debris, and installing erosion control measures. *We believe that continued site stewardship remains a vital part of maintaining valuable restored habitats at these sites.* As noted in years past, there are many different entities working on site maintenance and it remains difficult to quantify the effort and resources expended. *Quantifying the effort devoted to the sites by maintenance crews, volunteer organizations, and others would be helpful in assessing the level of effort contributed toward the success of the restoration sites.* We support the development of a process that improves coordination between monitoring and site stewardship activities enabling increased complementary efforts and overall site success. The capacity of the land management entities and volunteer groups to support continued site stewardship should be evaluated to identify potential stewardship gaps.

As site stewardship appears important to maintaining the long-term benefits of the restoration sites, we feel a discussion regarding how to support site stewardship should be undertaken. Hamm Creek, for example, should be evaluated for its extent of invasives, such as common water reed (*Phragmites communis*) and yellow flag iris (*Iris pseudacorus*), while populations of these species are still relatively small and manageable. Common water reed is listed in the EBDRP monitoring plan as an invasive species of special concern.

As mentioned in the report, other invasive species were noted during the 2007 monitoring event and again in 2010, besides the four invasive plant species of special concern listed in the EBDRP monitoring plan. These species included yellow flag iris and perennial pepperweed. Yellow flag iris is listed as a Class C noxious weed and perennial pepperweed is listed as a Class B weed in Washington State (WSNWCB 2016). It will be critical for future success of these sites to control occurrences of these invasives while they are relatively small in number and while control methods have a negligible impact on site restoration efforts.

2015 Report:

Additional recommendations to be considered for future monitoring studies include:

- Start the study with a clear and concise question.
- Require a clear and concise study design that can be easily followed from year to year and by different staff year to year.
- Conduct a rigorous scientific review of the proposed study design and methods.
- Conduct a pilot study.
- Conduct a rigorous scientific review of the results of the pilot study.
- Finalize the study design and methods post the pilot study, but still are willing to adapt to changing conditions and needs.
- Consider making all aspects of the monitoring project statistically valid.
- Choose study sites that will be available for the life of the study, specifically control sites.
- Make sure the study design is commensurate with the budget.
- Appoint a person to coordinate with NGO's and agencies working/volunteering in the study area. Conduct monthly coordination meetings to provide them an overview of the study and explain the importance of not disturbing (planting, invasive plant control etc…) the study sites.
- Appoint a person to address recommendations and confirm that there is value added in continuation of each part of the study.
- Just as success criteria were defined for each physical and biological variable in the study, criteria should also be defined to determine when a task is complete (e.g., when a task has met its success criteria two years in a row, that task is complete and can be discontinued).

In conclusion, we recommend that remaining funds may best be used to continue maintenance including controlling invasive species, planting additional vegetation, replacing dead plants, and removing trash and debris. Finally, we suggest development of a final summary report that explores the data collected to date combined with our ongoing recommendations. This report would provide an understanding of how these sites have progressed and the lessons learned in the process of collecting the data since 2000.

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APPENDICES

Appendix 1. Partial list of riparian and marsh plant species observed at the restoration and reference sites. An asterisk (*) denotes nonnative species.

