Portland Harbor NRDA Monitoring and Stewardship Framework

1.0 Purpose of this Framework

The purpose of this monitoring and stewardship framework is to (1) provide a summary of the Portland Harbor Natural Resource Trustee Council's (Trustee Council's) monitoring and long-term stewardship expectations, requirements and mechanisms for obtaining full restoration value at Natural Resource Damage Assessment (NRDA) restoration sites for the Portland Harbor Superfund Site (Portland Harbor); and (2) provide minimum standards for performance of Portland Harbor NRD restoration projects. The minimum performance standards have been developed with input from local restoration practitioners and are therefore considered to be reasonably achievable for projects in and around Portland Harbor. Any proposed adjustments to these standards would need to be strongly supported by site-specific conditions or circumstances, and would require comprehensive review and approval by the Trustee Council.

In order to increase consistency between projects and efficiency in reviewing proposed site specific performance plans, the Trustee Council has created an outline that should be followed to facilitate review (Appendix A). Site-specific lamprey monitoring will be designed and conducted by the U.S Fish and Wildlife Service (USFWS). The general plan and framework for lamprey monitoring is included in Appendix B.

The Trustee Council's Monitoring and Stewardship Framework includes the following components:

- Overview of the NRDA Restoration Approach at Portland Harbor (Section 2.0)
- Performance Period Monitoring Plan and Performance Standards (Section 3.0)
- Long-term Stewardship Framework (Section 4.0)
- Trustee Council Oversight (Section 5.0)
- Monitoring and Stewardship Funding (Section 6.0)
- References (Section 7.0)
- Site Specific Performance Plan Outline (Appendix A)
- Lamprey Monitoring Plan (Appendix B)[1]
- Portland Harbor Native Plants List (Appendix C)

[1] The lamprey monitoring plan is a separate document because it addresses compensation for lost use of tribal resources, and site-specific detailed monitoring plans and monitoring activities will be developed and conducted by USFWS.

2.0 Overview of the NRDA Restoration Approach at Portland Harbor

2.1 Project Types likely to Be Implemented

Off-channel habitats and the river's active channel margin[2] (ACM) have been identified as the highest priorities for restoration by the Trustee Council. In addition, shorelines and riparian zones, especially those adjoining off-channel habitat and contiguous upland habitats, are targeted habitat priorities because of their ability to support fish and wildlife and their ecological connections to aquatic habitats. River margins, including shorelines and their riparian zones, are dynamic, diverse habitats over a broad range of river flows. That diversity is a key component of productive stream ecosystems (Hill et al. 1991, Gore 1985, Poff et al.1997). In small tributary streams and off-channel habitats, riparian areas provide food, shade and cover for both aquatic and terrestrial animals, and enhance bank stability. In large rivers, vegetation on channel banks and floodplains increases hydraulic roughness, which in turn decreases channel conveyance and augments sedimentation (Kouwen and Unny 1973). Finally, vegetation increases the cohesion of bank sediments, thus influencing bank erosion and overall bank stability (Thorne 1990). Restoration actions that will improve the quantity or quality of these priority habitat types are likely to include levee removal and modification, dam removal, culvert removal or replacement, and restoration or creation of off-channel, ACM, and shallow water habitats. In addition, invasive plant removal and revegetation with native species will be a component of most project types.

2.3 Goals for Restoration

The Trustee Council's overall goal is to restore, rehabilitate, replace, or acquire the equivalent of those natural resources injured as the result of hazardous substance and oil releases within the Portland Harbor Superfund site. Restoration projects implemented as a result of this process will restore habitats that:

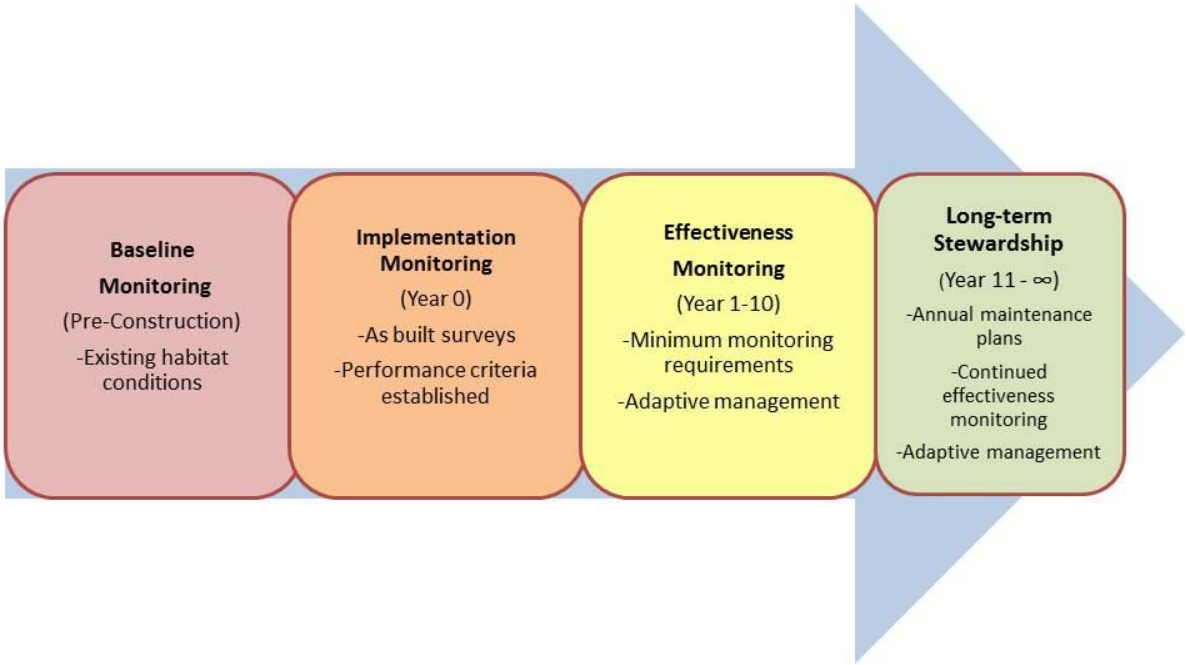
- Move towards normative hydrology.
- Restore floodplain function, including off-channel habitat for multiple species.
- Reestablish floodplain and riparian plant communities.
- Improve aquatic and riparian habitat conditions.
- Improve river margin habitat (increase complexity in river margins).
- Restore habitat that provides ecological value at the landscape scale (i.e., by providing connectivity, increasing habitat patch size, improving patch shape to provide more interior habitat, reducing distances between different patches of habitat and other factors).

[2] The portion of the river's edge that is at the interface of unwetted shoreline and shallow water, and occurs from the Ordinary High Water (OHW) mark to Ordinary Low Water (OLW).

2.4 Phases of Monitoring and Stewardship

As depicted in Figure 1, monitoring and stewardship of restoration sites in Portland Harbor will be divided into four phases. The first three phases make up the performance period, during which each site will be thoroughly monitored to ensure that it is on a trajectory toward full habitat function. The performance period will include baseline, implementation, and effectiveness monitoring phases, and will be guided by the site-specific performance plan. Once a project has met its performance criteria and the performance period is over, the long-term stewardship phase will begin. Long-term stewardship will involve activities such as regular site visits, maintenance, ongoing effectiveness monitoring, and other tasks required to maintain project effectiveness and full functionality in perpetuity. The monitoring plan for lamprey, presented in Appendix B, extends for a period of 20 years. It will begin during the performance period and end during the long-term stewardship phase.

Figure 1: Portland Harbor NRDA Site Monitoring and Stewardship Model.



3.0 Performance Period Monitoring and Performance Standards

3.1 Performance Period Monitoring Plan

The performance period monitoring plan is intended to guide the collection of data at Portland Harbor restoration sites.. Monitoring data will be collected at the restored sites and compared to site-specific reference conditions, if applicable. Baseline monitoring will occur before project work occurs at the site to document pre-restoration conditions. Implementation and effectiveness monitoring will take

place during an initial performance period of 10 years, or as needed until performance standards are met, followed by a less intense level of monitoring associated with long-term stewardship activities.[3]

Monitoring related to performance standards: Implementation and effectiveness monitoring will be used to ensure that projects are constructed as designed and that they meet site-specific performance standards. The monitoring data collected at the sites will be used to determine the following:

- Was the project constructed according to its final design? Are any adjustments necessary to achieve desired site conditions as described in the restoration plan for the site?
- Did the constructed restoration project create the quantity and quality of fish and wildlife habitat that were proposed?
- Is the restoration site meeting its interim performance standards (IPSs)?
- Have the performance standards been met? If so, is the site ready to move into the long-term stewardship phase?

Monitoring related to NRDA restoration goals: In order to determine whether the Trustee Council's overall restoration program goals for Portland Harbor are being met, additional monitoring will be performed at restoration sites that is not related to site-specific performance standards. This monitoring information will indicate whether the suite of restoration projects are facilitating increased utilization by injured fish and wildlife species, and will identify broader trends in the creation and restoration of habitat in the area. Monitoring results will ***not*** tier to individual project performance standards that must be met by the end of the performance period. Monitoring data collected under this heading will be used to:

- Verify that target fish and wildlife species are using the restored sites.
- Detect trends in species use of restored sites.
- Identify other environmental factors that could be influencing performance and species utilization of the restored sites (e.g., water quality).

3.2 Monitoring Parameters

Each site will be monitored for a specific set of parameters depending on the habitat types restored and the monitoring questions and performance standards associated with those habitat types. Table 1 provides the potential monitoring parameters and indicates which should be monitored for each habitat type. In addition, photographs should be taken at established points on a regular schedule to provide qualitative documentation of the site's progression. Monitoring parameters will be selected to verify that the goals and objectives of the project have been achieved and the performance standards have been met. The Trustee Council will work with the project implementer to determine which parameters will be monitored at each site based on the parameters and applicable habitats shown in Table 1, and will document the performance standards and monitoring parameters in a site-specific performance plan.

[3] The monitoring plan for lamprey, presented in Appendix B, extends for a period of 20 years.

3.3 Performance Standards

There will be an initial period of performance during which the project implementer is required to work with the Trustee Council to ensure that a project is on a positive habitat trajectory and is likely to meet project goals and performance standards within the specified period. Implementation and effectiveness monitoring results will be compared to performance standards to determine when a project is considered a success and can move into the long-term stewardship phase. Table 1 indicates which of the monitoring parameters the Trustee Council considers performance standards. A subset of these performance standards will be applied to each project (based on the habitat types being restored) and will be documented in the site-specific performance plan. The minimum performance standards that have been approved to date for geomorphic/structural habitat elements and vegetation are described in sections 3.3.1 and 3.3.2. Minimum performance standards for sediment, site hydrology and hydraulics, and water quality will be determined on a site basis where they are applicable.

If, at any time during the performance period, the project is not meeting its interim performance standards, appropriate adaptive management actions will need to be implemented to ensure the project obtains a trajectory that will meet the performance standards by the end of the performance period.

