PORTLAND HARBOR NATURAL RESOURCE TRUSTEE COUNCIL

RESTORATION PLANNING PROCESS AND CRITERIA

INTRODUCTION:

This first phase of restoration planning is limited in scope to developing technical and feasibility criteria that will be used to identify and evaluate early restoration opportunities, primarily along the Willamette River from the City of Portland to the confluence with the Columbia River.

The transport and fate of Portland Harbor releases have not yet been studied or determined, nor has there been an assessment of the injuries to natural resources that those releases may have caused. Potential restoration opportunities outside of the Portland Harbor study area will be addressed in a later document.

BACKGROUND:

In 2007, the Portland Harbor Natural Resource Trustee Council (Trustees) began working on a draft Restoration Plan with the goal of restoring natural resources in the Willamette River as well as other resources that have been adversely affected by releases of hazardous substances in Portland Harbor.[1] To accomplish this goal, the Trustees established three work objectives or tasks.

Task 1. Identify restoration objectives and selection criteria to apply to a list of potential restoration actions that could be implemented in the short term (up to five years). This list will be used to identify restoration projects and guide "early" restoration efforts.

Task 2. Apply restoration objectives and selection criteria to a more comprehensive list of longer term restoration opportunities within and potentially outside the Portland Harbor study area, which can be prioritized and scaled in accordance with the injury assessment as it proceeds and after it is completed.

Task 3. Develop an implementation plan for restoration within the Harbor, focusing on moving high-priority projects toward "readiness" (i.e., ready to implement within two to five years), and protecting limited, high-value restoration opportunities within the study area. Restoration plan implementation will require working closely with municipal and non-governmental partners, and *may* require the use of legal and administrative tools such as mitigation or conservation banks.

[1] The limited scope of this first phase of restoration planning is not to be construed as implying: 1) that natural resource injuries resulting from hazardous substances released within the Portland Harbor study area are limited to the Willamette River, or 2) that restoration projects outside the Portland Harbor study area are inappropriate.

The Trustees have completed Task 1, as described below.

CRITERIA:

Under Oil Pollution Act (OPA) regulations (15 CFR § 990.54), the Trustees may develop a reasonable range of primary and compensatory restoration alternatives, and then identify the preferred alternatives based on the following criteria[2] (Trustees may assign priority order, and add additional considerations):

- cost to carry out the alternative
- extent to which each alternative is expected to meet the Trustees' goals and objectives in returning the injured natural resources and services to baseline and/or compensating for interim losses
- likelihood of success of each alternative
- extent to which each alternative will prevent future injury as a result of the release and will avoid collateral injury as a result of implementing the alternative
- extent to which the alternative benefits more than one natural resource or service
- effect of each alternative on public health and safety

These threshold criteria will comprise the initial screening for all potential restoration actions under Tasks 1 and 2 (short term and long term restoration planning), above. The Trustees have separated these threshold criteria into four categories: 1) criteria to assess the ecological benefit of a project, 2) criteria to evaluate social constraints (feasibility), 3) criteria to evaluate geographic area, and 4) criteria to evaluate rare and unique restoration opportunities. A potential project that provides high ecological benefit and few social constraints will be a high priority restoration action, labeled 1 in Figure 1. Conversely, a project that provides low ecological benefit and high social constraints will be a low priority restoration action, labeled 3 on Figure 1.

[2] The OPA criteria are similar to the factors outlined in the CERCLA regulations (43 CFR § 11.82[d]) that should be considered when selecting restoration alternatives.

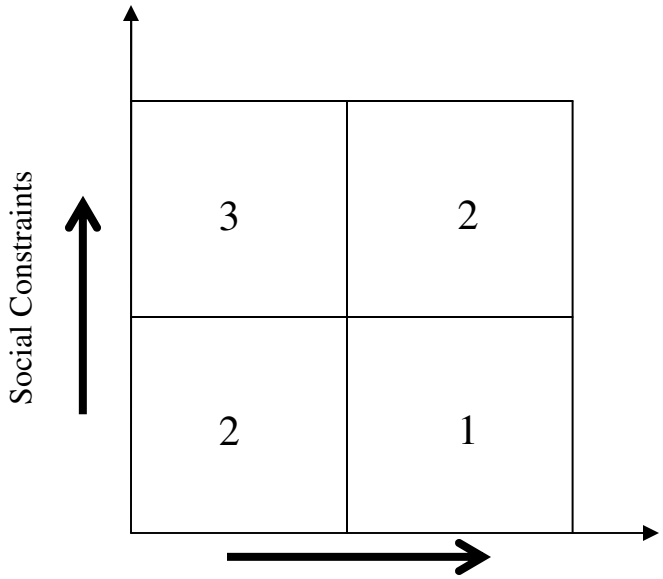

Figure 1. Highest priority restoration actions are the actions with the greatest amount of ecological benefit and the fewest social constraints.

The four criteria (ecological benefit, social constraints (feasibility), geographic area, and criteria to evaluate rare and unique restoration opportunities) will be applied to potential restoration actions. The next step will be to develop a list of high, medium and low priority restoration actions. The restoration actions will be grouped, rather than given an absolute ranking, because some of the criteria rely on subjective assessments and judgment by reviewers.

1. Ecological Benefit Criteria

Criteria to identify the ecological benefit of a potential restoration action were developed separately for fish and wildlife species. The Trustees identified salmon and steelhead, lamprey and sturgeon as the target fish species, and bald eagle, osprey, spotted sandpiper, and mink, as the target wildlife species. These species were selected because they represent guilds common in Pacific Northwest river systems, and because these species have the potential to be injured by hazardous releases in the Harbor.

The Trustees also studied the history of habitat changes in the lower Willamette River, defined desired future conditions, and determined that a restoration action must meet at least one of the following objectives:

1. move towards normative hydrology
2. restore floodplain function
3. reestablish floodplain and riparian plant communities

4. improve aquatic and riparian habitat conditions
5. improve river margin habitat (increase complexity in river margins)
6. restore habitat that provides ecological value in the landscape perspective (patch size, shape and distance between different patches of habitat)

To evaluate whether a potential restoration action can achieve these objectives, the Trustees developed indicators that describe the ecological variables that are needed to meet the objectives (Tables 1 for fish species and Table 2 for wildlife species). Some indicators are relevant for all species groups, and others are only relevant for one species group. The Trustees defined each indicator and developed a rationale for its application for each species; indicator definitions may vary when applied to different fish and wildlife species. For each indicator, specific criteria were identified to evaluate how well a proposed restoration project would meet the objectives through that indicator. The score for each restoration project can be calculated by taking the difference in the sum of the individual indicator scores before and after restoration project implementation. The score represents the difference between current and potential restored condition at a site, or in other words, restoration value. This process is more fully described in a separate document ("fish criteria").

Fish

Despite the extensive industrial presence and mixed habitat quality of the Portland Harbor, a wide variety of fish species rely on the area as a corridor for upstream and downstream movements, and for breeding, foraging and rearing young. At least 39 species of resident and anadromous fish, including 20 native species, have been documented in the lower Willamette River (Farr and Ward 1993). The area serves as a critical migratory corridor for both juvenile and adult anadromous Pacific salmon (*Onchorhynchus* spp.) listed as threatened under the Endangered Species Act, Pacific lamprey (*Lampetra tridentata*), and white sturgeon (*Acipenser transmontanus*). In addition, salmon species such as chum salmon that migrate or rear in the Columbia River use the Willamette River as a movement and rearing corridor.

Lower trophic level inhabitants of Portland Harbor include infaunal, epifaunal and pelagic invertebrates such as oligochaete worms, chironomid larvae and various midges. These are important food sources for juvenile salmon and steelhead in the lower Willamette River.

Similar to the risk assessment phase of the remedial investigation, the Trustees selected key ecological receptors representative of certain feeding guilds to help focus identification of initial restoration opportunities. These species were the same ecological receptors used in the risk assessment, and were also considered important due to their protection under federal or state statutes, their sensitivity to certain contaminants, or high potential to be injured by contaminants at the site as identified in the Preassessment Screen (Portland Harbor Natural Resource Trustee Council 2007). For instance, juvenile Chinook salmon collected at four locations in the harbor and an upstream reference site indicate that subyearlings spend sufficient time rearing in Portland Harbor to

bioaccumulate compounds at concentrations that represent local sources (Integral and Windward 2006). Contaminant concentrations circulating in the bloodstream during this early development stage pose a potential risk of sublethal effects to fish, including impacts to growth and maturation. PCB concentrations in subyearling salmon from Portland Harbor exceed adverse effects values, and PAHs in prey items and whole-body tissues threaten immune system function, growth, and long-term survival of these individuals.

The City of Portland developed criteria to determine the highest value restoration projects in the Lower Willamette River as part of its "Phase 1 Project Screening Process for the Lower Willamette Ecosystem Restoration Feasibility Study" based on value to salmonids. The Trustees modified and expanded the City's criteria to include lamprey and sturgeon, and to meet the Trustees' objective of the recovery and maintenance of processes essential to support ecosystem function in the lower Willamette River.

Table 1. The relevant indicators for functioning fish habitat within the lower Willamette River.

