This document is part of a collection of Ecological Integrity Assessments addressing 67 of Washington's 99 Ecological Systems. These documents were prepared by the Washington Natural Heritage Program with funding provided by the Washington Department of Fish and Wildlife.

Ecological Integrity Assessment:
Temperate Pacific Freshwater Emergent Marsh

Ecological Summary

The Temperate Pacific Freshwater Emergent Marsh system includes wetlands or the portion of wetlands dominated by emergent (mostly graminoid) species where standing water is seasonally or more typically semi-permanently present. This system mostly occurs as a small patch and confined to limited areas in suitable floodplain or basin topography. Freshwater marshes are found at all elevations below timberline throughout the temperate Pacific Coast and above lower treeline in the dry shrub steppe landscape in eastern Washington. However, the dynamic hydrological regimes, high nutrient status, and relatively warm growing season of lowlands in western Washington make this system more abundant at lower than at higher elevations (MacKenzie and Moran 2004). At higher elevations, marshes are most commonly found along wave-washed lakeshores and stream floodplains where continuous, oxygenated water flow prevents peat accumulation and keeps nutrient availability high, whereas, peatlands tend to form in isolated basins at higher elevations (MacKenzie and Moran 2004).

Marsh development along riparian areas is driven by the magnitude and frequency of flooding, valley and substrate type, and beaver activity. Seasonal and episodic flooding scour depressions in the floodplain, create side channels and floodplain sloughs, and force channel migration which can result in oxbows. Marsh vegetation establishes in those landforms if there is semi-permanent to permanent water. Marshes also occur near the fringes of lakes and ponds where their development is dictated by shoreline gradient and fluctuation of lake or pond levels. Relatively flat or gently sloping shorelines support a much larger marsh system than steep sloping shorelines. Water is at or above the surface for most of the growing season.In some areas water levels fluctuate with dramatic drawdowns that can expose bare soil by later summer. The frequency and magnitude of water level fluctuations determine the extent of each marsh zone (floating, submerged, emergent, etc.). Water level fluctuations also support the development of different marsh zones (floating, submergent, emergent, etc.) which vary according to the degree of inundation. Soils are muck or mineral, and water is nutrient rich. High nutrients favor aggressive species resulting in relatively low diversity of plant species (MacKenzie and Moran 2004). Freshwater marshes are dominated by emergent herbaceous species, mostly graminoids (*Carex*, *Scirpus* and/or *Schoenoplectus*, *Eleocharis*, *Juncus*, *Typha latifolia*) with some forbs. Trees, shrubs and bryophytes are typically absent or very sparse (MacKenzie and Moran 2004). Occurrences of this system typically are found in a mosaic with other wetland systems. Common emergent and floating vegetation includes species of *Scirpus* and/or *Schoenoplectus*, *Typha*, *Eleocharis*, *Sparganium*, *Sagittaria*, *Bidens*, *Cicuta*, *Rorippa*, *Mimulus*, and *Phalaris*.

When associated with relatively deep water, this system may co-occur with the Temperate Pacific Freshwater Aquatic Bed system with floating-leaved genera such as *Lemna, Potamogeton, Polygonum, Nuphar, Hydrocotyle,* and *Brasenia* being dominant. A consistent source of freshwater is essential to the function of these systems.

Stressors

The stressors described below are those primarily associated with the loss of extent and degradation of the ecological integrity of existing occurrences. The stressors are the cause of the system shifting away from its natural range of variability. In other words, type, intensity, and duration of these stressors is what moves a system's ecological integrity rank away from the expected, natural condition (e.g. A rank) toward degraded integrity ranks (i.e. B, C, or D).