Table 1: Monitoring plan for Portland Harbor restoration projects

Project Types					Tributary Habitat	Off-Channel Habitat	Active Channel Margin	Shallow Water Habitat	Beach Habitat	Riparian Habitat	Upland Habitat
Monitoring Questions	***Performance Standard?***	***Monitoring Attributes***	***Monitoring Techniques***	***Sampling Frequency/Timing***							
Geomorphic/Structural Habitat Elements											
• Were as many habitat elements placed on site as proposed in designs? • Are habitat elements being retained on site? (retention rate will be site specific)	Yes	Large wood (LW), downed wood, snags, and boulder and brush piles	Habitat Survey	Once a year after wet season; Post-construction, Years 1,3,5,7, and 10	X	X	X	X	X	X	X
• Is the total quantity of side-channel and ACM habitat that was created being retained over time?	Yes	Water depth	Survey a longitudinal profile		X	X	X	X			
		Stream gradient			X						
		Width to depth ratio	Survey established cross- sections		X						
		Elevational stability	Survey established cross-sections		X	X	X	X	X		
		Sediment accretion	Sediment accretion stakes			X	X	X	X		
• How much mink and bald eagle habitat was restored along the shorelines?	No	Length of shoreline and amount of shallow water and riparian habitats.	Topographic survey Habitat maps	Pre-construction baseline, as built and Year 10	X	X	X	X	X	X	X
• For fish passage projects, was the project completed as designed and does it meet state and federal fish passage criteria? • For off-channel projects, are the fish able to enter and exit the site?	Yes	Fish Passage Barriers (Egress and Ingress)	Survey jump heights/visual survey	Once a year after wet season; Years 1 through 10	X	X					
Hydrology and Hydraulics											
• What is the total area of the site that is inundated by the river during periods of high flow?	Yes	Lateral extent of flooding	Cross-section survey, water levels, aerial photos, and river flow data	Once a year after wet season; Years 1,3,7, and 10	X	X	X	X	X	X	

Project Types					Tributary Habitat	Off-Channel Habitat	Active Channel Margin	Shallow Water Habitat	Beach Habitat	Riparian Habitat	Upland Habitat
Monitoring Questions	***Performance Standard?***	***Monitoring Attributes***	***Monitoring Techniques***	***Sampling Frequency/Timing***							
Sediment											
• Was the sediment composition appropriate for the habitat type at the time of construction? • Is there a shift in sediment composition over time?	Yes	Substrate size and composition	Pebble counts, cores, grab samples, visual observations	Once a year after wet season; Years 1,3,5,7, and 10	X			X	X		
Vegetation											
• Is vegetation developing in a way that will ultimately generate a native assemblage of appropriate vegetation types?	Yes	Percent cover by type (shrubs, trees, herbaceous, bare ground)	Transect, quadrat sampling, photo points, and aerial photos	Post-planting (Year 1) and then yearly at end of growing season through Year 5, and Years 7 and 10			X			X	X
		Percent survival									
		Percent native versus non- native									
Water Quality											
• Is water quality at the site improving over time and comparable to an appropriate reference condition?	No	Temperature	Temperature probe with data logger	Continuous		X					
		Dissolved oxygen	Dissolved oxygen sensor	Once a month years 1 and 2 and during summer other years through year 10		X					
		Other site specific parameters	TBD	TBD	X	X	X	X			
Fish and Wildlife											
• Are native fish using the newly restored habitat? • What size salmonids and lamprey are using the site?	No	Species presence/absence	Snorkel surveys, beach seining, or trapping	Twice monthly from February through May; Years 1, 3, 5, 7, and 10	X	X	X	X	X		
		Size of salmon and lamprey									
• What birds are using the site? Do changes in the bird assemblage, diversity and abundance at the site indicate that habitat quantity and quality have improved?	No	Relative abundance/diversity/ species	Bird surveys: point counts	Three times (approximately monthly) within each habitat type during breeding season; Pre- construction baseline, and Years 1, 3, 5, and 10			X	X	X	X	X
		Habitat usage									

Project Types					Tributary Habitat	Off-Channel Habitat	Active Channel Margin	Shallow Water Habitat	Beach Habitat	Riparian Habitat	Upland Habitat
Monitoring Questions	***Performance Standard?***	***Monitoring Attributes***	***Monitoring Techniques***	***Sampling Frequency/Timing***							
• Are bald eagles using the site? If so, how often and for what activities?	No	Bald eagle presence/absence at the site; frequency of site use, behavior and habitat elements used	Site surveys for eagle use and behavior during the breeding season; habitat metrics (acreage of potential foraging habitat restored)	Weekly from mid- December through August; Pre-construction baseline), and Years 3, 5, 7, and 10.		X	X	X		X	X
• Are mink using the newly restored habitat? Has mink abundance at the site increased?	No	Presence/absence; abundance Habitat usage with GPS data on locations	Camera traps with scent stations within 50-feet of waterway, walking surveys for track, scat, den sites	Twice monthly for 3 months of the spring-summer to include mid-April through mid-July at a minimum; Pre-construction baseline, and Years 3,5,7, and 10	X	X	X	X	X	X	X
• Has the benthic macroinvertebrate community improved?	No	Benthic invertebrate species, abundance and diversity/richness	Macroinvertebrate surveys, lab identification	Once a year during late Spring/Fall, Pre-construction baseline (where applicable) and Years 1, 2, 5, 7 and 10	X						

3.3.1 Geomorphic/Structural Habitat Elements

This performance standard will use topographic surveys, aerial photography, hydrology, hydraulics and visual site inspections to verify that the total quantity of ACM and side channel habitat is being maintained, that there are no barriers to fish entering or exiting the site, and that structural habitat features were installed as designed and are being retained.

A minimum of 3 to 4 pieces of large woody debris ("LWD") will be installed within the active channel margin per acre (i.e., along the created channels and within the marsh, mudflat, and scrub-shrub habitats). Performance for LWD will be based on retention of pieces and/or natural recruitment, and the following standards will be used:

- Years 1, 2, 3, 5, 7, and 10: woody debris will have an 80% retention rate including naturally recruited material.

If the amount of LWD on-site fails to meet performance standards in Years 1, 2, 3, 5, 7 or 10 and if existing conditions and hydraulics will allow the retention of replacement materials, LWD will be installed within the ACM and off-channel habitats to achieve the targeted density.

In habitat types above the OHWL (non-ACM habitats), structural habitat elements in the form of debris piles, downed wood/logs, and rock piles will be installed at a minimum of 3 to 4 elements per acre.

Failure to meet the following performance standards at the site would trigger a project review with Trustee Council representatives to determine what, if any, adaptive management actions are necessary:

- Identification of any fish passage barriers.
- Changes of more than 10% in ACM and side channel habitat acreages from the as-built surveys.
- Changes of more than 20% in ACM or off-channel habitat depths from the as-built surveys. Channel depths will be measured from the OHWM.

3.3.2 Vegetation

Establishment of native vegetation at the restoration site is anticipated to result from both active planting and volunteer recruitment. Identification of non-native plant species will be based on the current Oregon Department of Agriculture (ODA) Noxious Weed list and the Portland Plant List (September 2011). Non-native species for the purposes of performance evaluation include the most updated versions of following:

- Species on the ODA Noxious Weed List
- Species on the Portland Plant List (Rank A, B, and C)

The most recent versions of the ODA and City of Portland lists will be used. All lists described above will serve as tools to identify and target species for treatment.

In addition, certain plants are classified as "early detection and rapid response" (EDRR) species. These species are newly identified non-native, invasive species that require a more aggressive approach to eradicate them. Multnomah County and the associated Soil and Water Conservation Districts (SWCDs) have identified 'EDRR weeds' in collaboration with neighboring counties to create a united approach to detection and eradication. The four County Cooperative Weed Management Area organizations work together to update the list periodically. As of May 2014, there are 19 species on the East and West

Multnomah SWCDs lists (ESWCD 2014 and WSWCD 2014) that are not widespread and will be treated as soon as detected, with the overall goal being total eradication from the restoration site. The most current version of these two lists will be used to determine which species will require this level of response effort.

In order to meet the performance standards described below, the project implementers should consider the following when designing their planting plans:

- Plant Selection: It is important that native plants and seed stock appropriate for the restoration site be used during revegetation work. Plants on the Trustee Council's "Portland Harbor Native Plants Restoration List" should be used and local stock should be identified and sourced.
- Planting Density: Mortality of some plants is expected during the first year. In order to achieve the stem densities described in the vegetation performance standards below, additional plants should be installed and plants should be replaced in subsequent years as needed. Based on other restoration projects in the area, planting densities for newly established habitats between 2,000 to 2,600 plants per acre of riparian, scrub-shrub, and upland habitats are likely to result in appropriate densities over time. It is recommended that the ratio of shrubs to trees planted initially should be 50% shrubs to 50% trees in the riparian and 60% shrubs to 40% trees in the upland.
- Soil: Ensuring that the soil conditions are conducive to native plant growth is critical to restoration success. If soils are imported or on-site soils are amended to promote plant growth, the following considerations and standards should be implemented:
    - Inorganic/organic and agronomy sampling should be performed whether the material is to be imported from off-site or has been stockpiled from material on-site.
    - Any imported material should be weed free; measures should be taken to avoid the relocation of on-site material if it contains a substantial seed bank of weed seeds.
    - Imported material should meet the State of Oregon's "Clean Fill" requirements as defined in OAR Chapter 340, Divisions 93, 94, 95, 96 and 97.
    - American Society of Agronomy analytical methods should be used to determine whether the parameters of organic matter, pH, electrical conductivity, sodium absorption ratio, soil texture, cation exchange capacity, and plant available levels of N, P, and K in the material are suitable for planting (SSSA 1996, Munshower 1993).
    - Soil amendments may be added as needed and compost proposed for use should also meet appropriate standards for plant growth (USCC 2001, CCQC 2001).

Vegetation performance standards will verify whether or not the native revegetation and invasive plant management in the ACM, riparian, and upland areas are developing toward a positive trajectory. Soon after the site is planted, the number, type, and location of plants installed will be documented. This documentation will be considered Year 1 of vegetation monitoring. Subsequent vegetation surveys should be completed at the end of the growing season in years 2 through 5, year 7, and year 10. A plan describing the monitoring methods to be used at the site will be prepared by the project implementer

and provided to the Trustee Council for review. The following are specific vegetation targets, which if not met, will trigger Trustee Council review to determine whether adaptive management actions are necessary:

Emergent Marsh (ACM*)*

Per a site-specific planting plan, 5,000 plug plantings of native vegetation per acre will be installed throughout any restored marsh habitat to facilitate the establishment of emergent marsh vegetation. It is anticipated that this habitat type will partially vegetate naturally by volunteer recruitment. Throughout the monitoring period, diversity of plant species in emergent marsh habitat should include at least 5 species of herbaceous plants. An herbaceous species will count towards diversity if there is at least 5% cover and it is in at least 10% of the monitored plots for the habitat type. The following performance standards will be used to assess the successful establishment of emergent marsh vegetation:

Year 2- 5:

- Cover :
  - ≥ 30% native herbaceous
  - ≤ 10% non-native herbaceous
  - The remaining percentage of cover can be made up of bare ground, rocks or native herbaceous.

Year 7

- Cover :
  - ≥ 50% native herbaceous
  - ≤10 % non-native herbaceous
  - The remaining percentage of cover can be made up of bare ground, rocks or native herbaceous.

Year 10

- Cover :
  - ≥ 70% native herbaceous
  - ≤10 % non-native herbaceous
  - The remaining percentage of cover can be made up of bare ground, rocks or native herbaceous.

Riparian Forest, Scrub-Shrub and Upland Forest

Newly established riparian forest, scrub-shrub, and upland forest habitats will be planted with 2,000-2,600 native woody plantings per acre and the use of seed or plugs as needed in the understory, to facilitate the establishment of vegetative communities with multiple structural layers.

Establishment of forested habitat vegetation will require active management to ensure that plant densities and percent cover performance criteria are met. The following performance standards will be used to assess successful vegetation establishment within the riparian, scrub shrub, and upland forest:

Years 2-5:

- A minimum of 1,200 native woody stems per acre.

- For riparian forest and upland forest habitats, at least 3 native tree species and 5 native shrub species.
- For scrub-shrub habitats, at least 5 native shrub species.
- Cover (during the first 5 years, trees/shrubs will be excluded from percent cover):
  - ≥ 10% native herbaceous
  - ≤30 % non-native herbaceous
  - The remaining percentage of cover can be made up of bare ground, rocks or native herbaceous.

Year 7:

- Cover:
  - ≥ 55% native woody species
  - ≥ 10% native herbaceous
  - ≤ 20% non-native herbaceous
  - ≤ 5% non-native shrubs
  - The remaining percentage of understory cover can be made up of bare ground, rocks, native shrubs or native herbaceous.

Year 10:

- Cover:
  - ≥ 80% native woody species
  - ≥ 10% native herbaceous
  - ≤ 20% non-native vegetation

Volunteer recruitment of native trees and shrubs in the riparian and upland habitats may be credited towards the density per acre performance standard. If the density rates fall below the required performance standards, the project implementer will consult with the Trustees regarding the precise plan for replanting. Replanting will be conducted during the appropriate season following monitoring.

Oak Woodland

In oak-dominated habitats, 500 native woody plantings per acre will be maintained or installed to facilitate the establishment of native woody vegetation that is likely to develop approximately 30-60% oak canopy cover over time (likely after the performance period). Establishment of oak-dominated upland forest vegetation will require active management to ensure that plant species survival and percent cover performance criteria are met. Throughout the monitoring period, diversity of plant species in oak-dominated forest habitat should be at least 1 species of tree (Oregon white oak) and 4 species of shrubs. A species will count towards diversity if there is at least 5% cover and it is in at least 10% of the monitored plots. The following performance standards will be used to assess successful oak woodland vegetation establishment:

Year 2-5:

- Density of shrubs and trees will be at least 500 shrubs/trees per acre. During the first 5 years trees and shrubs will be excluded from percent cover. Density of trees and shrubs will no longer need to be measured after year 5.