	Relevant for		
Indicator	Salmon	Lamprey	Sturgeon
1. Shallow in-water habitat-mainstem sites	✓	✓	
2. Residual Pool depth -tributary sites	✓	✓	
3. Shoreline gradient	✓		
4. Instream habitat structure	✓	✓	✓
5. Sediment and water quality	✓	✓	✓
6. Off-channel habitat proximity	✓	✓	
7. Off-channel habitat quality	✓	✓	
8. Floodplain connectivity	✓	✓	
9. Natural streambank	✓	✓	
10. Streambank slope	✓		
11. Quantity of riparian vegetation	✓	✓	
12. Presence of native vegetation	✓	✓	
13. Presence of wetlands	✓	✓	
14. Impervious area	✓	✓	✓
15. Presence of deep water habitat			✓
16. Connectivity between habitat patches	✓	✓	
17. Access to tributaries	✓	✓	

Wildlife

Despite the extensive industrial presence and mixed habitat quality of the Portland Harbor site, a wide variety of natural resources rely on the area as a migration corridor as well as for nesting, breeding, foraging, and rearing young. There are numerous

migratory birds nesting near or within the site and foraging in the open water and nearshore habitats, including piscivorous species such as bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), double-crested cormorant (*Phalacrocorax auritus*), great blue heron (*Ardea herodias*), belted kingfisher (*Ceryle alcyon*), common (*Mergus merganser*) and hooded (*Lophodytes cucullatus*) mergansers, and other waterfowl. The beach habitats and aquatic plants along the shorelines provide good habitat for passerines and aquatic-associated birds. Bird species nesting and foraging along the beach, nearshore habitat, and in unvegetated areas or on developed structures include cliff swallows (*Petrochelidon pyrrhonota*), various waterbirds, and shorebirds such as spotted sandpiper *(Actitis macularius*). Bird species that use gravel bars for nesting include common nighthawk, killdeer, and streaked horned lark. Insect production is high in river/riparian and wetland systems, and many bird species forage in the area, but may nest elsewhere. These species include purple martin, little willow flycatcher, olive-sided flycatcher, short-eared owl, and Wilson's warbler among other species. Mammals including mink (*Mustela vison*) and river otter (*Lontra canadensis*) use the area as a corridor, as well as forage in the river and rear young along the shoreline habitats. Some amphibian species such as northern red-legged frogs (*Rana aurora aurora*) and Pacific treefrogs (*Pseudacris regilla*) have been observed in the Portland Harbor study area, and long-toed salamanders (*Ambystoma Macrodactylum*) are expected in the area. Nearshore habitat, low water velocity areas, and lentic areas are important breeding and foraging areas for these amphibian species. In contrast, reptiles such as western painted turtles (*Chrysemys picta*) and northwestern pond turtles (*Actinemys marmorata*) are more likely to use the lower river as a corridor, especially at connections to and from areas such as Oaks Bottom, the Columba Slough, Sauvie Island, and Smith and Bybee Lakes. A number of species more common to habitats just outside the Portland Harbor study area may visit as transients.

During the risk assessment phase of the remedial investigation conducted by the Lower Willamette Group for the Portland Harbor Superfund site, a number of wildlife species were selected as key ecological receptors to represent different feeding guilds that would most likely be exposed to contaminants found in Portland Harbor. Of primary concern are fish-eating species due to the tendency of organochlorine contaminants to bioaccumulate or biomagnify through the food chain, ultimately residing in and having effects on top-level predators. Bald eagles and osprey were selected in the risk assessment as ecological receptors to represent fish-eating birds, and mink and river otter were selected to represent fish-eating mammals. Mink are especially known for their sensitivity to polychlorinated biphenyls (PCBs), and are considered the mammal most sensitive to these compounds in the harbor. Lower on the food chain, the hooded merganser was selected to represent diving carnivorous and omnivorous waterbird species using the harbor. Some bird species will contact contaminated sediment and sediment-dwelling organisms while feeding in nearshore habitats along the harbor, so spotted sandpipers were selected as key receptors to represent contaminant exposure in sediment-probing invertivores. Although amphibians are important species in the Portland Harbor, very little is known of their distribution in the riverine portion of the site and toxicity information on amphibians is sparse. Under the risk assessment framework, amphibians will be assessed by comparing water quality to thresholds considered

protective of species where data are available. Individual amphibian receptors are not identified in the risk assessment.

Similar to the risk assessment phase of the remedial investigation, the Trustees selected key ecological receptors representative of certain feeding guilds to help focus identification of initial restoration opportunities. Many of these species are the same ecological receptors used in the risk assessment, and were also considered important due to their protection under federal or state statutes, their sensitivity to certain contaminants, or high potential to be injured by contaminants at the site as identified in the Preassessment Screen (Portland Harbor Natural Resource Trustee Council 2007). For instance, fish collected from the Portland Harbor study area contained bioaccumulative contaminants above values considered protective of fish-eating birds, and contaminant concentrations in eggs of some osprey collected from the Portland Harbor exceeded values considered protective of successful hatching of osprey embryos (Portland Harbor Natural Resource Trustee Council 2007). Concentrations of PCBs and DDE in bald eagle eggs (predicted based on actual concentrations measured in osprey eggs collected from Portland Harbor) are estimated to exceed values associated with eggshell thinning and reduced productivity.

In addition, otters sampled from the Portland Harbor area had elevated concentrations of organochlorine contaminants in liver samples (Grove and Henny 2005), and fish collected from Portland Harbor exceeded threshold values associated with reproductive impairment in mink. For restoration planning efforts, the Trustees focused on identifying initial restoration attributes that would best benefit bald eagle, osprey, spotted sandpiper, and mink as representative species. Restoring habitat attributes for these representative species would also benefit other aquatic-dependent wildlife groups, including amphibians and other waterbirds, because many habitat characteristics along the river are shared by these species.

Following the identification of initial criteria and restoration attributes for wildlife, the Trustee Council convened a Wildlife Advisory Group in 2010 to conduct a site visit to ground-truth these attributes and to identify limiting habitat for some of the representative wildlife species. Specifically, this group was tasked to identify (1) existing habitat in Portland Harbor and surrounding areas that benefit mink, otter, osprey, and bald eagles; (2) areas that could become supporting habitat in the future with or without restoration; and (3) how past habitat changes and modifications could have influenced these species. Contaminant concerns related to these species also were addressed. The Wildlife Advisory Group confirmed the importance of the initial restoration attributes derived by the Trustee Council for multiple species of wildlife. The Wildlife Advisory Group also identified some of the primary factors, in addition to contaminants in prey items, which limit use of the area by these species. A recurring theme identified for all four representative species was lack of shallow water and wetland habitat that provides foraging opportunities for these species; shallow water and wetland habitat were also previously identified as highly beneficial to salmonids. This information helped confirm that an integrated habitat restoration approach focusing on restoring limiting habitat features and services could be highly beneficial to any potentially-injured trust resources.

Information gathered from the Wildlife Advisory Group was also used to establish baseline conditions (i.e., the condition the resources would be in now if the contamination was not present), quantify injury, and estimate service loss over time for some representative wildlife species.

Table 2. The relevant indicators for functioning wildlife habitat within the lower Willamette River and its riparian area.

	Relevant for			
Indicator	Bald Eagle	Osprey	Spotted Sandpiper	Mink
1. Shallow in-water habitat (mainstem sites)	✓	✓	✓	✓
2. Tidal mudflat			✓	✓
3. Instream habitat structure				✓
4. Off-channel habitat proximity				✓
5. Off-channel habitat quality				✓
6. Floodplain connectivity				✓
7. Natural streambank			✓	✓
8. Streambank slope				✓
9. Quantity of riparian vegetation				✓
10. Perch sites	✓	✓		
11. Nest sites	✓	✓		
12. Presence of native vegetation			✓	✓
13. Presence of wetlands with surface water				✓
14. Staging areas			✓	
15. Connectivity to other habitats				✓
16. Percent cover			✓	✓
17. Patch size	✓		✓	✓

2. Social Constraints Criteria (feasibility)

Social constraints can impede or hinder the success of a restoration action (Figure 1). Social constraints can be political (e.g., incompatible zoning), legal (e.g., ownership), factors that affect project readiness (e.g., continued contaminant inputs), or other factors that affect project implementation (e.g., cost, presence of utilities). The Trustees developed feasibility criteria to assess the non-ecological aspects of project development. Feasibility criteria are applied independently of the technical criteria; therefore, a project with significant social constraints can still receive a very high score for ecological benefit, and will be ranked based on the scores for all criteria.