Historic and contemporary land use practices have impacted hydrologic, geomorphic, and biotic structure and function of marshes in western Washington. Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can also have a substantial impact on the hydrological regime. Direct alteration of hydrology (i.e., channeling, draining, damming) or indirect alteration (i.e., roading or removing vegetation on adjacent slopes) results in changes in amount and pattern of herbaceous wetland habitat. If the alteration is long term, wetland systems may reestablish to reflect new hydrology, e.g., cattail is an aggressive invader. Human land uses both within the marshes as well as in adjacent upland areas have reduced connectivity between wetland patches and upland areas. Land uses in contributing watershed have the potential to contribute excess nutrients into to the system which could lead to the establishment of non-native species and/or dominance of native disturbance-increasing species. In general, excessive livestock or native ungulate use leads to a shift in plant species composition. Non-native plants or animals, which can have wide-ranging impacts, also tend to increase with these stressors. Although most wetlands some receive regulatory protection at the national, state, and county level, many wetlands have been and continued to be filled, drained, grazed, and farmed extensively in the lowlands of Washington. Montane wetlands are less altered than lowland wetlands even though they have undergone modification as well. A keystone species, the beaver, has been trapped to near extirpation in parts of the Pacific Northwest and its population has been regulated in others. Herbaceous wetlands (including freshwater emergent marsh) have decreased along with the diminished influence of beavers on the landscape.

Conceptual Ecological Model

The general relationships among the key ecological attributes associated with this system are presented in Figure 1.