- Cover:
  - ≥ 25% native herbaceous,
  - ≤ 15% non-native herbaceous
  - The remaining percentage of understory cover can be made up of bare ground, rocks or native herbaceous.

Year 7:

- Cover :
  - ≥ 40% native woody species, including Oregon white oak as the dominant tree species.
  - ≥ 30% native herbaceous
  - ≤ 10% non-native herbaceous
  - ≤ 5% non-native shrubs
  - The remaining percentage of understory cover can be made up of bare ground, rocks native shrubs or native herbaceous.

Year 10

- Cover
  - ≥ 50% native woody species, including Oregon white oak as the dominant tree.
  - ≥ 35% native herbaceous
  - ≤ 5% non-native herbaceous and shrubs
  - The remaining percentage of understory cover can be made up of bare ground, rocks native shrubs or native herbaceous.

Volunteer recruitment of native trees and shrubs in the oak-dominated upland forest planting areas may be credited towards the density per acre performance standard; however, very little natural recruitment of oak trees is expected to occur over the short-term. If the density rates fall below the required performance standards, the project implementer will consult with the Trustee Council or its designee(s) regarding the precise plan for replanting. Replanting will be conducted during the appropriate season following monitoring.

3.4 Monitoring Plan Study Design

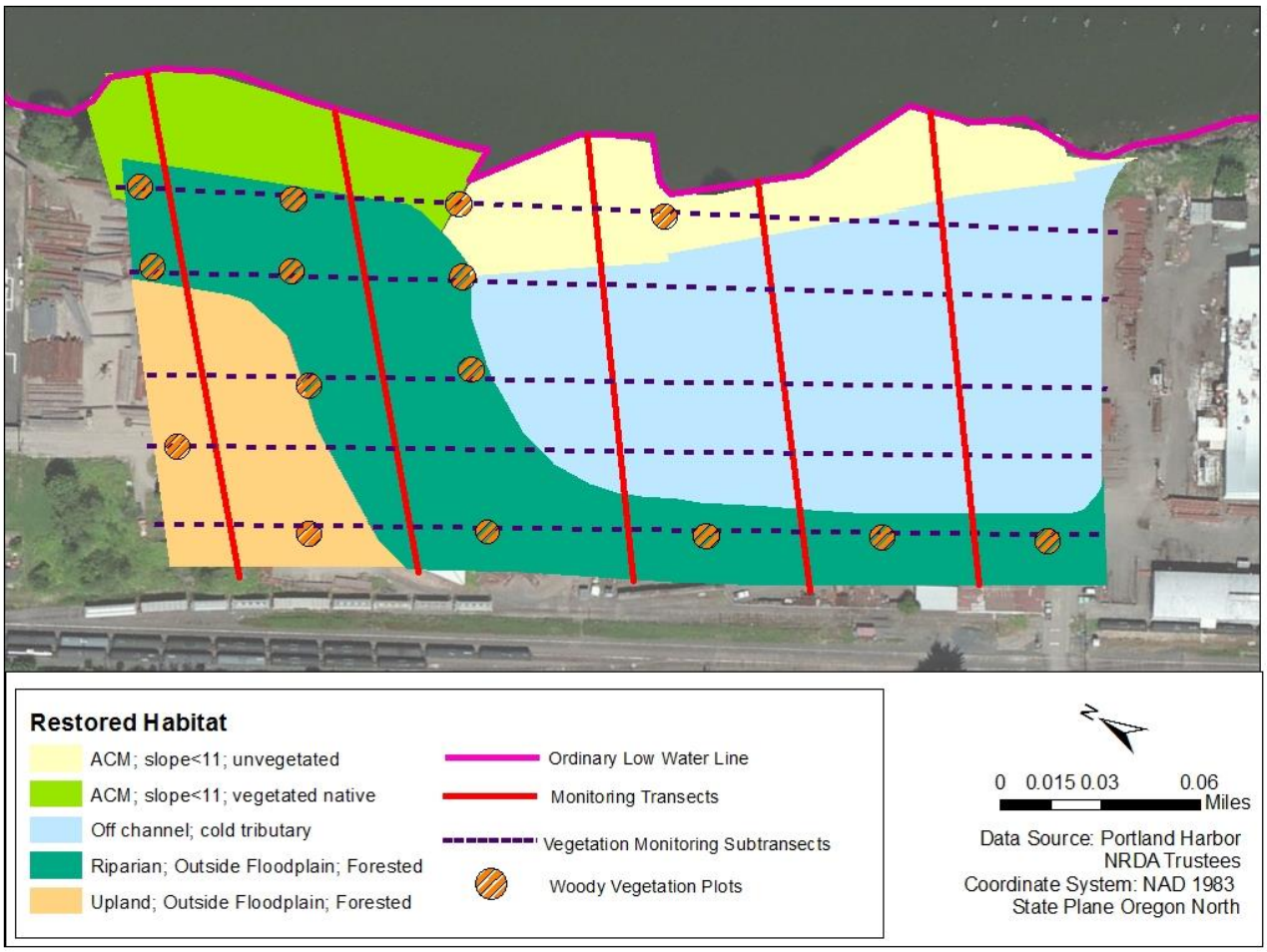
Each site will have a unique monitoring sampling design that is documented in a site-specific performance plan. It is recommended that each restoration site be divided into 100-meter sections that are oriented perpendicular to the floodplain axis. Within these 100-meter sections, sampling transects should be selected and sampled consistently each monitoring year to document changes at the site over time. The transects should be at fixed intervals from a random starting point according to the following guidance:

- Sites less than 300 meters long measured parallel to the flood plain axis (spanning 3 or fewer sections) will have a minimum of one sampling transect.
- Sites 300 to 600 meters long will have a minimum of 3 sampling transects, spaced at 100-meter intervals.
- Sites 600 to 1,000 meters long will have a minimum of 5 sampling transects spaced at 100-meter intervals.
- Sites greater than 1,000 meters in length will have a minimum of 5 sampling transects spaced at 200-meter intervals.

- More transects may be required if a restoration site contains multiple habitat types that are not adjacent (e.g., upland forest, active channel margin).

In some circumstances, sampling will be concentrated on transects proximal to expected changes, for example, near a culvert replacement or dike breach. Fixed reference points relative to the transects should be selected for vegetation plots, water level sensors/manual measurements, and cross section endpoints. Channel cross section endpoints, if applicable, should be sited along the transect at locations proximal to the restoration action and near the expected boundary of post-restoration mean low water and high-tide inundation. Figure 1 demonstrates an example of how a site should be divided.

Figure 1. Example monitoring transects and vegetation monitoring subtransects



Monitoring Related to Performance Standards:

<u>Geomorphic/Structural Habitat Elements</u>

Monitoring of the site's geomorphic features will allow the Trustee Council to determine whether the site was constructed as it was designed and that the designs resulted in the type and quantity of habitat that was anticipated. These monitoring results will also inform any adaptive management

decisions that are needed during the performance period to make the project self-sustaining in the long-term. The results from this monitoring will be compared to the site-specific performance standards and reference conditions.

Numbers of structural habitat elements such as in-stream wood, downed wood, rock piles, brush piles, and snags will be documented post-construction to verify that the items were maintained or placed according to the designs. Naturally recruited wood can be counted toward meeting these standards.

The results of structural habitat element monitoring will be compared to a site-specific performance standard and will be used along with other physical site measurements to determine if any adaptive management actions are needed to increase structural habitat elements, particularly large woody debris retention rates; depending on the project, it may be appropriate for all wood to be mobile at the site.

For fish and wildlife passage projects, as-built surveys will be conducted to verify that the site meets passage criteria appropriate for the site. In subsequent monitoring years, visual observations, photos, and survey data will be used to ensure that the site is passable during the periods of time intended by the project design.

For most restored habitat types, a professional surveyor will complete a topographic survey of the entire site. During subsequent sampling events, elevation measurements will be completed at transects, which will be established based on the protocol described above. A marker such as capped PVC pipes should be used to permanently mark transect endpoints (proximate to ordinary low water river boundary and to property boundary). In addition, if the site is to contain multiple restoration habitat types (e.g., constructed side-channel, ACM) a marker will be placed at habitat transition points along the line of the transect. All transect marker locations should also be recorded using a GPS so that the station can be reestablished if the marker is lost. In addition, elevations should be surveyed at other important site features such as water quality and water level instruments and at the location of vegetation sample plots.

Hydrology and Hydraulics

In the lower Willamette River, water level variation in tributary habitat, off-channel habitat, ACM, and shallow water habitat is a function of stream or river flow and tidal fluctuations. Many of the proposed restoration projects will result in reconnection of off-channel and floodplain habitats. For these restored habitat types, it will be important to monitor water levels and the extent and duration of floodplain inundation during high flows.

Water level data should be georeferenced to the site-specific topographic data and to specific river discharge levels (i.e., ordinary high water [OHW], ordinary low water [OLW] and, if applicable, high and low tide at mean low water [MLW] and flood stage). Water level information and topographic information combined can be used to determine inundation periods. Water levels can be measured either with continuous water level records (pressure transducer) and/or manually as part of the cross-sectional survey. If water level sensors are used, only one is needed and it should be installed at one of the physical transect locations.

Extent of floodplain inundation at flood stages relevant to the presence of target species should be determined if one of the project's goals is to improve floodplain connectivity. Cross section and water level measurements will be used to calculate area of floodplain inundation. A qualitative measurement of floodplain inundation can also be made by documenting elevations of debris lines and other

evidence of high water events during cross section surveys at established transects and by reviewing aerial photos.

Sediment

Sediment composition monitoring will only be a performance standard where a project goal is creation or modification of a specific type of sediment composition. Sediment samples should be collected and analyzed for grain size composition and compared to a performance standard determined based on the goals of the project and reference conditions. Samples should be collected at established transects or in areas of expected change and georeferenced to the topographic survey.

Vegetation

Vegetation will be sampled at all sites where the project goal includes establishment, enhancement, or conservation of vegetation. Sampling will be completed in all types of vegetation assemblages within the site. Results of the monitoring will be compared to site-specific percent cover, survival, percent native species, and non-native species targets based on reference conditions to determine if the performance standards are being met. Non-native plant species will be based on the current Oregon Department of Agriculture (ODA) Noxious Weed list and the Portland Plant List (Rank A, B, and C lists). The lists are regularly updated, and the most recent versions will be used.

Early Detection and Rapid Response Species will also be identified during the sampling. The current lists from the East and West Multnomah SWCDs (ESWCD 2014 and WSWCD 2014) will be used to determine the species that meet these criteria.

Sampling Methods

Sampling plots should be established along a straight line (sub-transects) perpendicular to the established physical transects with sub-transects spaced at a fixed interval with a randomly selected starting point. Number of plots, plot size, shape, and spacing will depend on the type of dominant vegetation at the site. For example, $1m^2$ plots are usually used for herbaceous plant communities (Thom et al. 2002), belt transects for shrubs (Havens et al. 2003), and 10-meter circular plots for riparian forest and upland forest (Roegner et al 2009). The details of the sample plot layout for a given site will be determined in the site-specific performance plan.
Table 2, which is adapted from Oregon Department of State Lands Routine Monitoring Guidance for Vegetation (ODSL 2009), can be used for an initial estimate the number of plots that will be needed by vegetation and habitat type.

Table 2. Minimum number of vegetation plots by vegetation and habitat type

Vegetation Types	Habitat Types	Number of Plots: Habitat type Up to 2 acres	Number of Plots: Habitat type >2 to 5 acres	Number of Plots: Habitat type >5 acres
Herbaceous	Emergent marsh, vegetated ACM, riparian, and upland	10	20	30
Shrub and Trees	Vegetated ACM, riparian, and upland	5	10	15

Monitoring Related to NRDA Restoration Goals:

Photo Monitoring

Photo points should be established at regular intervals along transects or other locations that would be suitable for documenting qualitative changes in site conditions for all habitat types that are being restored.

Water Quality

Water quality data should be collected at sites where the goal of the project includes improvements to water quality. If temperature is being monitored it is recommended that it be monitored continuously with a sensor and data logger. The sensor should be placed near one of the established physical transects and should be georeferenced. Other parameters such as dissolved oxygen should be collected at each established transect. These monitoring results will be compared to an appropriate reference condition.