1. Remedial action and/or ongoing contamination

a. The project can be implemented immediately and existing or ongoing contamination at the site will not limit habitat benefits. SCORE = 1
b. Remedial action is underway or planned in the short term; restoration can be implemented following remediation, and existing contamination will not limit habitat benefits. SCORE = 2
c. The project cannot provide maximum habitat benefits until remedial actions are complete or existing/ongoing contamination is addressed; timeline for remedial action is indefinite. SCORE = 3

2. Human disturbance
   a. The proposed restoration project (in as-built condition) will not include or will prohibit human disturbance from industrial/commercial, residential and recreational activities. SCORE = 1
   b. The project includes short-term or very limited ongoing human disturbance from industrial/commercial, residential or recreational activities. SCORE = 2
   c. The project's habitat benefits will be limited over the long term by significant ongoing human disturbance from industrial/commercial, residential or recreational activities. SCORE = 3

3. Land ownership
   a. Land is in private ownership; landowner is willing to use the parcel for restoration. SCORE = 1
   b. Land is in public ownership; public landowner is willing to use the parcel for restoration. SCORE = 2
   c. Land is in private or public ownership, and landowner is unwilling to use the parcel for restoration, or willingness is unknown. SCORE = 3

4. Permitting, zoning
   a. There are no known permitting or zoning obstacles to implementing restoration at the site. SCORE = 1
   b. There may be some minor permitting or zoning obstacles to implementing restoration at the site. SCORE = 2
   c. There are severe or unknown permitting or zoning obstacles to implementing restoration at the site. SCORE = 3

5. Long term maintenance (does not include monitoring)
   a. The project will be largely self-sustaining once it is complete, or will require only short-term maintenance (such as summer watering of riparian plantings) before becoming self-sustaining. SCORE = 1
   b. The project will require a minor amount of maintenance on an infrequent basis in order to provide anticipated habitat benefits. SCORE = 2
   c. The project will require a significant amount of maintenance on a frequent basis in order to provide anticipated habitat benefits. SCORE = 3

6. Feasibility (technical)

a. There are no known technical impediments (pipelines, infrastructure that cannot be moved, etc.) to implementing the restoration action. SCORE = 1
b. There may be some minor technical impediments that would increase the cost, and/or lengthen the timeline of implementation. SCORE = 2
c. There are severe or unknown technical impediments to implementation at the site. SCORE = 3

The highest potential score of 18 would indicate that a project has significant social constraints that would be challenging to overcome. The lowest possible score would be a 6.

3. Geographic Criteria

The Trustees have a strong preference for early restoration within the Willamette harbor area (river mile 1 through 12). This preference stems from the fact that all Willamette populations of salmon and some Columbia populations of salmon, as well as other fish, must pass through the study area, spending various amounts of time there, while moving to other habitats up or down stream. There are a limited number of high-value restoration opportunities within the Portland Harbor study area, and these should be prioritized above restoration sites outside the study area, to the maximum extent practicable. If injury assessment eventually identifies a need for more restoration than can be provided within the Portland Harbor area, potential projects outside the area may be considered. The boundary may be expanded after completion of part or all of the natural resource damage assessment. Compensatory restoration projects will be considered in the following priority order:

1. Mainstem Willamette River within boundaries of the Portland Harbor Superfund site study designation (river mile 1 to 12 until Superfund site boundaries are determined)

2. West Hayden Island
   Columbia Slough up to Union Pacific Railroad bridge
   Multnomah Channel
   Sauvie Island (portions not included in Tier 1)

3. Confluence areas of Tryon, Kellogg, and Johnson creeks
   Ross Island

4. Mainstem Columbia River, downstream or upstream of Willamette confluence

Restoration projects in the mainstem Willamette River and tributaries *above* Willamette Falls are excluded from consideration for compensatory restoration at this time.

If it becomes necessary to consider restoration opportunities below priority 1, the Trustees will expand the geographic area based on the location of injuries and the score of the ecological benefit and social constraints. Any potential project outside of the geographic area included in priority 1 is shown as a circle on Figure 2 (see below).

4. Rare and Unique Opportunities Criteria

The Trustees developed the "bonus points" criteria to incorporate factors and considerations that are not reflected elsewhere within the evaluation criteria. Specifically, criteria in this category place special emphasis on projects that include characteristics or functions that are rare or unique within the geographic area, and on projects with high "opportunity" value (i.e., projects whose viability could be jeopardized by possible development actions or other threats). The following questions were answered based on the Trustees' existing knowledge and best professional judgment.

1. Does the project represent an opportunity to protect or restore a unique, rare, or significant habitat type or feature?

2. Is the project area under immediate threat of development or other non-restoration action that would preclude future restoration of the site?

If the response is "yes" to one of these questions for a particular restoration action, then the project is shown as a triangle when mapped. If the response is "yes" to both questions for a restoration action, then the project is shown as a square when mapped. See the example in Figure 2 below.

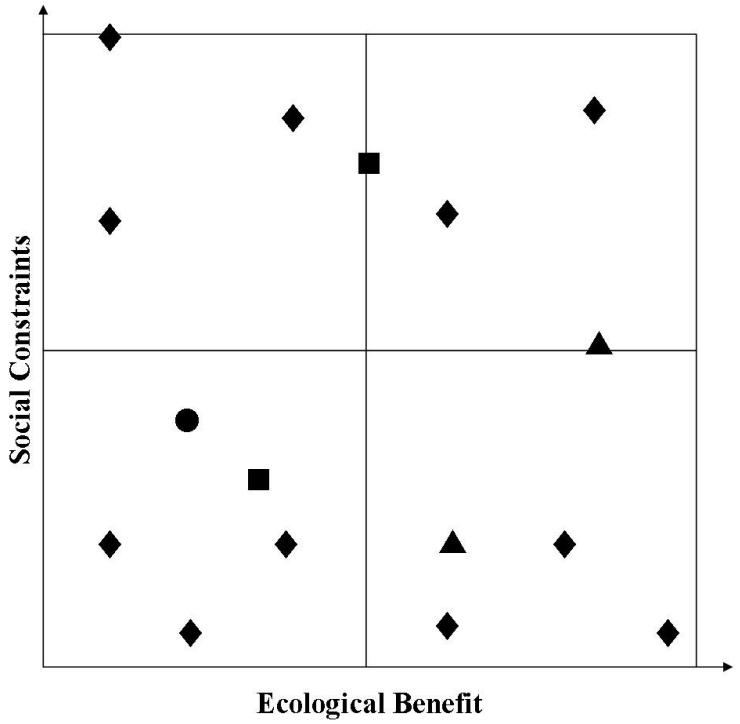

Figure 2. Plot of potential restoration projects scored for social constraints and ecological benefit, and coded for rare and unique opportunities and geographic area (diamond for no rare/unique criteria, triangle for one rare/unique criterion, square for two rare/unique criteria, circle for outside the geographic criteria at this time).

FISH CRITERIA

To evaluate potential restoration projects for their benefit to fish (Chinook salmon, steelhead, coho salmon, lamprey, steelhead), we adopted a screening process that the City of Portland developed to evaluate restoration projects for potential funding under the Water Resources Development Act (WRDA). To screen their projects, the City developed a document in November, 2005-- "Phase 1 Project Screening Process for the Lower Willamette Ecosystem Restoration Feasibility Study". This process focused solely on salmon and steelhead.

The Trustee Council Restoration Subgroup has expanded the City's approach to include lamprey and sturgeon, and modified some of the criteria to better compare the projects in the Portland Harbor ISA. Specifically, we added two objectives, added three indicators, modified the definition, rationale and criteria for each of the City's indicators to be more inclusive of lamprey and sturgeon.

Objectives

To aid the recovery of salmon, lamprey, or sturgeon populations, a restoration action must meet at least one of the following objectives:

1. move towards normative hydrology
2. restore floodplain function
3. reestablish floodplain and riparian plant communities
4. improve aquatic and riparian habitat conditions
5. improve river margin habitat (increase complexity in river margins)
6. restore habitat that provides ecological value in the landscape perspective for fish species (patch size, shape and distance between different patches of habitat)

To evaluate whether a potential restoration action will or can achieve the objectives, we developed a set of indicators that describe the ecological variables that are needed to meet the objectives. Some indicators are relevant for all three species groups (salmon, lamprey and sturgeon), and others are only relevant for one species group. For each indicator, we have developed criteria that will evaluate how well the proposed project will meet the objectives through that indicator. A score for a proposed restoration project will be calculated as the difference in the site with and without the proposed project.

	Relevant for		
Indicator	Salmon	Lamprey	Sturgeon
1. Shallow in-water habitat-mainstem sites	✓	✓	
2. Residual Pool depth -tributary sites	✓	✓	
3. Shoreline gradient	✓		
4. Instream habitat structure	✓	✓	✓
5. Sediment and water quality	✓	✓	✓

6. Off-channel habitat proximity	✓	✓	
7. Off-channel habitat quality	✓	✓	
8. Floodplain connectivity	✓	✓	
9. Natural streambank	✓	✓	
10. Streambank slope	✓		
11. Quantity of riparian vegetation	✓	✓	
12. Presence of native vegetation	✓	✓	
13. Presence of wetlands	✓	✓	
14. Impervious area	✓	✓	✓
15. Presence of deep water habitat			✓
16. Connectivity between habitat patches	✓	✓	
17. Access to tributaries	✓	✓	

1. Shallow In-Water Habitat (for mainstem river sites)

Definition: Shallow in-water habitat (for mainstem river sites) is defined as that portion of the site (in percent) inundated to a depth of 10 feet at approximately Mean Higher High Water (MHHW). The percentage is based on area calculations of the site inundated to a depth of 10 feet from existing bathymetry maps (at 0.00 ft NAVD-88) developed by the Lower Willamette Group (LWG).