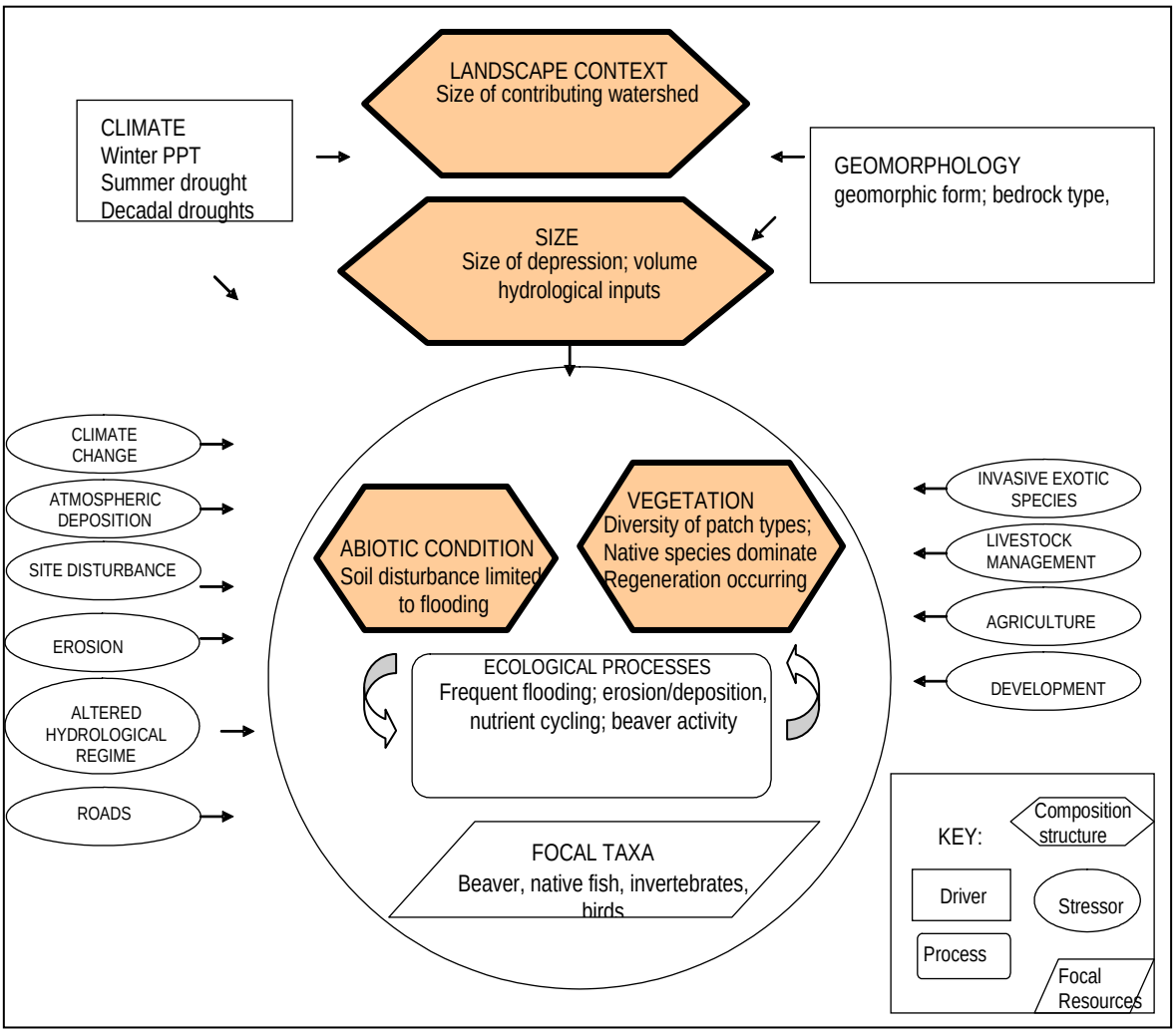

Figure 1. Conceptual Ecological Model for Temperate Pacific Freshwater Emergent Marsh

Ecological Integrity Assessments

The assessment of ecological integrity can be done at three levels of intensity depending on the purpose and design of the data collection effort. The three-level approach is intended to provide increasing accuracy of ecological integrity assessment, recognizing that not all conservation and management decisions need equal levels of accuracy. The three-level approach also allows users to choose their assessment based in part on the level of classification that is available or targeted. If classification is limited to the level of forests vs. wetlands vs. grasslands, the use of remote sensing metrics may be sufficient. If very specific, fine-scale forest, wetland, and grassland types are the classification target then one has the flexibility to decide to use any of the three

levels, depending on the need of the assessment. In other words, there is no presumption that a fine-level of classification requires a fine-level of ecological integrity assessment.

Because the purpose is the same for all three levels of assessment (to measure the status of ecological integrity of a site) it is important that the Level 1 assessment use the same kinds of metrics and major attributes as used at Levels 2 and 3. Level 1 assessments rely almost entirely on Geographic Information Systems (GIS) and remote sensing data to obtain information about landscape integrity and the distribution and abundance of ecological types in the landscape or watershed. Level 2 assessments use relatively rapid field-based metrics that are a combination of qualitative and narrative-based rating with quantitative or semi-quantitative ratings. Field observations are required for many metrics, and observations will typically require professional expertise and judgment. Level 3 assessments require more rigorous, intensive field-based methods and metrics that provide higher-resolution information on the integrity of occurrences. They often use quantitative, plot-based protocols coupled with a sampling design to provide data for detailed metrics.

Although the three levels can be integrated into a monitoring framework, each level is developed as a stand-alone method for assessing ecological integrity. **When conducting an ecological integrity assessment, one need only complete a single level that is appropriate to the study at hand.** Typically only one level may be needed, desirable, or cost effective. But for this reason it is very important that each level provide a comparable approach to assessing integrity, else the ratings and ranks will not achieve comparable information if multiple levels are used.

Level 1 EIA

A generalized Level 1 EIA is provided in Rocchio and Crawford (2009). Please refer to that document for the list of metrics applicable to this ecological system.

Ecological Integrity Assessments (Level 2 and 3)

The following tables display the metrics chosen to measure most of the key ecological attributes in the conceptual ecological model above. The EIA is used to assess the ecological condition of an assessment area, which may be the same as the element occurrence or a subset of that occurrence based on abrupt changes in condition or on artificial boundaries such as management areas. **Unless otherwise noted, metric ratings apply to both Level 2 and Level 3 EIAs. The difference between the two is that a Level 3 EIA will use more intensive and precise methods to determine metric ratings.** To calculate ranks, each metric is ranked in the field according the ranking categories listed below. Then, the rank and point total for each metric is entered into the EIA Scorecard and multiplied by the weight factor associated with each metric resulting in a metric 'score'. Metric scores within a key ecological attribute are then summed to arrive at a score (or rank). These are then tallied in the same way to arrive at an overall ecological integrity score.