Fish

Fish monitoring will be conducted at restoration sites to verify that the sites are being used by the target species. Where feasible, snorkel surveys, beach seining, or trapping of off- channel and tributary habitats will be conducted to determine presence or absence of juvenile salmonids and other native fish species. Snorkeling, where visibility allows, is the preferred method for confirming fish presence. If snorkeling is not feasible, seining or trapping methodologies may be approved (pursuant to a Section 7 consultation for ESA-listed salmonids); once fish presence is confirmed, sampling methods involving handling of ESA-listed fish will be discontinued. During the sampling the observer will attempt to estimate abundance and average size of any salmonids present. Generally, sampling for native fish should take place two times per month from February through May during years 1, 3, 5, 7, and 10. Lamprey monitoring will also be conducted by the USFWS to verify whether lamprey are using the sites and to enhance understanding of juvenile lamprey habitat preferences. Appendix B provides the details of the general lamprey monitoring plan. USFWS and the Tribal Trustees will develop a site-specific lamprey monitoring plan for each accepted restoration site.

Birds

Bird monitoring can be used to help validate project effectiveness by indicating changes in habitat structure and function, which tend to be reflected by associated changes in aquatic and terrestrial fauna and flora. Rather than monitoring a wider suite of wildlife species, birds were selected for several reasons: they are relatively cost-effective to monitor; birds are likely to be present on every site both before and after project construction; responses to on- the-ground changes can be readily documented; and trends in bird communities can be used to help confirm and communicate the outcomes of restoration projects to stakeholders, including the general public.

By conducting bird surveys, bird species and assemblages can be related to factors such as the availability and quality of various habitat types and trends that may be in response to restoration activities. Bird monitoring is also considered a surrogate for more detailed vegetation-based habitat monitoring. The vegetation monitoring outlined in Table 1 does not fully assess certain structural features that comprise functioning habitat. Vegetation monitoring that could assess functioning habitat would be time consuming and costly due to the amount of data and associated staff time associated with it. Bird monitoring is an effective way to gather information about habitat function.

Bird monitoring data will be collected pre-construction to document baseline conditions, and then

post-construction in years 1, 3, 5 and 10. The data will be used to document species occurrences, proportionate species abundances, species richness, and how bird assemblages change over time. Habitat that is becoming established and increasing in function for fish and wildlife should reflect an increasing number of bird species or detections of more sensitive species as habitats become more extensive, complex and suitable. It may be expected for some habitat types (i.e. ACM) that species richness reaches a plateau in earlier years of monitoring. Species richness in some other habitat types is likely to continue increasing (i.e. riparian forest) long after the 10-year monitoring period ends.

The site-specific monitoring plan will depend on what is found to be feasible and appropriate by the monitoring entity and Trustee Council representatives using guidance such as that found in Huff et al. 2000. Survey methods will involve point counts on transects or otherwise positioned throughout the site as needed to ensure all habitat types that will be impacted or restored are represented. Bird sampling will occur at least three times during the peak breeding season, generally spread out during the period between May 15 through the end of June. The locations of habitats both before and after the site is restored should be considered when establishing point count locations to ensure baseline conditions at the site can be compared with conditions that develop post-construction. Transects may be established that parallel the river, stream or other aquatic habitats or may be co-located with transects for other monitoring parameters, as appropriate.

Bald Eagle

Monitoring will determine bald eagle presence/absence, frequency of use and activity type, (e.g., perching, foraging and nesting activity) if present, and detect changes in these factors and use at the restoration sites over time. Data will be collected pre-construction to document baseline conditions and post-construction during years 3, 5, 7 and 10. Bald eagle use, and particularly foraging opportunities, are expected to increase as a result of the restoration activities and have a positive effect on bald eagle productivity.

Site-specific monitoring methods will depend on what is found to be feasible and appropriate by the monitoring party and Trustee Council representatives. Recommended methods include identifying an appropriate number and location(s) of monitoring stations that can be used to document bald eagle use of the entire site both pre- and post-construction. It may b e acceptable to use just one station if a suitable location can be identified. The station(s) can be located either on-site or off-site, and should be placed at the least intrusive (i.e., least likely to affect bald eagle behavior) vantage point(s) for observing bald eagle use at the project site. Monitoring should occur once a week for a total of two hours per day, varying between dusk and dawn on different sampling days from mid-December through August.

Mink

To measure mink response to the restoration projects, restored miles of shoreline, associated riparian habitat width (or acreage equivalent) and the number of structures installed that can provide den sites should be tracked. The sampling methods will depend on what is found to be feasible by the monitoring entity and Trustee Council representatives. Recommended methods include camera traps, which are non-invasive to the animal, and scent stations to lure animals into camera view, as they are mostly nocturnal and secretive. Scent stations with remote cameras should be installed and operated on each restoration site to detect presence/absence of mink before and after the project. Although mink will not be handled or marked, it may be possible to identify individuals based on their unique frontal markings or other physical features that can be observed in camera photos in order to document numbers of mink observed. Detecting juveniles traveling with adults will be possible through use of remote cameras.

Mink monitoring should take place pre-construction, and during years 3, 5, 7 and 10. Monitoring should take place at least twice a month for at least 12 weeks of the spring and summer, including the period from mid-April through mid-July at a minimum, and should take place in the same locations as the pre-construction monitoring, or as close as possible. Visual surveys for tracks, scat and den sites should be conducted in potential use areas during camera trap data collection and maintenance visits, or at least twice per month. Documentation of observed signs of mink should include GPS locations.

Benthic Macroinvertebrates

Benthic invertebrates will be collected and identified to determine richness and the types of macroinvertebrates that are present as indicators of habitat health. A habitat health index has not been developed for the mainstem Willamette River so benthic macroinvertebrate sampling will only be conducted at tributary sites. The number and locations of samples will depend on the specifics of the site location and will be identified in the site specific performance plan; data will be compared to reference conditions.

3.5 Data Analysis

The monitoring data will be analyzed using a combination of statistical and graphical analysis depending on the data type and the monitoring question being answered. Some parameters such as fish passage will be compared to a set of criteria (e.g. state and federal fish passage criteria). Other parameters such as vegetation will require additional statistical analysis to determine if performance standards are being met. The details of the data analysis will be determined *a priori* and will be specific to the habitat or species under evaluation. Success will be measured based on biological or statistical significance, as appropriate. For example, bald eagle monitoring will include collecting behavioral observations during distinct time periods to determine if the frequency of use at a site increases after restoration compared to baseline conditions or over time as the restoration develops. Table 3 shows the likely analysis methods for the different categories of monitoring parameters.

Table 3: Likely analytical methods for groups of monitoring parameters.

Parameter	Analysis Method
Geomorphic/Structural Features	Compare to as-built surveys using graphical and GIS analysis.
Hydrology	Graphical time series and analysis of aerial photos.
Sediment	Compare grain size distribution to site designs.
Vegetation	Graphical comparison and statistical analysis based on before-after-control-impact paired series (BACIPS) study design/minimal recovery repeated measures design.
Water Quality	Graphical time series with comparison to Willamette River or Multnomah Channel as a reference site.
Fish	Graphical time series of abundance and size frequency histograms for salmonids.
Birds	Graphical or statistical comparison of species richness values; develop species lists; tabulate numbers of individuals observed for each species detected to determine relative abundance.
Bald Eagles	Comparison of presence/absence data, categorical behavioral observations and changes in type and frequency of use to identify trends in use over time.
Mink	Tabulate mink camera passes (single or multiple individuals) observed by remote cameras. Record presence of juveniles observed by remote cameras. Identify individuals to the extent possible by unique frontal markings or other features observed on mink in photos.
Benthic Invertebrates	Tabulate numbers and types; compare to appropriate index.

3.6 Data Management and Reporting

At the completion of each sampling effort, data will be entered and stored in a project specific database. Whenever possible, monitoring data will be georeferenced and spatial information will be stored in the database. The field forms will be created to be compatible with the database in order to reduce the possibility of error during data entry.

3.7 Adaptive Management Framework

Each compensatory restoration project in Portland Harbor will have established final performance standards, which must be met by the end of the 10-year performance period in order to receive full restoration credit. In order to track progress toward attainment of the final performance standards, each project will also have interim performance standards (IPSs) established for monitored parameters at intervals throughout the 10-year period. It is expected that a project that is consistently meeting its IPSs is very likely to meet its final performance standards at the 10-year mark. A project that is not consistently meeting its IPSs may be at risk of failing to meet its final performance standards, which may result in a reduction of the project's final credit value.

The use of IPSs will provide timely information to the Trustee Council and project implementers (PIs) about the trajectory of habitat development that is taking place at the project site. Small adjustments made early in the performance period may help avoid the need for larger-scale, more expensive

course corrections later on. The Trustee Council has identified IPSs that are good indicators of performance, can be easily measured, and for which there are adaptive management measures that can be applied within the performance period.

Some IPSs will change over the 10-year monitoring period, reflecting expectations about progressive habitat development. See Section 3.3.2 for an example of progressive (i.e., interim performance) standards for riparian forest habitat.

Some IPSs will be constant throughout the 10-year performance monitoring period. For example, a project that removes a fish-blocking culvert to provide passage for salmon and other species will be expected to meet the standard of passability each year following project implementation. This IPS, therefore, will not be graduated, but will remain static throughout the monitoring period.

The Trustee Council anticipates that during the performance period, monitoring data may occasionally indicate that the project is not meeting one or more of its IPSs. Failure to meet the success milestones indicates that a basic restoration goal is not being met, and will trigger discussions and potential investigations regarding possible causes. Adjustments may need to be taken to ensure that the project is on track to meet its final performance standards.

Monitoring data showing that a project is not meeting its IPSs will trigger a consultation among Trustee Council and PI representatives. Possible causes for the non-conformance will be discussed. Supplemental monitoring data (i.e., data from monitoring not tied to performance standards, such as water quality) will be examined for information that would help identify the cause of the non-conformance. Assumptions about appropriate plant species, elevation, and other design factors will be reexamined and the project's performance standards adjusted if new information suggests this is appropriate. The PI will, in consultation with the Trustees, conduct an investigation of the reasons for the non- conformance, addressing:

- Can the cause of the non-conformance be identified?
- Is it technically feasible to modify or adjust the physical, chemical, or biological feature(s) of the habitat, or regulate operation or maintenance of the habitat, such that a parameter could subsequently achieve an acceptable level of development?
- What is the projected success and cost of the proposed modification?

Results of the investigation will determine modifications that may need to be implemented by the PI. If remedial measures are judged by the Trustee Council and the PI to be feasible and cost-effective, the PI will implement such measures, upon the Trustee Council's written recommendation. The Trustee Council has identified contingency measures by habitat attribute that are most likely to be recommended for implementation. Table 4 describes types of adaptive management actions that are likely to be taken to address performance issues by habitat type.

In order to ensure that funds are available to maximize the project's potential benefit, the PI will be required to place funds into a contingency fund (25% of habitat-related construction costs) for the purpose of implementing necessary adaptive management actions. Both the PI and the Lead Administrative Trustee will be signatories to the fund, so funds can only be released with approval of both parties. Adaptive management actions, jointly identified by the Trustee Council and PI, will be funded through the contingency account. At the end of the 10-year performance period, if the project meets its performance standards, any unspent funds can be returned to the PI by agreement of both parties.

In some cases, despite the implementation of adaptive management measures jointly identified by the Trustee Council and the PI, a project may fail to meet one or more of its final performance standards at the end of the 10-year performance period. This could result from one or more factors, including those related to design and construction, and those related to large-scale environmental events (100-year flood, earthquake, etc.). If the project has not met one or more of its performance standards at the end of the 10-year period, the PI will be required to implement adaptive management actions identified by the Trustee Council, to be funded with remaining contingency funds; these actions will be selected to maximize the project's benefit in light of limiting factors (including "acts of God" and events beyond the PI's control).

If the project has not met all of its performance standards after all contingency funds have been expended, but has met 90% or more of its' final performance standards, the PI will not be required to implement any further adaptive management actions, and release of the final 10% of credit can take place for a total of 100% credit released. Any further adaptive management actions deemed necessary by the Trustee Council will be funded through the Long-Term Stewardship Endowment, and carried out by the long-term steward. If the project has *not* met its performance standards after all contingency funds have been expended, and the project has met less than 90% of its' final performance standards, the PI will have the following two options:

1) the PI may allocate additional funds to adaptive management actions designed to help the project meet its performance standards; or
2) the PI may accept a reduction in the project's total credit value, to reflect lower-than- anticipated project performance. If the PI has already released more credit than the project provided (for example, if the PI has released 90% of credit and the project has only met 80% of performance standards), the PI will be required to produce the difference (in this example, 10% of the credit) through additional restoration on-site, through restoration at another site, or by purchasing credits from another restoration project.