Rationale: Juvenile salmon seek out and prefer shallow, low velocity, littoral (shoreline) habitat areas (as summarized in CH2M Hill 2005). In the mainstem Willamette River, shallow water habitat is crucial for salmon rearing, particularly for subyearling Chinook salmon. The portion of the site inundated to a depth of 10 feet at approximately MHHW provides an accurate approximation of shallow water habitat over a range of conditions of seasonal flow variations and tidal influence in the lower Willamette River. The LWG bathymetry maps are based on a datum at 0.00 ft NAVD-88, which is approximately equal to the MHHW elevation of 0.02 ft NAVD-88.

There is some evidence that lamprey densities in the sediment may be higher at shallow sites in the lower Willamette River, particularly at the mouths of tributaries. This may be due to higher oxygen concentrations in the sediments at these sites, or improved access to food.

Criteria:

76-100% of inwater portion within 10-ft depth	= 4
51-75% of inwater portion within 10-ft depth	= 3
26-50% of inwater portion within 10-ft depth	= 2
1-26% of inwater portion within 10-ft depth	= 1
No shallow water habitat	= 0

2. Residual Pool Depth (for tributary sites)

Definition: Residual pool depth (for tributary sites) is defined as the average of residual depths in pools on site. The residual depth is the depth of water in a pool below the crest of the pool's downstream hydraulic control (i.e., pool tailout).

Rationale: In streams, pools are important mesohabitats for juvenile salmon rearing, and pool tailouts are important for salmon spawning and invertebrate production. These areas are also important for lamprey rearing. Residual pool depth provides an indicator of the quality of these important mesohabitats, including the extent to which pool infilling has occurred in streams affected by urban runoff. The criteria assumed in this scoring system for residual pool depth are based on habitat benchmarks reported by the ODFW Aquatic Inventory and Analysis Project (Friesen 2005). ODFW habitat surveys of Portland tributaries (1999-2001) provide the source of data for residual pool depth.

Criteria:

Average of residual depths > 0.5 m	= 4
Average of residual depths 0.35 – 0.5 m	= 3
Average of residual depths 0.2 - 0.35 m	= 2
Average of residual depths < 0.2 m	= 1
None	= 0

3. Shoreline Gradient

Definition: Shoreline gradient (percent, to the nearest 20%) is determined as the lateral channel bottom average gradient from MHHW (at 0.00 ft NAVD-88) to the 10-ft depth contour (or deeper contours is the gradient is steep) from existing LWG bathymetry maps.

Rationale: Juvenile salmon prefer shoreline areas with bottom slopes less than 40 percent (as summarized in CH2M Hill 2005). The lateral channel bottom gradient between approximately MHHW and a depth of 10 ft provides an accurate approximation of preferred shallow water bottom slope over a range of conditions of seasonal flow variations and tidal influence in the lower Willamette River. The LWG bathymetry maps are based on a datum at 0.00 ft NAVD-88. Shallow gradients also tend to collect wood, which allows the development of more complex habitat structure, and potentially greater prey densities for salmon.

Criteria:

Shoreline gradient less than 20%	= 4
Shoreline gradient between 20 and 40%	= 2
Shoreline gradient greater than 40%	= 0

4. Instream Habitat Structure

Definition: Instream habitat structure includes elements such as large wood and boulders within the in-water portion of a site. For mainstem sites, this is based on a qualitative estimate of the extent of large wood (>10 in. diameter and >10 ft in length) and boulders (>24 in diameter) within in-water portion of the site as determined from site reconnaissance, photos, or reports. A "significant" accumulation of wood or boulders is greater than 10 pieces per 500 ft of shoreline. An accumulation that is "present but not significant" is less than 10 pieces per 500 ft of shoreline. "None" is no wood or boulder present.

For tributary sites, the criteria is based on a qualitative estimate of the extent of large wood (>6 in diameter and >10 ft length) and boulders (>24 in diameter) within the in-water portion of the site as determined from field measurements or ODFW habitat surveys. A 'significant' accumulation of wood is greater than 20 pieces of wood or boulders per 100 m of shoreline. An accumulation that is 'present but not significant' is <20 pieces of wood or boulders per 100 m of shoreline. 'None' is no wood or boulders present.

Rationale: Juvenile salmon and lamprey prefer littoral habitat that contain interspersed cover elements such as large wood, boulders or vegetation (e.g., natural bank vegetation, overhanging vegetation, and emergent plants, notably grasses) (summarized in CH2M Hill 2005). Wood is significant because it has an important influence on channel hydraulics and plays an important role in the physical processes associated with pool formation and the flow of sediment, gravel, organic matter, and other materials through the system. Wood also provides cover and feeding stations for juvenile and adult salmon. Loss of wood from streams usually diminishes habitat quality and reduces the carrying capacity for rearing salmon and lamprey during all or part of the year (Hicks et al. 1991).

For mainstem sites, the criteria assumed in the scoring system for large wood or boulders are based on a survey by City biologists of wood in the Willamette River in the Portland area and a qualitative categorization of existing conditions into high, medium and low levels. For tributary sites, the criteria developed are based on habitat benchmarks reported by the ODFW Aquatic Inventory and Analysis Project (Friesen 2005). ODFW habitat surveys of Portland tributaries (1999-2001), plus aerial photos, provide the source of data for large wood or boulder conditions.

Criteria:

Significant	= 4
Significant in some areas	= 3
Present but not significant	= 2
None	= 0

5. Sediment and Water Quality

Definition: Sediment and water quality are rated based on the presence of sediment or water quality degradation or contamination at or adjacent to the site. A 'significant'

rating indicates there are known persistent, bioaccumulative or toxic concentrations of metals or other contaminants of concern, or placed on the Oregon Department of Environmental Quality's 303(d) list of water quality streams for water temperature (this is more valuable for tributary sites). A 'moderate' rating indicates there are moderate concentrations of metals or other contaminants of concern. A 'low' rating means that conditions meet sediment and water quality criteria, and water temperatures in tributary streams are adequate to support the rearing of juvenile salmon.

Rationale: Rationale: Water and sediment quality are of vital importance to the health of aquatic ecosystems and the plant and animal life that depend on them. The Willamette River has a history of impaired water and sediment conditions that have resulted in a number of regulatory actions aimed at restoring water and sediment quality. This indicator represents water and sediments conditions at a site that have the potential to cause contamination or impairment. The criteria for this indicator were developed from professional judgment based on qualitative ratings. This rating is valid for salmon, sturgeon, and lamprey, as all have a history of responding to poor water and sediment quality.

Criteria:

Low	= 4
Moderate	= 2
Moderate but some improvement	= 1
Significant	= 0

6. Off-channel Habitat Proximity

Definition: Off-channel habitat proximity is defined as the proximity or connectivity of the site to existing or newly-created off-channel habitats, or previously inaccessible upstream habitat. It is rated based on the acres of existing off-channel or secondary channel habitat that is connected to or adjacent to the site. Alternatively, it is rated based on the acres of previously inaccessible upstream habitat such as in the case of culvert replacements. Existing off-channel or secondary channel habitat has been estimated for the lower Willamette River via GIS analysis by City staff.

Rationale: Salmon and steelhead require a network of connected spawning and rearing habitats. Migration barriers or impediments have fragmented habitats and thus reduced and constrained salmon populations. In the Columbia basin, about 55 percent of the total area and 33 percent of the total stream miles are no longer accessible to salmon (Spence et al. 1996). Some of the most productive rearing sites in streams are located in backwaters along the edge of the channel and in side-channel areas (Sedell and Beschta 1991). Development next to streams and rivers often disrupt access to these off-channel sites by physically isolating them from the main channel. Increase passage through culverts can increase connectivity and open previously unused habitat for salmon and lamprey. The specific criteria and project rankings were developed from professional judgment based on a quantification of the size and frequency of off-channel habitats from

aerial photos, ODFW habitat surveys (1999-2001), and the City of Portland refined streams data.

Data are not available to provide information on the presence of lamprey in off-channel areas. Lamprey have been found in the Columbia Slough, and they are present in relatively high numbers in tributary streams within the City of Portland. Therefore, it is reasonable to assume that off-channel areas that are readily accessible from the Willamette River would provide the fine sediments and velocities important to lamprey.

Criteria:

Proximal off-channel habitat >5 acres	= 4
Proximal off-channel habitat 1-5 acres	= 3
Proximal off-channel habitat <1 acres	= 2
No proximal off-channel habitat	= 0

7. Off-Channel Habitat Quality

Definition: Off-channel habitat quality is defined as the quality of existing or newly-created off-channel habitat, or previously inaccessible upstream habitat. It is rated based on an estimate of the quality of the existing or newly-created off-channel habitat or previously inaccessible upstream habitat that is connected to or adjacent to the site based on site knowledge, reconnaissance, photos or reports. Off-channel habitat that is seasonally inundated with good habitat and water quality attributes is considered to have 'high' quality. Off-channel habitat that is infrequently inundated with degraded habitat and water quality attributes is considered to have 'low' quality. Off-channel habitat that is intermediate between the high and low categories is of 'moderate' quality.