Scientific name	Common name	Scientific name	Common name
Abies grandis	Grand fir	*Lolium perenne*	Rye grass*
Acer circinatum	Vine maple	*Lonicera involucrata*	Black twinberry
Acer macrophyllum	Big Leaf Maple	*Lotus corniculatus*	Birds-foot trefoil*
Agrostis sp.	Bentgrass	*Mahonia sp.*	Oregon grape
Alnus rubra	Red alder	*Malus fusca*	Pacific crabapple
Amelanchier alnifolia	Serviceberry	*Medicago hispida*	Bur clover*
Ammophila arenaria	Beach grass*	*Melilotus alba*	White sweet clover*
Anaphalis margaritacea	Pearly everlasting	*Morella californica*	California wax myrtle
Anthemis cotula	Dog Fennel*	*Oemleria cerasiformis*	Indian plum
Anthoxanthum odoratum	Sweet vernal grass*	*Oxalis sp.*	Oxalis
Arbutus menziesii	Pacific madrona	*Phalaris arundinacea*	Reed canary grass*
Arctostaphylos uva-ursi	Kinnikinnick	*Philadelphus lewisii*	Mock orange
Asclepias sp.	Milkweed?	*Physocarpus capitatus*	Pacific ninebark
Aster subspicatus	Douglas aster	*Picea sitchensis*	Sitka spruce
Atriplex patula	Orache	*Pinus contorta*	Lodgepole pine
Atropa belladonna	Nightshade*	*Pinus contorta var. contorta*	Shore Pine
Betula papyrifera	Paper birch	*Plantago major*	Common plantain
Betula spp.	Birch	*Plantago maritima*	Goose tongue
Bromus sp.	Bromegrass*	*Plantago sp.*	Plantain
Buddleja sp.	Butterfly bush*	*Poa sp.*	Bluegrass
Callitriche sp.	Water star-wort	*Polygonum sp.*	Knotweed*
Carex lyngbyei	Lyngby's sedge	*Polystichum munitum*	Sword fern
Chenopodium album	Lambs-quarters*	*Populus balsamifera*	Black cottonwood
Cirsium arvense	Canada thistle*	*Populus tremuloides*	Quaking aspen
Cirsium vulgare	Bull thistle*	*Potentilla anserina*	Pacific silverweed
Conium maculatum	Poison hemlock*	*Prunus sp.*	Plum
Convolvulus arvenis	Morning glory*	*Pseudotsuga menziesii*	Douglas fir
Cornus nuttallii	Pacific flowering dogwood	*Quercus sp.*	Oak
Cornus stolonifera	Red-osier dogwood	*Ranunculus repens*	Creeping buttercup*
Corylus cornuta	Beaked hazelnut	*Rhamnus purshiana*	Cascara
Cotula coronopifolia	Brass buttons	*Ribes sanguineum*	Redflower currant
Crataegus douglasii	Black Hawthorne	*Robinia pseudoacacia*	Black locust*
Cytisus scoparius	Scot's Broom*	*Rosa nutkana*	Nootka Rose
Dactylis glomerata	Orchardgrass*	*Rubus discolor*	Himalayan blackberry*

Appendix 1. (cont.)

Scientific name	Common name	Scientific name	Common name
Deschampsia cespitosa	Tufted hairgrass	*Rubus laciniatus*	Evergreen blackberry*
Dicentra formosa	Pacific bleeding heart	*Rubus parviflorus*	Thimbleberry
Distichlis spicata	Saltgrass	*Rubus spectabilis*	Salmonberry
Eleocharis palustrus	Creeping spikerush	*Rumex acetosella*	Common sheep sorrel*
Eleocharis parvula	Small spike rush	*Rumex crispus*	Curly Dock*
Eleocharis sp.	Tall spike rush?	*Salicornia pacifica*	Pickleweed
Elymus repens	Quackgrass*	*Salix hookeriana*	Hooker's willow
Epilobium angustifolium	Fireweed	*Salix lucida*	Pacific willow
Epilobium sp.	Willowherb	*Salix sitchensis*	Sitka willow
Equisetum sp.	Horsetail	*Schoenoplectus tabernaemontani*	Softstem bulrush
Festuca arundinacea	Tall fescue*	*Scirpus acutus*	Hard-stemmed bulrush
Festuca rubra	Red fescue*	*Scirpus americanus*	American bulrush
Fragaria chiloensis	Pacific beach strawberry	*Scirpus maritimus*	Seacoast bulrush
Fraxinus latifolia	Oregon Ash	*Scirpus validus*	Soft stemmed bulrush
Galium spp.	Bedstraw	*Senecio vulgaris*	Common groundsel*
Gaultheria shallon	Salal	*Sonchus sp.*	Sow-thistle*
Glaux maritima	Sea milkwort*	*Sorbus sp.*	Mountain ash*
Hedera helix	English ivy*	*Spergularia canadensis*	Canadian sandspurry
Holcus lanatus	Common velvetgrass*	*Spiraea douglasii*	Hardhack
Holodiscus discolor	Ocean spray	*Symphoricarpos albus*	Common snowberry
Hypericum sp.	St. Johns wort*	*Tanacetum vulgare*	Common tansy*
Hypochaeris radicata	Hairy cat's-ear*	*Taraxacum officinale*	Common dandelion*
Ilex aquifolium	English holly*	*Thuja plicata*	Western Red cedar
Impatiens noli-tangere	Western touch-me-not	*Trifolium pratense*	Red clover*
Iris pseudacorus	Yellow-flag iris*	*Trifolium repens*	White clover*
Juncus bufonius	Toad rush*	*Triglochin maritima*	Seaside arrowgrass
Juncus effusus	Common rush	*Typha angustifolia*	Narrowleaf cattail
Juncus sp.	Rush	*Vaccinium ovatum*	Evergreen Huckleberry
Juncus uncialus	Inch-high	*Verbascum thapsus*	Great mullein
Lactuca serriola	Prickly lettuce*	*Vicia sp.*	Vetch
Lapsana communis	Nipplewort*	*Vinca major*	Bigleaf periwinkle*
Lilaeopsis occidentalis	Western lilaeopsis		