If the Trustee Council and PI agree that a project has not met one or more of its performance standards because the standard is not attainable (because of individual project circumstances, or because of new information indicating that the selected standard was not appropriate for the site), the site will be re-surveyed and one or more new, site-appropriate standards will be identified. A revised credit estimate will be developed if the adjustment alters the amounts and/or types of habitat that the project is expected to provide. An adjustment of this type may trigger additional performance monitoring beyond the original 10 year performance period.

Table 4: Example site issues and adaptive management responses

Performance Standard	Example of Potential Problem	Example Adaptive Management Response
Geomorphic/Structural Habitat Elements		
At least X% of large wood and other critical habitat features that are placed in tributary, off-channel, active channel margin, riparian, and upland habitats will be retained.	More than X% of the large wood that was placed on site in the side channel has drifted away and no new wood has replaced it.	Review site configuration to determine if any structural changes could be made to help retain wood. If solution is found then additional wood should be placed.
Total area of side channel and active channel margin habitat will not change more than +/- X% from as built conditions	The site begins to silt in over a several year period and there continues to be a trend toward overall shallower depths that reduces the quantity of total ACM and side channel habitat.	Review monitoring results to determine if structural changes such as reconfiguring channel openings or addition of large wood structures are needed.
	Substantial erosion is occurring where the side channel connects to the Willamette River, Columbia River or Multnomah Channel.	
There will be no barriers to fish passage in or out of a site	Entrances to the site become silted in and cause fish stranding or block fish access.	Review monitoring results and project designs to determine if structural changes are necessary to maintain access.
Hydrology and Hydraulics		
These features will be comparable to an appropriate reference site and will not change more than +/- X% from as built conditions	Quantity of floodplain reconnection during high flows that was proposed was not created.	Review other physical monitoring results to determine the likely reason the habitat is not functioning as designed.
Sediment Composition		
Sediment composition will be comparable to an appropriate reference condition and remain consistent with project design.	A restored tributary or beach site becomes heavily silted.	Review physical monitoring data to determine what is causing the shift in sediment composition and determine what the appropriate solution is.
Vegetation		
Vegetation parameters will be site specific and comparable to reference conditions, if applicable.	Newly installed plants are not becoming established and thriving because of soil conditions or unsuitable hydrology. Plants are being grazed on by geese and animals using the site. Invasive plants begin to crowd out natives.	Amend the soil with an appropriate growing medium; review plant list and ensure species are suitable for site conditions, revegetate as needed. Install exclusion fencing until plants can become established. Institute a more aggressive invasive plant removal program.

4.0 Long-term Stewardship Framework

Long-term stewardship refers to described monitoring, maintenance, and adaptive management at a restoration project in perpetuity. At Portland Harbor, long-term stewardship will begin after a ten-year performance period of active monitoring and maintenance. The performance period will end when the Year 10 performance standards have been met or when the project implementer and the Trustee Council agree that that the establishment period is complete, whichever occurs first. Long-term stewardship will involve tasks such as:

- Regularly scheduled site visits to observe and document site conditions
- Managing invasive vegetation
- Maintaining fences and gates
- Ensuring any public uses are appropriate and any illegal or incompatible uses are addressed
- Long-term monitoring of parameters such as vegetation survival
- Clean-up and debris removal
- Maintaining positive relationships with adjacent landowners and interested community members
- Any other tasks required to maintain project effectiveness and full functionality of a given NRDA restoration project.

The goal of long-term stewardship is to ensure that a restoration project continues to meet the goals and objectives for that restoration project in perpetuity. In addition to active stewardship of the site through the types of activities listed above, the Trustee Council requires that the Project site be permanently protected with a conservation easement prior to the end of the 10-year performance period.

4.1 Need for Long-term Stewardship

The Habitat Equivalency Analysis (HEA) model used to calculate ecological credit for a NRDA restoration project assumes that a given site will continue to provide ecological benefit to injured resources at least 300 years into the future. In practice, a variety of natural and anthropogenic phenomena threaten the ecological value of a project throughout its existence. Newly disturbed soils may activate a fallow seed bank that includes invasive species. Major flood events may occur 5, 15, or 50 years after a project is installed and severely alter habitat element locations, elevations, or features. Decades in the future, project ownership or land ownership may be questioned or challenged by new land uses, new community members, or shifting management priorities. A long-term stewardship plan and permanent legal protection of the property by a conservation easement are needed to ensure that a restoration project's ecological integrity is maintained in perpetuity.

4.2 Long-term Steward Selection

The Long-term Steward (Steward) for a restoration project will be determined by the Trustee Council in cooperation with the Landowner and conservation easement holder (Easement Holder). This decision will be made before the long-term stewardship phase begins. Likely candidates for the role of Steward may be the Landowner or a third-party group, such as a non-profit organization with a natural resource conservation-oriented mission and restoration project management expertise.

Although there may be significant temptation to allow various project implementers, landowners, or potentially responsible parties to provide long-term stewardship at individual restoration projects, the Trustee Council has a strong preference towards employing a single, outside entity to provide long-term stewardship services at all Portland Harbor NRDA restoration projects to ensure objectivity, maximum efficiency, and consistency among the projects. The initial agreement between the Trustee Council and the Steward may be termed in order to allow for a trial period to make sure that the Steward is a proper fit for the needs of the restoration project. The Steward may choose to subcontract with other organizations for work crews, specialized technical assistance, or other activities as needed.

The Steward will work with the Landowner, Easement Holder, Trustee Council, and other stakeholders to develop a site-specific long-term stewardship agreement before the 10-year performance period ends or the10-year performance standards are met, whichever occurs first. The agreement must be consistent with the long-term stewardship requirements outlined in this framework. Once the Trustee Council has reviewed and approved the agreement, a transition period will follow. Documentation from as-built surveys, implementation monitoring, annual effectiveness monitoring, and records of all adaptive management decisions made within the initial 10-year performance monitoring period will be provided to the Steward. At that time, appropriate arrangements will be made between the Landowner and/or Easement Holder for access to the restoration project for regular site visits and work activities. Adequate funding to cover the cost of long-term stewardship will be provided by the endowment fund.

4.3 Scope of Work for the Long-Term Steward

Once the performance period has ended, the Steward acts as the primary manager of the NRDA restoration site. Tasks as Steward of the sites will include:

Program Management

If the Steward is responsible for more than one restoration project implemented to restore trust resources injured by contamination in Portland Harbor, the Steward will coordinate all long-term stewardship activities occurring across all sites. This task may include supervision of employees, contract negotiation with work crews or scientists conducting long-term effectiveness monitoring, development of scopes of work, management of subcontracts, and providing or contracting technical assistance. The Steward will be responsible for timely communications with the Trustee Council or its designee(s) and other stakeholders, and identification of additional partnerships or opportunities that may leverage the value and benefit of the Portland Harbor restoration projects. Its tasks will also include fiscal management of the long-term stewardship fund.

Initial Site Assessment

When a site first enters the Steward's Portland Harbor portfolio, an initial site assessment will be conducted to establish and document the current condition and identify any immediate maintenance needs. The site should have successfully met its performance standards during the 10-year performance period. Site visits, meetings with the project stakeholders, observational data collection, photo documentation, and GIS mapping might all be conducted in order to develop an initial assessment of the site's condition that will allow for subsequent evaluation of change at the site. The Steward will use this information to create a site-specific long-term stewardship plan.

Site-Specific Long-term Stewardship Plan

The Steward will develop a site-specific long-term stewardship plan for each restoration site in order to maintain the site's full functionality using the effectiveness monitoring results, adaptive management techniques employed during the first 10 years of a site's performance, and the initial site assessment. The plan should include a schedule for site visits, monitoring activities, anticipated maintenance needs, and provide a framework for decision-making should an unexpected event occur (e.g. trespass, arrival of a new invasive species). The plan should outline and define the types of maintenance actions anticipated at the site that will be included in the annual maintenance plan for the portfolio of projects as well as describe the approach that will be used to prioritize stewardship actions among sites each year. Development of the plan may also involve defining staff or stakeholder roles, identifying subcontracting mechanisms that could be used at the site, and establishing a process for regular documentation and reporting.

Site Visits

Visits will be made to the restoration site by the Steward on a regular basis in perpetuity. Site visits may take place on a more frequent basis (e.g. quarterly) in the early stages of site stewardship and be scheduled less frequently (e.g. annually) after a site has proven to need little maintenance. The frequency of site visits will be specified in the site-specific long-term stewardship plan. During site visits, the Steward will observe, document, and identify potential maintenance and adaptive management practices for the site to ensure that the ecological value for which it was credited is maintained in perpetuity. A thorough and consistent method for observational data collection will be developed and used at all sites within the Steward's Portland Harbor portfolio. This task will include labor, supplies used for assessment, and travel to and from the site.

Annual Maintenance Plan

Potential maintenance and adaptive management needs identified during site visits, monitoring data review, or through other methods will be documented for all restoration sites within the Steward's Portland Harbor portfolio on an annual basis. This list of potential actions will be prioritized and form the basis of an annual maintenance plan. Identifying individual priorities by considering them in the context of the needs of the entire portfolio ensures the most effective use of limited resources.[4] This task will include maintenance plan development, review among various stakeholders, and plan distribution.

Maintenance and Adaptive Management

The Steward will be responsible for implementing the site-specific long-term stewardship plan, annual maintenance plan, and employing adaptive management as needed. The Steward may employ staff, contracted crews, or volunteers to address maintenance and adaptive management concerns, such as invasive vegetation problems, fence maintenance, trash clean up, etc. This task will include on-site management, contracting, supplies for maintenance (e.g. plantings, mulch, and equipment) and travel.

[4] If a restoration project shares an endowment fund and Steward with one or more additional restoration projects, the Steward shall identify restoration project-specific priorities after considering those priorities in the context of the needs of the entire portfolio of restoration projects with shared endowment funding under its common stewardship.

Ongoing Effectiveness Monitoring

Some parameters from the original monitoring and maintenance plan at the site may warrant data collection beyond the initial 10-year performance period. These may be specific to habitat types that take greater than 10 years to establish (such as upland forests), individual species that may take longer to show a response at the site level (such as lamprey), or other factors that require less frequent monitoring over a longer period of time (such as contamination from upland or upstream sources). Potential parameters might include vegetation survival and composition. Starting in year 11, the Steward will take on primary responsibility for monitoring data collection. The monitoring plan for lamprey extends for a period of 20 years after project implementation and will be led by the USFWS and/or the Tribal Trustees throughout its duration. All effectiveness monitoring results will be shared with the Trustee Council or its designee(s) on an annual basis. This task will include labor, transportation, and supplies associated with planning, conducting, analyzing, and reporting on the ongoing effectiveness monitoring.

Community Relations and Engagement

The long-term viability of a restoration site is dependent upon a community that understands and supports the project and contributes towards site stewardship. The Steward cannot be expected to notice all of the potential issues that may threaten a site through occasional site visits alone. Encroachment onto the site by livestock or other domestic animals, illegal trespassing by humans, or large accumulations of human-derived trash and debris due to dumping or after a storm might each be most quickly observed (and consequently dealt with) by an informed and concerned community. The Steward will foster positive community relations with the landowner or easement holder, neighbors, and broader community so that such issues are dealt with quickly and thoroughly. This task might include labor for regularly scheduled community meetings, presentations to interested audiences, volunteer involvement, and email, flyers, posters, telephone, or in-person communications.

Enforcement

Trespassing, dumping, or other illegal activities may occasionally occur at the site and require enforcement of the conservation easement. This task may include labor and fees associated with reporting violations of the conservation easement to the landowner, easement holder, legal authorities, the Trustee Council or its designee(s), and others. The appropriate Trustee or its designee(s) will assume the responsibility of taking legal action on an enforcement issue as part of its ongoing oversight at the restoration sites.

Documentation and Reporting

The Steward will provide documentation of all monitoring, adaptive management, and stewardship tasks to the Trustee Council or its designee(s) and other interested parties on a regular basis. At a minimum, the documents outlined in Table 5 will be provided to the Trustee Council or its designee(s) as they are developed or on an annual basis, depending on their frequency. In addition, the Steward will make restoration site information and data available to the general public in the form of a website, online database, and/or online mapping feature so that the general public can access information about the site and stay involved in events such as work parties and community discussions.