Rationale: The basic rationale is the same as summarized above for Off-Channel Habitat Proximity. It is recognized that the quality of the existing or newly-created off-channel habitat, or previously inaccessible upstream habitat, is an important determinant of the habitat's usability and productivity. Perhaps the single most effective habitat-oriented action for salmon sustainability is to protect existing high quality habitat (Lichatowich et al. 2000). The concept of protecting remaining high-quality habitat areas is crucial to maintenance and recovery of listed species (Williams and Williams 1997). The specific criteria for this indicator were developed from professional judgment based on site knowledge, aerial photos, ODFW habitat surveys (1999-2001), and City of Portland refined streams data. This argument is valid for salmon and lamprey.

Criteria:

High habitat quality	= 4
Moderate habitat quality	= 3
Low habitat quality	= 1
No off-channel habitat present	= 0

8. Floodplain Connectivity

Definition: Floodplain connectivity is defined as the percent of the site area (to the nearest 20 percent) that floods routinely at least once every ten years.

Rationale: There is an increasing recognition that floodplains play a major role in the productivity and diversity of riverine communities (Bayley 1995). Annual inundation is the principal force determining productivity and biotic interactions in river-floodplain systems. Floodplains can provide higher biotic diversity and increased production of fish through increased habitat diversity and area. Most of the historic off-channel and floodplain habitat has been disconnected from the river by diking and hardening of channel banks. Loss of these off-channel habitats limits rearing and over-wintering habitat for juvenile salmon in the lower Willamette River. Maps or other information were not available to quantify annual flood inundation of sites along the lower Willamette River. The specific criteria were therefore conservatively developed from available FEMA 100-year floodplain data and 1996 flood extent data.

Floodplain connection is also important for lamprey because of the abundant food supply and greater habitat complexity.

Criteria:

>65% of site within floodplain	= 4
>35% and <65% of site within floodplain	= 2
35% or less of site within floodplain	= 0

9. Natural Streambank

Definition: Natural streambank is defined as the percent of lineal amount of bank along the site that is natural (e.g., beach, vegetated), and not hardened with riprap, sheet pilings, walls, or other means. The bank is that portion of the channel margin from approximately MHHW to top-of-bank. The percentage is based on a gross estimate (to the nearest 20 percent) of bank area at the site that is mostly natural or not hardened.

Rationale: Channelization and bank hardening reduce habitat diversity by reducing shoreline complexity and deformity. Channelization and bank hardening can also act to increase bedload transport, which increases fine sediment deposition in downstream rearing areas for salmon and rearing. For these reasons, higher percentages of bank in all or mostly natural conditions are preferred. The criteria assumed in the scoring system are based on a gross estimate (to the nearest 20 percent) of bank area at the site that is mostly natural or not hardened. The specific criteria were developed from professional judgment, and project rankings based on information from the ODFW Fish Study bank composition survey (ODFW 2002) and ODFW habitat surveys of Portland tributaries (1999-2001).

Criteria:

≥65% of bank along site all or mostly natural, not hardened = 4
>35% to <65% of bank natural or unhardened condition = 2
35% or less of bank natural or unhardened condition = 0

10. Streambank Slope

Definition: Streambank slope is defined as the average bank slope along the site, in percent to the nearest 20 percent. The average bank slope is determined as the lateral bank gradient from MHHW to top-of-bank from existing site topography and bathymetry maps (based on NAVD-88).

Rationale: Bank slope is an important determinant of bank and riparian stability, as well as shoreline habitat diversity and complexity. For example, a vertical bank generally lacks the habitat structure preferred by rearing salmon, and oversteepened banks are more prone to soil failure and wasting. In the mainstem Willamette River, the bank slope from above the approximately MHHW provides an accurate approximation of bank slope over a range of conditions of seasonal flow variations and tidal influence in the lower Willamette River. The specific criteria were developed from professional judgment, and project rankings based on information from the ODFW Fish Study bank composition survey (ODFW 2002) and calculations from City GIS data on 2-ft and 5-ft contours.

Criteria:
Average bank slope less than 40% = 4
Average bank slope 40-60% = 2
Average bank slope more than 60% = 0

11. Quantity of Riparian Vegetation

Definition: Quantity of riparian vegetation is the percent of vegetated riparian forest within 300 ft or in the floodplain area on the site. It is based on an estimate of the percent of vegetated riparian forest that is above MHHW and within 300 ft of the river channel or in the floodplain area on the site. The assumed 300-ft width is based on City of Portland E zone and Metro Goal 5 guidance (City of Portland Bureau of Planning 2001, Metro 2002).

Rationale: Riparian corridors provide some of the most important avian habitats because of their vegetation, proximity to water, and connectivity to larger habitat areas with and without the urban landscape. Bird abundance and diversity are typically higher near streams, especially in urban areas. Local research has found that roughly 93 percent of native birds found in the Portland-Metro region use streamside habitats (Hennings and Edge 2003). This research has found that narrower riparian corridors support greater numbers of non-native birds that compete with and prey upon native birds.

Riparian zones provide key contributions to the health of aquatic habitats by providing shade, thus decreasing water temperatures, streambank stabilization, sediment control, leaf litter input, large wood, and nutrients (Spence et al. 1996). Riparian vegetation provides long-term ecosystem function by anchoring streamside soils, providing overhanging and undercut streambanks, increasing habitat complexity, enhancing flows between instream and hyporheic zones, and supplying large wood (Beschta 1997).

The specific criteria for this indicator were developed from professional judgment based on the City of Portland E zone and Metro Goal 5 guidance (City of Portland Bureau of Planning 2001, Metro 2002). Project rankings were based on estimates of vegetated riparian forest area derived from City of Portland June 2002 multi-spectral remote sensing data.

Criteria:

>75%	= 4
>50 to 75%	= 3
>25 to 50%	= 2
>10 to 25%	= 1
10% or less	= 0

12. Presence of Native Vegetation

Definition: Presence of native vegetation is determined by presence of both overstory and understory native vegetation in the floodplain and riparian zone. It is based on a qualitative estimate of the extent of native vegetation within the floodplain and riparian zone at the site based on site knowledge, reconnaissance, photos or reports.

Rationale: Many riparian habitats have been affected by the invasion of non-native plants and introduced animals. On many sites, these non-native species have become well established, commonly replacing native species or exerting large influences on the functional dynamics of existing native habitats. Therefore, the presence and dominance of native plant species in riparian areas is considered an important indicator of riparian quality and health. Native riparian vegetation provide long-term stability to the river bank, and contribute to the development and maintenance of complex habitat important to salmon and lamprey. The specific criteria and project rankings for this indicator were developed from professional judgment based on riparian vegetation information in reports by contractors for the City of Portland and ODFW habitat surveys of Portland tributaries (1999-2001).

Criteria:

Dominated by native vegetation	= 4
Some native vegetation	= 2
No native vegetation	= 0

13. Presence of Wetlands

Definition: The presence of emergent and scrub/shrub wetlands is determined as the approximate acres of emergent wetland or scrub/shrub wetland habitat types on the site, based on existing City habitat mapping studies.

Rationale: Five key habitat types of importance to wildlife are directly associated with riparian areas along the lower Willamette River as identified in the Willamette River Inventory – Natural Resources (City of Portland Bureau of Planning 2001). These include open water, beach bottomland forest, emergent wetland, shrub/scrub wetland. This indicator represents two of these habitat types that are of added importance to a variety of native birds, reptiles and amphibians along the city's watercourses. As well, lamprey and salmon use seasonally flooded wetlands. The specific criteria and project rankings for this indicator were developed from professional judgment based on a quantification of the size and frequency of emergent and scrub/shrub wetlands from aerial photos, Metro wetland inventories (Metro Data Resource Center 1998) and the City of Portland refined streams data.

Criteria:

Scrub/shrub wetland >2 acres	= 4
Scrub/shrub wetland >1, but <2 acres	= 3
Scrub/shrub wetland >0.5, but <1 acres	= 2
Scrub/shrub wetland 0- 0.5 acres	= 1
No scrub/shrub wetland present	= 0

14. Impervious Area

Definition: Impervious area is based on the estimated percent of total impervious area, or preferably percent effective impervious area, on the site based on site maps, photos, or reconnaissance. Total impervious area (TIA) refers to area within the site that is covered by constructed, non-infiltrating surfaces (such as pavement, roofs, etc.), whereas effective impervious area (EIA) is impervious surfaces with direct hydraulic connection to the downstream drainage or stream system (Booth and Jackson 1997). Impervious area which drains onto pervious surfaces such as lawns, vegetated areas, and fields, would be included in calculations of TIA, but excluded from EIA calculations; if, however, those areas contribute runoff directly into stream and other surface water bodies, they would be included in calculations of EIA.

Rationale: Research in Puget Sound streams and rivers has shown that as little as 10 percent impervious surface in a watershed may destabilize stream channels and affect productivity. Increases in impervious area act to decrease stream-based flow as infiltration and absorptive surfaces decrease. Also, more runoff is conveyed in higher-flow periods, hence less is available for summer based flows. These flow changes reduce living space for resident and migratory fishes. In addition, particularly at mainstem sites, increases in stormwater runoff from impervious areas can further act to cause bank

erosion or water quality impairment of shoreline or nearshore habitats. The specific criteria for this indicator were developed from professional judgment based on information reported by Booth (1991) and Booth and Reinelt (1993).