Table 1. Temperate Pacific Freshwater Emergent Marsh Level 2 EIA.

Metric	Justification	Rank			
		A (5 pts.)	B (4 pts.)	C (3 pts.)	D (1 pts.)
Rank Factor: LANDSCAPE CONTEXT					
Key Ecological Attribute: *Buffer Effects*					
Buffer Length	The buffer can be important to biotic and abiotic aspects of the wetland as it provides connectivity and provides a 'filter' from exogenous threats.	Buffer is > 75 – 100% of occurrence perimeter.	Buffer is > 50 – 74% of occurrence perimeter.	Buffer is 25 – 49% of occurrence perimeter	Buffer is < 25% of occurrence perimeter.
Buffer Width		Average buffer width of occurrence is > 200 m, adjusted for slope.	Average buffer width is 100 – 199 m, after adjusting for slope.	Average buffer width is 50 – 99 m, after adjusting for slope.	Average buffer width is < 49 m, after adjusting for slope.
Buffer Condition		Abundant (>95%) cover native vegetation, little or no (<5%) cover of non-native plants, intact soils, AND little or no trash or refuse.	Substantial (75–95%) cover of native vegetation, low (5–25%) cover of non-native plants, intact or moderately disrupted soils; minor intensity of human visitation or recreation.	Moderate (25–50%) cover of non-native plants, moderate or extensive soil disruption; moderate intensity of human visitation or recreation.	Dominant (>50%) cover of non-native plants, barren ground, highly compacted or otherwise disrupted soils, moderate or greater intensity of human visitation or recreation, no buffer at all.
Key Ecological Attribute: *Landscape Structure*					
Connectivity	Intact areas have a continuous corridor of natural or semi-natural vegetation between shrub steppe areas	Intact: Embedded in 90-100% natural habitat; connectivity is expected to be high.	Variegated: Embedded in 60-90% natural or semi-habitat; habitat connectivity is generally high, but lower for species sensitive to habitat modification;	Fragmented: Embedded in 20-60% natural or semi-natural habitat; connectivity is generally low, but varies with mobility of species and arrangement on landscape.	Relictual: Embedded in < 20% natural or semi-natural habitat; connectivity is essentially absent

Landscape Condition Model Index	The intensity and types of land uses in the surrounding landscape can affect ecological integrity.	Landscape Condition Model Index >0.8		Landscape Condition Model Index 0.79 – 0.65	Landscape Condition Model Index < 0.65
Rank Factor: CONDITION					
Key Ecological Attribute: *Vegetation Composition*					
Relative Cover Native Plant Species	Native species dominate this system; non-natives increase with human impacts.	Cover of native plants 95-100%.	Cover of native plants 80-95%.	Cover of native plants 50 to 79%.	Cover of native plants <50%.
Absolute Cover of Invasive Species	Invasive species can inflict a wide range of ecological impacts. Early detection is critical.	None present.	Invasive species (e.g., *Typha, Phalaris, Phragmites*) present, but sporadic (<3% cover).	Invasive species (e.g., *Typha, Phalaris, Phragmites*) prevalent (3–10% absolute cover).	Invasive species (e.g., *Typha, Phalaris, Phragmites*) abundant (>10% absolute cover).
Relative Cover of Native Increasers	Some stressors such as grazing can shift or homogenize native composition toward species tolerant of stressors.	Absent or incidental	<10% cover	10-20% cover	>20% cover
Species Composition Note: Once developed, the Floristic Quality Assessment index could be used here instead.	The overall composition of native species can shift when exposed to stressors.	Species diversity/abundance at or near reference standard conditions. Native species sensitive to anthropogenic degradation are present, functional groups indicative of anthropogenic disturbance (ruderal or "weedy" species) are absent to minor, and full range of diagnostic / indicator species are present.		Species diversity/abundance close to reference standard condition. Some native species reflective of past anthropogenic degradation present. Some indicator/ diagnostic species may be absent.	Species diversity/abundance is different from reference standard condition in, but still largely composed of native species characteristic of the type. This may include ruderal ("weedy") species. Many indicator/diagnostic species may be absent.
Key Ecological Attribute: *Vegetation Structure*					
Organic Matter Accumulation	Accumulation of coarse and fine debris is integral to a variety of ecological processes	The site is characterized by a moderate amount of fine organic matter. There is some matter of various sizes, but new materials seem much more prevalent than old materials. Litter layers, duff layers, and leaf piles in pools or topographic lows are thin.		The site is characterized by occasional small amounts of coarse organic debris, such as leaf litter or thatch, with only traces of fine debris, and with little evidence of organic matter recruitment, or somewhat excessive littler.	The site contains essentially no significant amounts of coarse plant debris, and only scant amounts of fine debris. OR too much debris
Key Ecological Attribute: *Hydrology*					