Table 5: Required documentation for long-term stewardship activities at Portland Harbor.

Product	Purpose	Frequency	Individual Site or Portfolio?
Site Assessment	Describe baseline condition of site when long-term stewardship begins.	One time	Site
Stewardship Plan	Provides prioritization methodology and actions among sites.	Once at the beginning and then update periodically as needed.	Site and Portfolio
Maintenance Plan	Describes each year's activities based on priority actions.	Annual	Portfolio
Monitoring Report	Provides current condition information and management and maintenance recommendations for the following year.	Annual	Site
Fiscal Report	Document interest accrual, spending, and overall standing of long- term stewardship fund.	Annual	Site and Portfolio
Notification of Enforcement Issue	Notify the Trustee Council or its designee of enforcement issue and whether assistance is needed to resolve the problem.	As needed	Site

5.0 Trustee Council Oversight

During the performance period, the Trustee Council will oversee monitoring of all restoration projects implemented in the Portland Harbor NRDA case whether implemented by PRPs or by third party developers. The Trustee Council will work with project implementers to develop a site-specific monitoring plan for the performance period and the long-term stewardship period. During the performance period, the Trustee Council will review monitoring results, validate that the projects are meeting their performance standards, and work with the Steward and project implementers to develop site-specific long-term stewardship plans.

During the long-term stewardship phase of the project, the Trustee Council or its designee(s) may review and oversee regular reporting of effectiveness monitoring results, site visits, maintenance activities, qualitative monitoring results (observational and photographic), enforcement issues, financial management, adaptive management activities, and descriptions of community involvement that will be provided to the Trustee Council or its designee by the Steward.

6.0 Monitoring and Stewardship Funding

Monitoring during the performance period will be funded directly by the project implementer. During the long-term stewardship period, the costs for maintenance and monitoring will be paid for by an endowment established for this purpose. Since the long- term function of a restoration site cannot be ensured without long-term stewardship, credit for a site will not be given unless costs of long-term stewardship are included in a project's budget. Long-term stewardship funds will be transferred to an endowment and invested such that it will provide sufficient funds for management in perpetuity. Until a long-term steward is selected, the stewardship endowment will be overseen by a third party fiscal manager.

7.0 Permanent Protection

Prior to the end of the performance period, the restoration project will be permanently protected with a conservation easement. The Easement Holder shall be an organization qualified under ORS 271.715 (3) to hold a conservation easement. A permanent Easement Holder shall be approved by the Trustee Council, in cooperation with the Steward and Landowner, prior to the close of the 10-year performance period or before the performance standards are met, whichever occurs first. Once the permanent Easement Holder is approved, a conservation easement deed running with the land and restricting the uses of a restoration project consistent with the restoration plan, performance standards, and conservation values expressed therein will be recorded to ensure the protection of a restoration project in perpetuity.

In addition, a stewardship endowment will be established and funded up to a previously determined target amount. Long-term activities covered by this fund include, but are not limited to, the following: maintenance, monitoring, remediation, management, debris removal if hydrologic function is impaired, and removal of invasive vegetation impairing habitat function. As part of the process to approve a permanent Easement Holder, the Trustee Council, Easement Holder, Landowner, Endowment Manager, and Project Implementer shall create a mutually agreeable mechanism for the permanent Easement Holder to receive funding from the endowment fund to cover all reasonable expenses that it has incurred during the performance of its responsibilities under the conservation easement.

8.0 References

East Multnomah Soil and Water Conservation District. 2014. West Multnomah Early Detection and Rapid Response (EDRR) Weeds to Report. Retrieved May 15, 2014 from East Multnomah Soil and Water Conservation District Web Site: http://emswcd.org/on-your-land/weeds/weeds-to-report/

Gore, J.A. 1985. Mechanisms of colonization and habitat enhancement for benthic macroinvertebrates in restored river channels. Pages 81-101 in The Restoration of Rivers and Streams, J.A. Gore (ed). Boston, Massachusetts: Butterworths.

Hill, M.T., W.S. Platts, and R.L. Beschta. 1991. Ecological and geomorphological concepts for instream and out-of-channel flow requirements. Rivers 2(3): 198-210.

Huff, M.H., K.A. Bettinger, H.L. Ferguson, M.J. Brown and B. Altman. A Habitat-Based Point-Count Protocol for Terrestrial Birds, Emphasizing Washington and Oregon. Gen. Tech. Rep. PNW-GTR-501. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. P. 39

Hulse D., S. Gregory, J. Baker. (Eds). 2002. Willamette River Basin Planning Atlas: Trajectories of environmental and ecological change. (2nd edition), Oregon State University Press, Corvallis, Oregon 97333. p. 180.

Kouwen, N. and T.E. Unny. 1973. Flexible roughness in open channels. Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers 99 (HY5): 713-728.

Oregon Department of State Lands (ODSL). 2009. Routine Monitoring Guidance for Vegetation. Retrieved April 14, 2014 from the State of Oregon Web Site: http://www.oregon.gov/dsl/PERMITS/docs/dsl_routine_monitoring_guidance.pdf

Poff, N.L., and J.V. Ward, 1989. Implications of streamflow variability and predictions of lotic community structure: a regional analysis of streamflow patterns. Canadian Journal of Fisheries and Aquatic Sciences, pp. 1805-1818.

Roegner, G.C., H.L. Diefenderfer, A.B. Borde, R.M. Thom, E.M. Dawley, A.H. Whiting, S.A. Zimmerman, G.E. Johnson. 2009. Protocols for monitoring habitat restoration projects in the lower Columbia River and estuary. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-97, 63 p.

Thayer, G.W., T.A. McTigue, R.J. Bellmer, F.M. Burrows, D.H. Merkey, A.D. Nickens, S.J. Lozano, P.F. Gayaldo, P.J. Polmateer, and P. T. Pinit. 2003. Science-Based Restoration Monitoring of Coastal Habitats, Volume One: A Framework for Monitoring Plans Under the Estuaries and Clean Waters Act of 2000 (Public Law 160-457). NOAA Coastal Ocean Program Decision Analysis Series No. 23, Volume 1. NOAA National Centers for Coastal Ocean Science, Silver Spring, MD. 35 p. plus appendices.

Thorne, C.R. 1990. Effects of vegetation on riverbank erosion and stability. Pages 125-144 in Vegetation and Erosion, J.B. Thornes (ed), John Wiley and Sons Ltd.

West Multnomah Soil and Water Conservation District. April 2014. West Multnomah Early Detection and Rapid Response (EDRR) Treatment Species List. Retrieved April 20, 2014 from West Multnomah Soil and Water Conservation District Web Site: http://www.wmswcd.org/public/file/EDRR%20Booklet/WMSWCD_EDRR_List.pdf

Appendix A: Site Performance Plan Outline

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Appendix B. Lamprey Monitoring Plan

Introduction

The Portland Harbor Natural Resource Trustee Council Tribal Working Group (TWG) has found sufficient evidence that lamprey have been injured due to the release of hazardous substances in Portland Harbor to require compensation for these injuries. While restoration of habitat will most likely benefit lamprey as well as other species, additional compensation is appropriate to offset the lost services provided by lamprey due to their unique importance to tribes. Injury to lamprey ammocoetes due to contamination was identified through preliminary toxicity testing performed by the Trustee Council. The lost use of lamprey due to contamination was identified through interviews with Tribal members. During two workshops with Tribal and Trustee lamprey experts, the TWG learned that not enough is known about the types of habitat that lamprey prefer in large river systems or what habitat features would be most beneficial to design effective restoration projects targeted at benefiting lamprey. The TWG, with the help of the lamprey experts, decided that the best use of resources at this time is to incorporate a comprehensive lamprey monitoring program into the harbor-wide restoration monitoring plan, as well as detailed lamprey monitoring at each specific restoration site, rather than design restoration projects specifically for the benefit of lamprey. The objectives of this program are to evaluate how the restoration projects designed to benefit salmon and other species also benefit lamprey, and to gather data about habitat use by lamprey ammocoetes that may be used by the Tribal Trustees and others in the future to improve the design of restoration projects for lamprey.

Description of Lamprey Monitoring Plan

This over-arching lamprey monitoring plan is based on a set of monitoring goals and objectives (see Table B.1) that were developed by Trustee lamprey experts over two workshops held in the fall of 2011. This monitoring plan was developed to simultaneously monitor the impact of restoration actions on juvenile lamprey populations and health in Portland Harbor, and gather information about juvenile lamprey life history, biology, and habitat requirements that may be used by the Trustees in the future to design and evaluate lamprey restoration projects. This component differs from the general restoration monitoring and stewardship plan in that the lamprey monitoring continues for a period of 20 years.

The plan presented here represents a generalized approach for monitoring at individual restoration sites, reference sites, and harbor-wide study sites. While the goals and objectives will be consistent across study sites, site-specific conditions may result in slight modifications to the plan as outlined in this document (e.g., in terms of metrics collected, or methodology used). The specific study design for monitoring at each individual site will be outlined in a detailed site-specific monitoring plan.

Table B.1. Lamprey restoration monitoring goals and objectives

Goal	Objective
Evaluate how individual projects affect lamprey and their habitat	Determine occupancy by lamprey
	Determine where lamprey colonize within a site (habitat preference)
	Characterize genus and life history stage that colonized
	Determine health of lamprey observed in each location
Evaluate harbor-wide impact of restoration projects on Pacific lamprey	Evaluate colonization between sites
	Evaluate harbor-wide changes and trends
	Describe changes in ecosystem health (e.g., ecosystem diversity index)
Evaluate information from monitoring to inform future restoration work	Evaluate and use information to inform future restoration actions

Monitoring metrics and timing

A series of specific monitoring metrics will be measured to confirm locations where lamprey are found and to characterize habitat conditions where lamprey are observed. Some of the metrics that will be monitored for lamprey overlap with the general restoration monitoring metrics.

However, because lamprey are very different from other biota, the overlap between the lamprey monitoring plan and the general restoration monitoring and stewardship framework is not extensive. In most cases, the metrics collected as part of the lamprey monitoring effort need to be co-located with lamprey sampling. To maximize efficiencies, the Trustee Council will use the data collected as part of the lamprey monitoring plan for the general restoration monitoring and stewardship effort as much as possible. Table B.2 presents the lamprey monitoring metrics and the years in which monitoring will occur. It also indicates the overlap between the lamprey monitoring plan and the general restoration monitoring and stewardship framework, which will improve cost efficiency.

Table B.2. Lamprey monitoring metrics and data collection times

Metric	Years monitored	
	Restoration and reference sites	**Harbor-wide**
Presence/absence – probabilistic; standard effort; influence of habitat on sampling (e.g., conductivity, large woody debris, depth); time series over the course of monitoring	Pre-implementation, years 1–5, 10, 15, 20	Pre-implementation,[c] mid-point (years 9-11), end-point (years 18-20)
Relative abundance	Pre-implementation, years 1–5, 10, 15, 20	Pre-implementation,[c] mid-point (years 9-11), end-point (years 18-20)
Grain size and grain type[a]	Pre-implementation, years 1–5, 10, 15, 20	Pre-implementation,[c] mid-point (years 9-11), end-point (years 18-20)
Depth of sediment, changes in grain size with depth[a]	Pre-implementation, years 1-5, 10, 15, 20	
Sediment compactness	Pre-implementation, years 1-5, 10, 15, 20	
Sediment contaminant concentrations[a]	Pre-implementation, years 1, 10[b]	
Organic content	Pre-implementation, years 1–5, 10, 15, 20	
Water column temperature – time series[a]	Pre-implementation, years 1–5, 10, 15, 20	Pre-implementation, [c] mid-point (years 9-11), end-point (years 18-20)
Water depth	Pre-implementation, years 1–5, 10, 15, 20	
Water velocity – water column	Pre-implementation, years 1–5, 10, 15, 20	
Water velocity – at substrate surface	Pre-implementation, years 1–5, 10, 15, 20	
Presence and type of aquatic vegetation	Pre-implementation, years 1–5, 10, 15, 20	
Turbidity	Pre-implementation, years 1–5, 10, 15, 20	
Conductivity	Pre-implementation, years 1-5, 10, 15, 20	

Table B.2. Lamprey monitoring metrics and data collection times

Metric	Years monitored	
	Restoration and reference sites	Harbor-wide
Habitat complexity (e.g., number of transitions from fast to slow-moving water)	Pre-implementation, years 1-5, 10, 15, 20	
Detritus	Pre-implementation, years 1-5, 10, 15, 20	
Length of lamprey	Pre-implementation, years 1–5, 10, 15, 20	
Weight of lamprey	Pre-implementation, years 1–5, 10, 15, 20	
Identify fish genera	Pre-implementation, years 1–5, 10, 15, 20	
Qualitative health assessment (e.g., record lesions)	Pre-implementation, years 1–5, 10, 15, 20	
Life history stage (ammocoete, macrophthalmia, adult, egg/redd)	Pre-implementation, years 1–5, 10, 15, 20	
Compare spatial distribution data across sites	Pre-implementation, years 1–5, 10, 15, 20	
Characterization of Type I habitat	Pre-implementation, years 1–5, 10, 15, 20	

Notes:

a. Metric overlaps with general monitoring and stewardship program. Data collected as part of the lamprey monitoring program will be used for general monitoring and stewardship purposes as well.

b. Contaminant concentrations are not expected to change rapidly over 10 years. However, if monitoring data indicate that contaminant concentrations have changed or if an event occurs that could lead to recontamination, sediment contaminant data will be collected more frequently as needed.

c. Pre-implementation monitoring has already been completed for the harbor-wide sampling metrics (e.g., Jolley et al., 2012; Silver et al., Undated), and therefore the Trustees will rely on this work completed by the USFWS to characterize the pre-implementation baseline conditions.