Criteria:

<5% impervious area	= 4
<25% impervious area	= 3
>25% and <50% impervious area	= 2
>50% and <75% impervious area	= 1
>75% and <100% impervious area	= 0

15. Presence of Deep Water Habitat

Definition: The criteria are based on the minimum depth for sturgeon and the presence of natural substrates

Rationale: Juvenile sturgeon are found at depths ranging from 2 to 58 meters. Adult sturgeon tend to be found in deeper water areas. Access to varying flows is important for sturgeon because the yolk-sac larvae are transported by currents from spawning areas into deeper areas. The need for deeper water is different than the habitat requirements for salmon and lamprey. Juvenile sturgeon tend to be found associated with natural substrates ranging from hard clay, silt and mud, sand, gravel, cobble and bedrock.

Criteria:

Habitat deeper than 2 m with no artificial structures	= 4
Habitat deeper than 2 m	= 2
Habitat shallower than 2 m	= 0

16. Connectivity Between Habitat Patches

Definition:

Rationale: No information is available on the importance of habitat patches for sturgeon. Juvenile salmon and lamprey move through the lower Willamette River, growing and feeding as they travel. Shallow water areas provide resting and feeding opportunities. The distance between the feeding and resting sites can affect the ultimate growth and lipid storage (and therefore ultimate survival upon reaching the estuary and ocean).

Criteria:

Less than 0.5 mi between habitat patches	= 4
Between 0.5 and 1 mile between habitat patches	= 2
More than 1 mile between habitat patches	= 0

17. Access to Tributaries

Definition: Access to tributaries provides access to spawning and rearing sites for salmon and lamprey. Lamprey are not able to jump, therefore their requirements for passage are more restrictive than salmon. Hence the scoring below is greatest for tributaries that can provide access to both lamprey and salmon.

Rationale: Availability and accessibility of suitable spawning and rearing habitat ay affect the recruitment of lamprey that occurs within a basin (Houde 1987, Potter et al. 1986). Access to spawning and rearing habitat in tributaries is also listed as a limiting factor for salmon (NMFS 2007). Improved access has the potential to increase productivity of native fish by opening up tributary habitat, particularly if the habitat is of adequate quality.

Criteria:

Access to upstream tributaries for salmon and lamprey	= 4
Access to upstream tributaries for just salmon	= 2
Restore partial connection	= 1
No access to upstream tributaries	= 0

WILDLIFE CRITERIA

1. Shallow In-Water Habitat (for mainstem river sites)

Definition: Shallow in-water habitat (for mainstem river sites) is defined as that portion of the site (in percent) inundated to a depth of up to 10 feet at approximately Mean Higher High Water (MHHW). The percentage is based on area calculations of the site inundated to a depth of up to 10 feet from existing bathymetry maps (at 0.00 ft NAVD-88) developed by the Lower Willamette Group (LWG).

Rationale (Bald Eagle, Osprey, Spotted Sandpiper, Mink): Due to the presence of various fish species (juvenile salmonids, largescale suckers, walleye, northern pikeminnow, common carp, largemouth bass, smallmouth bass and brown bullhead) in shallow, low velocity, littoral (shoreline) habitat areas, these are important hunting areas for piscivorous predators, such as bald eagles, osprey, spotted sandpipers and mink.

Spotted sandpipers require shallow water habitat or water's edge habitat for hunting.

Criteria:

81-100% of inwater portion within 10-ft depth	= 4
61-80% of inwater portion within 10-ft depth	= 3
41-60% of inwater portion within 10-ft depth	= 2
21-40% of inwater portion within 10-ft depth	= 1
0-20% of inwater portion within 10-ft depth	= 0

2. Tidal Mudflats and Beaches

Definition: Mudflats may be viewed geologically as exposed layers of mud, resulting from deposition silts, clays and animal detritus. Relatively natural shorelines (vs. those with armored banks or seawalls) may support the formation of mudflats or beaches; these areas are typically open or sparsely vegetated, and may contain some organic debris or drift.

Rationale (Spotted Sandpiper and Mink): The diet of spotted sandpipers and mink are made up of high levels of invertebrates. Due to the high level of invertebrate production in tidal mudflats and on debris, they are important foraging areas for these predators.

Criteria:

51-100% relatively natural shoreline with beach or mudflat	= 4
26-50% relatively natural shoreline with beach or mudflat	= 2
0-25% relatively natural shoreline with beach or mudflat	= 0

3. Instream Habitat Structure

Definition: Instream habitat structure includes elements such as large wood and boulders within the in-water portion of a site. For mainstem sites, this is based on a qualitative estimate of the extent of large wood (>10 in. diameter and >10 ft in length) and boulders (>24 in diameter) within in-water portion of the site as determined from site reconnaissance, photos, or reports. A "significant" accumulation of wood or boulders is greater than 10 pieces per 500 ft of shoreline. An accumulation that is "present but not significant" is less than 10 pieces per 500 ft of shoreline. "None" is no wood or boulder present. Where possible for mainstem sites, the scoring is based on a survey by City biologists of wood in the Willamette River in the Portland area and a qualitative categorization of existing conditions into high, medium and low levels. For tributary sites, the scoring is based on an estimate of the extent of large wood within in-water portion of the site considering any available data and surrounding vegetation and land use.

Rationale (Mink): The mink's diet consists primarily of fish and invertebrates, as well as, amphibians (Verts & Carraway, 1998). Juvenile salmon, lamprey, invertebrates and many amphibians prefer littoral habitat that contain interspersed cover elements such as large wood, boulders or vegetation (e.g., natural bank vegetation, overhanging vegetation, and emergent plants, notably grasses) (summarized in CH2M Hill 2005). Wood is significant because it has an important influence on channel hydraulics and plays an important role in the physical processes associated with pool formation and the flow of sediment, gravel, organic matter, and other materials through the system. Wood also provides cover and feeding stations for juvenile and adult salmon. Loss of wood from streams usually diminishes habitat quality and reduces the carrying capacity for rearing salmon and lamprey during all or part of the year (Hicks et al. 1991). Due to the increased presence of salmon, lamprey, amphibians and invertebrates, in-stream habitat structures are important foraging areas for mink. Logjams are used by mink approximately 55% of the time for hunting aquatic prey (Verts & Carraway, 1998)

Criteria

Significant	= 4
Significant in some areas	= 3
Present but not significant	= 2
None	= 0

4. Off-channel Habitat Proximity

Definition: Off-channel habitat proximity is defined as the proximity or connectivity of the site to existing or newly-created off-channel habitats, or previously inaccessible upstream habitat. It is rated based on the acres of existing off-channel or secondary channel habitat that is connected to or adjacent to the site. Alternatively, it is rated based on the acres of previously inaccessible upstream habitat such as in the case of culvert

replacements. Existing off-channel or secondary channel habitat has been estimated for the lower Willamette River via GIS analysis by City staff.

Rationale (Mink): Due to the presence of fish in backwaters along the edge of the channel and in side-channel areas (Sewell and Beschta 1991), these habitats are important foraging habitat for mink.

Criteria:

Proximal off-channel habitat >5 acres	= 4
Proximal off-channel habitat 1-5 acres	= 3
Proximal off-channel habitat <1 acres	= 2
No proximal off-channel habitat	= 0

5. Off-Channel Habitat Quality

Definition: Off-channel habitat quality is defined as the quality of existing or newly-created off-channel habitat, or previously inaccessible upstream habitat. It is rated based on an estimate of the quality of the existing or newly-created off-channel habitat or previously inaccessible upstream habitat that is connected to or adjacent to the site based on site knowledge, reconnaissance, photos or reports. Off-channel habitat that is seasonally inundated with good habitat and water quality attributes is considered to have 'high' quality. Off-channel habitat that is infrequently inundated with degraded habitat and water quality attributes is considered to have 'low' quality. Off-channel habitat that is intermediate between the high and low categories is of 'moderate' quality.

Rationale (Mink): The basic rationale is the same as summarized above for Off-Channel Habitat Proximity. It is recognized that the quality of the existing or newly-created off-channel habitat, or previously inaccessible upstream habitat, is an important determinant of the habitat's usability and productivity. Perhaps the single most effective habitat-oriented action for salmon sustainability is to protect existing high quality habitat (Lichatowich et al. 2000). Due to the presence of juvenile salmon in high quality off channel habitat, this is an important foraging habitat for mink.

Criteria:

High habitat quality	= 4
Moderate habitat quality	= 3
Low habitat quality	= 1
No off-channel habitat present	= 0

6. Floodplain Connectivity

Definition: Floodplain connectivity is the hydrological connection between floodplains and their associated waterways from periodic inundation during flood events. For the purposes of scoring this factor, the potential floodplain at a site is defined as any former floodplains known to have been filled or blocked by dikes and levees, streamside areas

within 25 feet on either side of a water body, and the current (i.e., functionally connected) floodplain. Functionally connected floodplains are defined as the combined extent of the current FEMA 100-year floodplain, 1996 flood extent data, and restored floodplain areas.

Rationale (Mink): There is an increasing recognition that floodplains play a major role in the productivity and diversity of riverine communities (Bailey 1995). Annual inundation is the principal force determining productivity and biotic interactions in river-floodplain systems. Large, infrequent floods can play important roles in shaping channels, transporting and depositing bed material within the stream and on the floodplain, dispersing vegetation and woody debris and recharging floodplain aquifers (Spence *et al*. 1996). Flooding is a natural disturbance regime that can reset the natural succession of riparian vegetation, bringing about early successional communities that contribute to habitat heterogeneity. Floodplains can provide higher biotic diversity and increased production of fish and wildlife through increased habitat diversity and area. Most of the historic off-channel and floodplain habitat has been disconnected from the river by diking and hardening of channel banks. Loss of these off-channel habitats limits rearing and over-wintering habitat for juvenile salmon and has reduced depositional areas used by lamprey in the lower Willamette River. Due to the increased invertebrate and fish production in floodplain habitat, it is important foraging habitat for minks. Floodplain vegetation and structure can also provide habitat for mink den sites, and movement and dispersal corridors.

Criteria:

>65% of the potential floodplain at the site is functionally connected	= 4
>35% and <65% of the potential floodplain at the site is functionally connected	= 2
35% or less of the potential floodplain at the site is functionally connected	= 0

7. Natural Streambank

Definition: Natural streambank is defined as the percent of lineal amount of bank along the site that is natural (e.g., beach, vegetated), and not hardened with riprap, sheet pilings, walls, or other means. The bank is that portion of the channel margin from approximately MHHW to top-of-bank. The percentage is based on a gross estimate (to the nearest 20 percent) of bank area at the site that is mostly natural or not hardened.

Rationale (Spotted Sandpiper, Mink): Channelization and bank hardening reduce habitat diversity by reducing shoreline complexity and deformity. Natural stream banks have a higher level of vegetation and invertebrate production. For these reasons, higher percentages of bank in all or mostly natural conditions are preferred. Spotted sandpipers require mudflats associated with natural stream banks for foraging habitat. Due to the high levels of invertebrate production in natural stream banks, this is important foraging habitat for sandpipers and minks. The criteria assumed in the scoring system are based on a gross estimate (to the nearest 20 percent) of bank area at the site that is mostly natural or not hardened. The specific criteria were developed from professional judgment, and project rankings based on information from the ODFW Fish Study bank

composition survey (ODFW 2002) and ODFW habitat surveys of Portland tributaries (1999-2001).

Criteria:

≥65% of bank along site all or mostly natural, not hardened	= 4
>35% to <65% of bank natural or unhardened condition	= 2
35% or less of bank natural or unhardened condition	= 0

8. Streambank Slope

Definition: Streambank slope is defined as the average bank slope along the site, in percent to the nearest 20 percent. The average bank slope is determined as the lateral bank gradient from MHHW to top-of-bank from existing site topography and bathymetry maps (based on NAVD-88).

Rationale (Mink): Bank slope is an important determinant of bank and riparian stability, as well as shoreline habitat diversity and complexity. For example, a vertical bank generally lacks the habitat structure preferred by rearing salmon, and oversteepened banks are more prone to soil failure and wasting. Bank slope is also an important factor for wildlife movement, such as, mink. Steep slopes make it difficult for mink for access invertebrates, amphibians and fish for hunting. In the mainstem Willamette River, the bank slope from above the approximately MHHW provides an accurate approximation of bank slope over a range of conditions of seasonal flow variations and tidal influence in the lower Willamette River. The specific criteria were developed from professional judgment, and project rankings based on information from the ODFW Fish Study bank composition survey (ODFW 2002) and calculations from City GIS data on 2-ft and 5-ft contours.

Criteria:

Average bank slope less than 40%	= 4
Average bank slope 40-60%	= 2
Average bank slope more than 60%	= 0

9. Quantity of Riparian Vegetation

Definition: Quantity of riparian vegetation is the percent of vegetated riparian forest within 300 ft or in the floodplain area on the site. It is based on an estimate of the percent of vegetated riparian forest that is above MHHW and within 300 ft of the river channel or in the floodplain area on the site. The assumed 300-ft width is based on City of Portland E zone and Metro Goal 5 guidance (City of Portland Bureau of Planning 2001, Metro 2002).

Rationale (Mink): Riparian corridors provide some of the most important avian habitats because of their vegetation, proximity to water, and connectivity to larger habitat areas

with and without the urban landscape. Bird abundance and diversity are typically higher near streams, especially in urban areas. Local research has found that roughly 93 percent of native birds found in the Portland-Metro region use streamside habitats (Hennings and Edge 2003). This research has found that narrower riparian corridors support greater numbers of non-native birds that compete with and prey upon native birds. Riparian areas also support 60-80% of all Oregon vertebrates for at least one stage of their life cycle. The mink is typically associated with riparian habitats, including small streams, tidal flats, cattail marshes, rivers, lakes, bogs, swamps and bottomland woods (Allen 1986).

Riparian zones provide key contributions to the health of aquatic habitats by providing shade, thus decreasing water temperatures, streambank stabilization, sediment control, leaf litter input, large wood, and nutrients (Spence et al. 1996). Riparian vegetation provides long-term ecosystem function by anchoring streamside soils, providing overhanging and undercut streambanks, increasing habitat complexity, enhancing flows between instream and hyporheic zones, and supplying large wood (Beschta 1997).

The specific criteria for this indicator were developed from professional judgment based on the City of Portland E zone and Metro Goal 5 guidance (City of Portland Bureau of Planning 2001, Metro 2002). Project rankings were based on estimates of vegetated riparian forest area derived from City of Portland June 2002 multi-spectral remote sensing data.

Criteria

>75%	= 4
>50 to 75%	= 3
>25 to 50%	= 2
>10 to 25%	= 1
10% or less	= 0

10. Perch Sites

Definition: The number of large trees is defined by the number of trees that could be used as perch sites for bald eagles and osprey. Trees are characterized by having large trunk forks or multiple forks of the trunk within 2 miles of a fish-bearing water body.

Rationale (Bald Eagle and Osprey): Migrant and wandering bald eagles roosts singly or in groups in suitable trees adjacent to hunting areas (Marshall *et al.* 2006). Osprey historically nested only in forested regions due to the requirement for large live trees and snags. These trees are usually located within 2 miles of a large water body. Nest and perch sites are now limited due to previous conversion of forest land to agriculture and housing development. Due to the limited availability of large trees for nest and perch sites, Osprey will use channel markers and utility poles for nest sites (Marshall *et al.* 2006). Protecting and restoring areas with suitable nest and perch sites are important to retain and expand historical nesting habitat along the Willamette River.

Criteria:
At least 1 large tree per ¼ acre within range of a fish-bearing water body = 4
At least 1 large tree per ½ acre within range of a fish-bearing water body = 2
< 1 large tree per ½ acre within range of a fish-bearing water body = 0

11. Nest Sites for Bald Eagle and Osprey

Definition: The presence of large trees that can be used as nesting sites for bald eagles and osprey. Trees are characterized by having large trunk forks or multiple forks of the trunk within 2 miles of fish-bearing water body. Trees are present with a surrounding buffer of additional trees.

Rationale (Bald Eagle): Bald eagles primarily nest in forested areas within 2 miles of a fish-bearing water body. Nests observed in Oregon have been in Sitka spruce and Douglas-fir west of the Cascades. Columbia and Willamette River populations have shown an increase in the use of black cottonwood for nesting. Minimizing disturbance is important for successful hunting, feeding of young and nesting. Protecting and enhancing nest sites with buffer zones would minimize disturbance.

Rationale (Osprey): Osprey historically nested only in forested regions due to the requirement for large live trees and snags. These trees are usually located within 2 miles of a large water body. Nest and perch sites are now limited due to previous conversion of forest land to agriculture and housing development. Due to the limited availability of large trees for nest and perch sites, Osprey will use channel markers and utility poles for nest sites (Marshall *et al.* 2006). The installation of nesting platforms designed for osprey may be considered on a site-by-site basis as a restoration strategy. Protecting and restoring areas with suitable nest and perch sites are important to retain and expand historical nesting habitat along the Willamette River.

Criteria:
≥ ¼ acre patch of mature trees within range of a fish-bearing water body = 4
≥ ¼ acre patch of young trees within range of a fish-bearing water body = 2
< ¼ acre patch of trees within range of a fish-bearing water body = 0

Note: Installing a nesting platform for osprey in a suitable location could qualify for a score of "4" for osprey. This option is not currently reflected in the wildlife scores, but may be considered on a site-by-site basis as projects are developed.

12. Presence of Native Vegetation

Definition: Presence of native vegetation is determined by presence of both overstory and understory native vegetation in the floodplain and riparian zone. It is based on a

qualitative estimate of the extent of native vegetation within the floodplain and riparian zone at the site based on site knowledge, reconnaissance, photos or reports.

Rationale (Spotted Sandpiper, Mink): Many riparian habitats have been affected by the invasion of non-native plants and introduced animals. On many sites, these non-native species have become well established, commonly replacing native species or exerting large influences on the functional dynamics of existing native habitats. Therefore, the presence and dominance of native plant species in riparian areas is considered an important indicator of riparian quality and health. Native riparian vegetation provides long-term stability to the river bank, and contributes to the development and maintenance of complex habitat important for foraging habitat for mink. Native riparian vegetation provides necessary cover habitat for spotted sandpipers. The specific criteria and project rankings for this indicator were developed from professional judgment based on riparian vegetation information in reports by Adolphson (2000), Parametrix (2003), and ODFW habitat surveys of Portland tributaries (1999-2001).