The experts recommended monitoring lamprey for 20 years, with the goal of capturing data for one to two complete generations. Pre-implementation monitoring will be conducted to the extent practical at each restoration site (i.e. to the extent there is existing lamprey habitat pre-restoration). At some restoration sites, monitoring data may be available from other sources (e.g., existing USFWS or other agency studies). Where available and appropriate, these data

will supplement pre-implementation monitoring. Lamprey are expected to colonize habitats rapidly. Therefore, the experts recommended that monitoring be conducted on a yearly basis for the first five years, and every five years thereafter (see Table B.2). Sediment contaminant concentrations will be monitored less frequently – during pre-implementation and in years 1 and 10– than other metrics because this parameter is not likely to change quickly and the analyses are relatively expensive. Sediment contaminants will be monitored more frequently if there is a reason to suspect that contaminant levels at a site are causing adverse impacts, or if there is a release nearby or other event (e.g., flood or earthquake) that could cause recontamination at a restoration site.

In addition to the metrics measured in the field, three metrics will be evaluated using the data collected during monitoring: detection probability, occupancy, and diversity. Each of these parameters will be evaluated after field sampling has been completed for each sampling year for restoration project sites, reference monitoring sites, and harbor-wide sampling sites. The detection probability is calculated as the proportion of sampling units that are occupied.

Occupancy is a statistical evaluation of presence or absence of lamprey; using these data and the detection probability, this metric represents the probability that a sampling unit is occupied when a lamprey was not detected at a given location. Diversity will be calculated as part of the general restoration monitoring and stewardship framework and will help track the effect of restoration of total species diversity.

Monitoring locations

Lamprey monitoring will occur at three primary types of locations: restoration project sites, reference monitoring sites, and harbor-wide monitoring sites.

Restoration project sites

Lamprey will be monitored in off-channel wet areas and areas that are deeper than ordinary low water (5.1 feet North American Vertical Datum of 1988) at each restoration project site. At each site, sampling locations will be developed using methods previously devised by the USFWS (Jolley et al., 2012; Silver et al., Undated). These methods have been used in past studies to sample in areas of particular interest that are comparable in size to the restoration projects anticipated. The number of samples collected will depend on the number of distinct habitat types being created or restored in the restoration project (e.g., a project that creates an off channel alcove and restores a tributary stream channel would have two different types of lamprey habitat).

Reference monitoring sites

Reference monitoring sites will be used to assist in interpreting the results from monitoring of restoration project sites. Without reference information, it will not be possible to evaluate whether improvements to habitat associated with the restoration actions are responsible for observed changes in lamprey habitat usage or part of broader trends. Each restoration site will have a paired reference monitoring site, based on the BACI (Before-After- Control-Impact monitoring approach; Smith et al., 1993) method. BACI is a statistically sound monitoring method that uses paired sites and pre-implementation monitoring to evaluate the effects of a

restoration (or other) action in an area, while controlling for outside factors that may also influence the success of a project (e.g., hydrologic conditions, temperature, basin-wide population dynamics).

The reference monitoring sites will be selected by lamprey experts and will be located in or near the Portland Harbor study area. Sampling locations within each reference site will be developed using the same methods and frequencies as for the restoration sites. Where appropriate, the same reference monitoring site may be used for more than one restoration project with similar types of lamprey habitat.

Harbor-wide monitoring sites

To evaluate harbor-wide effects of restoration projects on lamprey health and population, a harbor-wide survey will be conducted at regular intervals throughout the 20-year monitoring period. These surveys will be completed less frequently than regular restoration project and reference site monitoring. The harbor-wide monitoring will be conducted throughout the

Portland Harbor study area and surrounding area using a statistically sound sampling method developed by the USFWS for past surveys of lamprey populations in the Willamette River (Jolley et al., 2012; Silver et al., Undated). A randomized set of sampling locations will be selected based on a statistical grid of the harbor. The metrics identified in Table B.2 will be included in the harbor-wide monitoring effort but the frequency will differ.

Harbor-wide monitoring will be completed at two future times: at the mid-point of the lamprey monitoring timeline and at the end of the monitoring period. A previous survey by the USFWS will be relied on to characterize baseline (i.e., pre-implementation) conditions. To help reduce uncertainty caused by inter-annual variability, each of the three sampling events will occur over a three-year period:

- Pre-restoration implementation: previous work by the USFWS will be used; new data do not need to be collected (e.g., Jolley et al., 2012; Silver et al., Undated)
- Mid-point sampling will occur in years 9, 10, and 11[5]
- End-point monitoring will occur in years 18, 19, and 20.

Methods

Individual sampling locations will be identified according to the randomized sampling technique used by the USFWS in their previous lamprey surveys conducted in Portland Harbor (Jolley et al., 2012; Silver et al., Undated).

Lamprey ammocoete sampling will be conducted using electroshocking techniques consistent with those used in previous USFWS lamprey sampling studies in Portland Harbor (Jolley et

[5] Where year 1 is the first year a restoration project is implemented in Portland Harbor.

al., 2012; Silver et al., Undated). In water shallow enough to wade (approximately < 3 feet), backpack shocking equipment and techniques will be used. In water too deep to wade (approximately > 3 feet), a deep-water electroshocking boat and techniques will be used.

Length, weight, genus, health (e.g., presence of lesions), and life history stage will be determined for lamprey collected by electroshocking (Table B.2.).

Habitat data (Table B.2) will be collected at each sampling location. Sediment samples will be collected at a sub-set of sampling locations and sent to an outside laboratory to analyze for dissolved oxygen content, grain size and type, and contaminant concentrations. Other habitat metrics identified in Table B.2 will be collected as appropriate (not all metrics will be collected for harbor-wide sampling or in deep- water conditions), including sediment depth, sediment compactness, water column temperature, water depth, water velocity, presence of aquatic vegetation, turbidity, conductivity, and presence of Type I habitat. These data will be collected at the same time as fish sampling and using standard techniques and equipment, as described in the general restoration monitoring and stewardship plan and in previous USFWS surveys. The details of the sampling plan will be developed by the group implementing the monitoring (e.g., USFWS) and will be reviewed by lamprey experts to ensure that appropriate techniques are used.

References

Jolley, J.C., G.S. Silver, and T.A. Whitesel. 2012. Occupancy and detection of larval Pacific lampreys and lampetra spp. in a large river: The Lower Willamette River. *Transactions of the American Fisheries.*

Silver, G.S., J.C. Jolley, and T.A. Whitesel. Undated. White Salmon River Basin: Lamprey Project (NFWF Project #2006-0175-020) Final Programmatic Report. Available: http://www.fws.gov/columbiariver/publications/WhiteSalmonR NFWF Final.pdf. Accessed 4/6/2012.

Smith, E.P., D.R. Orvos, and J. Cairnes Jr. 1993. Impact assessment using the Before-After-Control-Impact (BACI) Model: Concerns and comments. *Canadian Journal of Fish and Aquatic Science* Vol. 50. Available: http://www.web-e.stat.vt.edu/vining/smith/Impact Assessment.pdf. Accessed 4/30/2012.

Appendix C: Portland Harbor Native Plants Restoration List

Scientific Name Of Stock	Common Name	Status	Grouping	Elevation	Availability Of Stock	Ease Of Establishment	Historic Presence
Abies grandis	Grand fir	Native	Wetland, Riparian, Forest, Forest Slope	Low to Mid Elevation	Good	Good	Uncommon
Acer circinatum	Vine maple	Native	Forest, Forest Slope, Grassland	Low to Mid Elevation	Good	Good	Moderate
Acer macrophyllum	Bigleaf Maple	Native	Forest/Thicket	Low to Mid Elevation	Good	Good	Common
Achillea millefolium L.	Yarrow	Native	Grassland, Thicket	Low to High Elevation	Good	Good	Common
Adiantum pedatum	Maidenhair Fern	Native	Riparian, Forest, Forest Slope, Rocky	Low to Middle Elevation	Good	Moderate	Uncommon
Allium accuminatum	Hooker's Onion	Native	Open Forest, Rocky, Grassland	Low Elevation	Good	Good	Uncommon
Allium cernuum	Nodding Onion	Native	Open Forest, Rocky, Grassland	Low Elevation	Good	Good	Uncommon
Alnus rhombifolia	White Alder	Native	Riparian	Low to High Elevation	Good	Good	Uncommon
Alnus rubra	Red Alder	Native	Riparian, Forest, Forest Slope	Low Elevation	Good	Good	Common
Amelanchier alnifolia	Serviceberry, Saskatoon	Native	Forest, Forest Slope, Thicket	Low to Mid Elevation	Good	Good	Moderate
Angelica arguta	Sharptooth angelica	Native	Wetland, Riparian	Low to Mid Elevation	Good	Probably best from seed	Common
Angelica spp.	Angelica	Native	Riparian	Low to High Elevation	Good	Probably best from seed	Common
Apocynum cannabinum	Dogbane (Indian Hemp)	Native	Grassland, Thicket	Low to High Elevation	Moderate	Good	Uncommon
Aquilegia formosa	Red Columbine	Native	Riparian, Forest, Meadow, Rocky	Low to High Elevation	Good	Good	Uncommon
Arbutus menziesii	Pacific Madrone	Native	Rocky	Low to Mid Elevation	Good	Hard	Moderate
Arctostaphylos uva-ursi	Kinnikinnick	Native	Forest, Forest Slope, Rocky, Riparian	Low to High Elevation	Good	Moderate	Moderate
Asarum caudatum	Wild Ginger	Native	Forest, Forest Slope	Low to Mid Elevation	Good	Moderate	Moderate

Scientific Name Of Stock	Common Name	Status	Grouping	Elevation	Availability Of Stock	Ease Of Establishment	Historic Presence
Brodiaea hyacinthia	Hyacinth Broadiaea	Native	Meadow, Forest Slope, Rocky	Low Elevation	Good	Good	Uncommon
Camassia quamash	Camas	Native	Wetland, Meadowland	Low to Mid Elevation	Good	Good	Uncommon
Carex obnupta	Slough Sedge	Native	Wetland, Riparian	Low Elevation	Good	Good	Common
Carex pellita	Woolly Sedge	Native	Wetland, Riparian, Meadow	Low to High Elevation	Review	Review	Review
Carex spp.	Sedges	Native	Wetland	Low to High Elevation	Good	Good	Common
Carex vesicaria	Inflated Sedge	Native	Wetland, Riparian	Low to Mid Elevation	Review	Review	Review
Cicuta douglassi	Douglas' Water-Hemlock	Native	Wetland, Riparian	Low to Mid Elevation	Review	Review	Review
Claytonia perfoliata	Miner's lettuce	Native	Riparian, Forest	Low to Mid Elevation	Review	Review	Moderate
Clinopodium douglasii	Yerba buena	Native	Riparian	Low to High Elevation	Review	Review	Review
Cornus canadensis	Bunchberry dogwood	Native	Riparian, Forest, Thickets, Meadows	Low to High Elevation	Good	Moderate	Moderate
Cornus nuttallii	Pacific Dogwood	Native	Riparian, Forest, Thickets, Forest Slope	Low Elevation	Good	Moderate	Moderate
Cornus sericea ssp. Sericea	Red Osier Dogwood	Native	Wetland, Riparian, Thicket	Low to Mid Elevation	Good	Good	Common
Cornus stolonifera	Red Osier Dogwood	Native	Wetland, Riparian, Thicket	Low to Mid Elevation	Good	Good	Common
Corylus cornuta	Beaked Hazelnut	Native	Forest, Forest Slope, Thicket	Low to Mid Elevation	Good	Good to moderate	Moderate
Crataegus douglassii	Black hawthorn	Native	Thickets, Grasslands	Low to Mid Elevation	Good	Good	Moderate
Delphinium menziesii	Menzies' Larkspur	Native	Grasslands, Meadows, Thickets	Low to Mid Elevation	Good	Good	Uncommon
Delphinium spp.	Larkspur	Native	Riparian, Forest, Thickets, Meadows	Low to High Elevation	Good	Good	Uncommon
Eleocharis palustris	Creeping Spike-Rush	Native	Wetland, Riparian	Low to Mid Elevation	Good	Moderate	Review
Eloecharis spp.	Spike Rush	Native	Emergent, Wetland, Riparian	Low to Mid Elevation	Good	Moderate	Review
Epilobium angustifolium	Fireweed	Native	Grasslands	Low to Mid Elevation	Good	Good	Common