Criteria:

Dominated by native vegetation	= 4
Some native vegetation	= 2
No native vegetation	= 0

13. Presence of Wetlands with Surface Water

Definition: The presence of surface water for a percentage of the year. Surface water habitats include palustrine emergent wetlands (marshes) and open water, such as, streams, ponds and lakes).

Rationale (Mink): Five key habitat types of importance to wildlife are directly associated with riparian areas along the lower Willamette River as identified in the Willamette River Inventory – Natural Resources (City of Portland Bureau of Planning 2003). These include open water, beach bottomland forest, emergent wetland, shrub/scrub wetland. This indicator represents two of thee habitat types that are of added importance to a variety of native birds, reptiles and amphibians along the city's watercourses. Preferred mink habitats are generally shallow and deep marshes and ponds. Suitable mink habitat also includes palustrine and estuarine wetland systems (Allen 1986). It is assumed that surface water must be present for a minimum of nine months of the year to provide optimum foraging habitat for mink. Habitats with less permanent surface water are assumed to be less suitable mink habitat. Wetland habitats consisting only of saturated soils or lacking surface water are assumed to be of no value as year-round mink habitat (Allen 1986).

Criteria:

Presence of surface water 9-12 months	= 4
Presence of surface water 5-8 months	= 3
Presence of surface water 2-4 months	= 2

Presence of surface water 0-1 months	= 1
No surface water/no wetland	= 0

14. Staging Areas

Definition: During migration, shorebirds, such as, spotted sandpipers rely on staging areas to meet the energy demands of their migrations. Habitats used for staging areas are usually shallow wetlands with mudflats that are surrounded by short, sparse vegetation (WetNet 1999). Western Sandpipers also use dry or flooded agricultural lands during northward migration (Wilson 1994). Since spotted sandpipers don't migrate in large groups, even small restoration projects along the Willamette River might be able to provide important areas for foraging and resting in preparation for or during migration as individuals or small groups. During migration and winter, they can be found almost anywhere near water, including mudflats, beaches, breakwaters, sewage ponds, and even in irrigation ditches. They prefer fresh water, but can also be found along salt water during migration. Shorelines and riverine areas are important for species that generally do not occur in large concentrations. Riverine areas are particularly important for Spotted Sandpipers and exposed shorelines of shallow ponds and lakes are valuable habitats for shorebirds such as Solitary Sandpiper and Semipalmated Plover. Shoreline use occurs primarily during fall migration when typically lower water levels create opportunities for foraging (Drut 2000).

Rationale (Spotted Sandpiper): Migration staging areas and breeding sites are the most important components of shorebird habitat needs. Shorebirds rely on these staging areas to meet the energy demands of their migrations (Thurston 1996). The greatest risk to shorebird migration and to their critical breeding grounds is habitat change through degradation, fragmentation, and loss, which results from human disturbances and expanding development. Shorebirds are highly dependent on the resources found at the staging areas along their migrations (Environment Canada 1999). Many species concentrate together at these relatively limited staging areas along their extensive migratory routes. This makes them very vulnerable to environmental change, particularly when large percentages of entire populations gather in one place at one time. Human disturbance has had direct, measurable effects on shorebirds (Thurston 1996).

Criteria (Size of Available Habitat for Staging Areas Within the Pacific Flyway):

≥ 5 acres	= 4
2.1 - 5 acres	= 3
0.6 - 2 acres	= 2
0.1 - 0.5 acres	= 1
0 acres	= 0

15. Water/Shoreline/Upland Connectivity to Other Habitats

Definition: Connectivity between habitats provides access between various foraging locations and den sites. For this criterion, connectivity is evaluated in each primary direction of potential wildlife movement. For example, connectivity for sites along the Willamette River is considered upstream, downstream, toward any upland habitats, and toward the river.

Rationale (Mink): Although mink are considered non-migratory, they will travel distances up to 7.5 mi between forage locations and den sites (Whitaker and Hamilton 1998). Mink will use upland habitat if sufficient cover and prey are available (Degraaf and Yamasaki 2001).

Criteria:

Connectivity promoting wildlife movement from the project site in 4 directions	= 4
Connectivity promoting wildlife movement from the project site in 3 directions	= 3
Connectivity promoting wildlife movement from the project site in 2 directions	= 2
Connectivity promoting wildlife movement from the project site in 1 direction	= 1
No connectivity in any direction	= 0

16. Cover

Mink

Definition: The percentage of tree, shrub, and/or persistent emergent herbaceous vegetation canopy closure.

Rationale (Mink): Mink are most often found in close association with wetland cover types and the vegetative communities immediately adjacent to streams, rivers, and lakes. Optimum cover is assumed when woody cover within 330 ft of the water's edge is ≥75% (Allen 1986). Dense woody cover provided by trees and/or shrubs provides the mink with potential den sites, escape cover, and foraging cover. Persistent herbaceous cover may also provide mink with sufficient cover for foraging and shelter.

Criteria (Percent Canopy Closure within 330 ft of a Waterbody):

81-100% Canopy Closure	= 4
61-80% Canopy Closure	= 3
41-60% Canopy Closure	= 2
21-40% Canopy Closure	= 1
0-20% Canopy Closure	= 0

Spotted Sandpiper

Definition: Spotted sandpipers use a mosaic of habitats that include open and semiopen areas with herbaceous ground cover (generally vegetation less than 2' tall). For this

criterion, significant habitat value is defined as semiopen areas with herbaceous cover that are relatively undisturbed near water and patches of more dense vegetation. Semiopen habitats with herbaceous cover that are low value include areas that are heavily disturbed, or that are not near water or patches of more dense vegetation. Habitat that is scored as insignificant includes areas that do not support any notable patches of herbaceous cover, or areas that are too densely vegetated (i.e., 75-100% herbaceous cover, such as monotypical stands of reed canarygrass).

Rationale (Spotted Sandpiper): Fairly open areas with some herbaceous cover are important elements of spotted sandpiper habitat. Oring and Knudson stated that spotted sandpipers nest in sparsely vegetated areas and Bent (1929) stated that spotted sandpipers will not nest in densely wooded areas. According to Oring et al. (1997), "Females normally defend all-purpose territory that includes (1) shoreline (stream or lake) for foraging, drinking, bathing, and displaying; (2) semiopen habitat for nesting; and (3) patches of dense vegetation for brood cover (Maxson and Oring 1980, Oring et al. 1983)." The authors state that in urban areas, they can also breed in fields, lawns and parks. Allard (2001) defined areas with herbaceous ground cover ranging from 10-50% as optimal for nesting cover in a spotted sandpiper suitability index.

Criteria:

Herbaceous cover present and provides significant habitat value	= 4
Herbaceous cover present, but provides low habitat value	= 2
Herbaceous habitat not present or is insignificant	= 0

17. Patch Size

Mink

Definition: Any wetland or wetland associated habitat that has connectivity to a suitable den site.

Rationale: Minimum habitat area is defined as the minimum amount of contiguous habitat that is required before an area will be occupied by a species. The size and shape of mink home ranges vary in response to topography and food availability. Home ranges of both sexes tend to parallel the configuration of a body of water or wetland basin. Based on this information, it is assumed that any wetland, or wetland associated habitat, large enough to be identified and evaluated as such, has the potential to support mink. Mink move back and forth in a core area to forage, which is located adjacent to the den site (Allen 1986). The area is typically does not exceed 300 meters in shoreline length (Gerell 1970).

Criteria: Patch size of suitable habitat for foraging and denning

≥ 50 acres	= 4

20 - 49.9 acres = 3
10 - 19.9 acres = 2
0.1 - 9.9 acres = 1
0 acres = 0

Spotted Sandpiper

Definition: Spotted sandpipers occupy almost all habitats near water. For breeding, females normally defend territories that include 1) shoreline for foraging, drinking, bathing, and displaying, 2) semi-open habitat for nesting, and 3) patches of dense vegetation for brood cover (Maxson and Oring 1980, Oring *et al*. 1983 as cited in Oring *et al*. 1997, p. 5).

Rationale: Female breeding territories often include territories of one or more males. Research has found territory sizes ranging from approximately 0.01 to 0.34 acres at a study area in Minnesota, up to between approximately 0.74 to 4.94 acres at a study area in New York. In some cases, spotted sandpipers have been found nesting within 5 meters of each other. Territory sizes tend to increase in size with higher levels of predation and lower food resources (Oring *et al*. 1997, p. 11).

Criteria: Habitat patch size; habitat must include or be connected to a shoreline area.

≥ 5 acres = 4
2.1 - 5 acres = 3
0.6 - 2 acres = 2
0.1 - 0.5 acres = 1
0 acres = 0

Bald Eagle

Definition: The area immediately surrounding the nest site.

Rationale: Bald eagles are sensitive to human disturbance. Protection from human disturbance is important for successful hunting, feeding of young and nesting (Marshall 2006). Based on this information, the U.S. Fish and Wildlife Service require a minimum 0.25 mile line-of-sight buffer to protect bald eagles from disturbance.

Criteria: Line-of-sight Distance (miles)

1.1 - 2.0 miles = 4
0.25 - 1.0 miles = 2
0 - 0.24 miles = 0

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