Scientific Name Of Stock	Common Name	Status	Grouping	Elevation	Availability Of Stock	Ease Of Establishment	Historic Presence
Eriophyllum lanatum	Common Wooly Sunflower, Oregon Sunshine	Native	Rocky	Low to Mid Elevation	Good	Good	Uncommon
Fragaria vesca	Woodland Strawberry	Native	Riparian, Forest, Grassland	Low to High Elevation	Good	Good	Moderate
Fragaria virginiana	Wild Strawberry	Native	Riparian, Forest, Grassland	Low to High Elevation	Good	Good	Common
Fraxinus latifolia	Oregon Ash	Native	Riparian, Wetland, Thickets	Low to High Elevation	Good	Good	Common
Galium aparine	Cleavers	Native	Riparian, Forest, Thickets	Low to Mid Elevation	Review	Review	Review
Galium boreale	Small Bedstraw	Native	Riparian, Forest, Thickets, Rocky	Low to High Elevation	Good	Good	Moderate
Galium triflorum	Sweet Scented Bedstraw	Native	Wetland, Riparian	Low to Mid Elevation	Good	Good	Moderate
Gaultheria shallon	Salal	Native	Forest, Forest Slope, Rocky, Thickets	Low to Mid Elevation	Good	Good to moderate	Common
Goodyera oblongifolia	Rattlesnake Plantain	Native	Forest	Low to Mid Elevation	Good	Good	Uncommon
Heracleum lanatum	Cow parsnip	Native	Riparian, Forest	Low to High Elevation	Good	Good	Common
Holodiscus discolor	Oceanspray	Native	Forest, Forest Slope, Thicket	Low to Mid Elevation	Good	Good	Common
Howellia aquatilis	Water Howellia	Native	Aquatic, Wetland	Low to Mid Elevation	Poor	Unknown	Uncommon
Juncus effusus	Soft Rush	Native	Wetland, Riparian	Low to Mid Elevation	Good	Good	Common
Juncus spp.	Rushes	Native	Wetland, Riparian	Low to High Elevation	Good	Good	Common
Ledum glandulosum	Western Labrador tea	Native	Riparian, Thickets	Low to Mid Elevation	Good	Moderate, alkaline soils, bogs	Uncommon
Ledum groenlandicum	Bog Labrador tea	Native	Riparian, Thickets	Low to Mid Elevation	Good	Moderate, alkaline soils, bogs	Uncommon
Linnaea borealis	Twinflower	Native	Forest, Forest Slope	Low to High Elevation	Good	Low to moderate	Uncommon

Scientific Name Of Stock	Common Name	Status	Grouping	Elevation	Availability Of Stock	Ease Of Establishment	Historic Presence
Lomatium spp.	Lomatium	Native	Grassland, Rocky	Low to Mid Elevation	Good	Moderate	Uncommon
Lonicera ciliosa	Orange Honeysuckle	Native	Forest, Thicket	Low to High Elevation	Good	Moderate	Moderate
Lonicera involucrata	Black Twinberry	Native	Wetland, Riparian, Grassland	Low to High Elevation	Moderate	Good	Moderate
Lupinus spp.	Lupine	Native	Grassland	Low to High Elevation	Good	Good	Varies by
Lysichiton americana	Skunk cabbage	Native	Wetland, Riparian	Low to Mid Elevation	Good	Good	Uncommon
Mahonia (Berberis) aquifolium	Tall Oregon grape	Native	Forest, Forest Slope	Low to Mid Elevation	Good	Good	Moderate
Mahonia (Berberis) nervosa	Dull (Low) Oregon Grape	Native	Riparian, Forest	Low to High Elevation	Good	Moderate	Moderate
Malus fusca	Pacific Crabapple	Native	Forest, Riparian, Thickets	Low to Mid Elevation	Good	Good	Moderate
Mentha arvensis	Field Mint	Native	Wetlands, Riparian, Thickets	Low to Mid Elevation	Good	Good	Common
Mimulus guttatus	Sticky monkeyflower	Native	Riparian	Low to High Elevation	Good	Moderate	Moderate
Nuphar polysepalum	Yellow pond lily, wocas	Native	Wetland Submerged	Low to Mid Elevation	Good	Good	Moderate
Oemleria cerasiformis	Indian Plum, Osoberry	Native	Open Forest, Riparian	Low to Mid Elevation	Good	Good	Common
Osmorhiza occidentalis	Western sweet cicely	Native	Forest	Low to Mid Elevation	Review	Review	Review
Oxalis oregana	Wood Sorrel	Native	Forest, Open Forest, Riparian	Low to Mid Elevation	Good	Good	Common
Perideridia gairdneri	Gairdner's Yampah	Native	Thickets, Meadows	Low to Mid Elevation	Review	Review	Uncommon
Philadelphus lewisii	Mock Orange	Native	Forest, Forest Slope, Thicket	Low to Mid Elevation	Good	Good to moderate	Uncommon
Physocarpus malvaceus	Pacific Ninebark	Native	Riparian, Forest	Low to Mid Elevation	Good	Good	Common
Populus balsamifera	Black Cottonwood	Native	Wetland, Riparian	Low to Mid Elevation	Good	Good	Common
Potentilla anserina	Silverweed	Native	Riparian	Low to Mid Elevation	Good	Good	Moderate

Scientific Name Of Stock	Common Name	Status	Grouping	Elevation	Availability Of Stock	Ease Of Establishment	Historic Presence
Potentilla spp.	Silverweed, Cinquefoil	Native	Riparian	Low to High Elevation	Good	Good	Uncommon
Prunus emarginata	Bitter Cherry	Native	Riparian, Forest, Forest Slopes, Thickets	Low to Mid Elevation	Good	Moderate	Uncommon
Prunus virginiana	Chokecherry	Native	Riparian, Forest, Thicket	Low to Mid Elevation	Good	Good	Uncommon
Pseudotsuga menziesii	Douglas-fir	Native	Forest, Forest Slope	Low to High Elevation	Good	Good	Common
Pteridium aquilinum	Bracken Fern	Native	Riparian, Forest, Forest Slopes, Meadow	Low to High Elevation	Review	Review	Review
Quercus garryana	Oregon White Oak	Native	Forest, Grassland	Low Elevation	Good	Good to moderate	Moderate
Rhamnus purshiana	Cascara	Native	Riparian, Forest, Forest Slope	Low to Mid Elevation	Good	Good	Common
Ribes spp.	Currants	Native	Riparian, Forest, Forest Slope, Thicket, Meadow	Low to High Elevation	Good	Good to moderate by species	Moderate
Rosa spp.	Wild rose	Native	Riparian, Forest, Forest Slope, Thickets	Low to Mid Elevation	Good	Good to moderate	Common
Rubus idaeus	Wild raspberry	Native	Thickets, Open Forest	Low to Mid Elevation	Good	Good	Uncommon
Rubus leucodermis	Black Raspberry, Blackcap	Native	Thickets, Open Forest	Low to Mid Elevation	Good	Good	Uncommon
Rubus parviflorus	Thimbleberry	Native	Riparian, Forest, Forest Slope	Low to High Elevation	Good	Good	Moderate
Rubus spectabilis	Salmonberry	Native	Riparian, Forest	Low to High Elevation	Good	Good to moderate	Moderate
Rubus ursinus	Trailing blackberry	Native	Thickets, Open Forest	Low to Mid Elevation	Good	Good	Common
Sagittaria latifolia	Wapato	Native	Wetland, Riparian; Submerged	Low Elevation	Good	Good	Uncommon
Salix spp.	Willow	Native	Wetland, Riparian, Forest	Low to High Elevation	Good	Good	Common
Sambucus spp.	Elderberry	Native	Riparian, Forest, Forest Slope, Thicket	Low to Mid Elevation	Good	Good to moderate	Moderate

Scientific Name Of Stock	Common Name	Status	Grouping	Elevation	Availability Of Stock	Ease Of Establishment	Historic Presence
Satureja douglasii	Yerba Buena	Native	Open Forest, Thickets, Rocky	Low to Mid Elevation	Good	Good	Uncommon
Schoenoplectus acutus, Scirpus acutus	Tule, Hard-stemmed bullrush	Native	Wetland, Riparian	Low to Mid Elevation	Good	Good	Common
Sidalcea Nelsoniana	Nelson's Checkermallow	Native	Wet meadow, Forest edge, Riparian	Low to Mid Elevation	Good	Good	Uncommon
Sium suave	Hemlock water parsnip	Native	Wetland, Riparian	Low to Mid Elevation	Review	Review	Review
Smilacina racemosa	False Solomon's seal, large	Native	Wetland, Forest, Forest Slope, Thicket	Low to High Elevation	Good	Moderate	Moderate
Smilacina stellata	False Solomon's seal, small	Native	Forest	Low to High Elevation	Good	Moderate	Moderate
Solidago canadensis	Canada Goldenrod	Native	Grasslands, Meadowland	Low to Mid Elevation	Good	Good	Moderate
Spiraea douglasii	Douglas Spirea	Native	Wetland, Riparian, Thicket	Low to Mid Elevation	Good	Good	Moderate
Symphoricarpos albus	Snowberry	Native	Forest, Forest Slope, Thicket	Low to Mid Elevation	Good	Good	Moderate
Taxus brevifolia	Western Yew, Pacific Yew	Native	Forest, Forest Slope	Low to Mid Elevation	Good	Good	Uncommon
Thalictrum occidentale	Western Meadow Rue	Native	Forest	Low to High Elevation	Good	Good	Review
Thuja plicata	Western Red Cedar	Native	Wetland, Riparian, Forest	Low to Mid Elevation	Good	Moderate	Moderate
Tricholoma populinum	Mushroom	Native	Forest, Forest Slope, Open Forest	Low to High Elevation	Review	Review	Varies by variety
Tsuga heterophylla	Western Hemlock	Native	Forest, Forest Slope, Riparian	Low to Mid Elevation	Good	Moderate	Moderate
Urtica dioica	Nettle	Native	Riparian, Thickets, Meadow, Open Forest	Low to High Elevation	Good	Good	Common
Vaccinium spp.	Huckleberry	Native	Forest, Forest Slope	Low to High Elevation	Good	Low to Moderate	Uncommon

Scientific Name Of Stock	Common Name	Status	Grouping	Elevation	Availability Of Stock	Ease Of Establishment	Historic Presence
Veratrum viride	Indian hellebore, False Hellebore	Native	Riparian, Thickets, Meadows, Open Forest	Low to High Elevation	Good	Good	Uncommon
Veronica americana	American Speedwell, Brooklime	Native	Wetland, Riparian	Low to Mid Elevation	Good	Good	Uncommon
Veronica anagallis-aquatica	Water Speedwell	Native	Wetland, Riparian	Low to High Elevation	Review	Review	Review
Viola canadensis	Canada Violet	Native	Riparian, Forest	Low to Mid Elevation	Review	Review	Review
Xanthium strumarium	Cocklebur	Native	Riparian, Thickets	Low to Mid Elevation	Review	Review	Review
Zigadenus spp.	Death camas	Native	Meadow, Grasslands	Low to Mid Elevation	Good	Good	Uncommon