Water Source	Anthropogenic sources of water can have detrimental effects on the hydrological regime	Source is natural or naturally lacks water in the growing season. No indication of direct artificial water sources	Source is mostly natural, but site directly receives occasional or small amounts of inflow from anthropogenic sources	Source is primarily urban runoff, direct irrigation, pumped water, artificially impounded water, or other artificial hydrology	Water flow has been substantially diminished by human activity
Hydroperiod	Alteration in hydrology or sediment loads or some onsite stressors can degrade channel stability	Hydroperiod of the site is characterized by natural patterns of filling or inundation and drying or drawdown.	The filling or inundation patterns in the site are of greater magnitude (and greater or lesser duration than would be expected under natural conditions, but thereafter, the site is subject to natural drawdown or drying.	The filling or inundation patterns in the site are characterized by natural conditions, but thereafter are subject to more rapid or extreme drawdown or drying, as compared to more natural wetlands. OR filling or inundation patterns are of substantially lower magnitude or duration than expected under natural conditions, but thereafter, the site is subject to natural drawdown or drying.	Both the filling/inundation and drawdown/drying of the site deviate from natural conditions (either increased or decreased in magnitude and/or duration).
Hydrological Connectivity (Non-riverine)	Floodwater should have access to the floodplain. Stressors resulting in entrenchment affect hydrological connectivity	Rising water in the site has unrestricted access to adjacent upland, without levees, excessively high banks, artificial barriers, or other obstructions to the lateral movement of flood flows.	Lateral excursion of rising waters is partially restricted by unnatural features, such as levees or excessively high banks, but < than 50% of the site is restricted by barriers to drainage. Restrictions may be intermittent along the site, or the restrictions may occur only along one bank or shore. Flood flows may exceed the obstructions, but drainage back to the wetland is incomplete due to impoundment.	Lateral excursion of rising waters is partially restricted by unnatural features, such as levees or excessively high banks, and 50-90% of the site is restricted by barriers to drainage. Flood flows may exceed the obstructions, but drainage back to the wetland is incomplete due to impoundment.	All water stages in the site are contained within artificial banks, levees, sea walls, or comparable features, or greater than 90% of wetland is restricted by barriers to drainage. There is essentially no hydrologic connection to adjacent uplands.
Key Ecological Attribute: *Physicochemical*					
Soil Surface Condition	Soil disturbance can result in erosion thereby negatively affecting many ecological processes	Bare soil areas are limited to naturally caused disturbances such as flood deposition or game trails	Some bare soil due to human causes but the extent and impact is minimal. The depth of disturbance is limited to only a few inches and does not show evidence of ponding or channeling water.	Bare soil areas due to human causes are common. There may be pugging due to livestock resulting in several inches of soil disturbance. ORVs or other machinery may have left some shallow ruts.	Bare soil areas substantially & contribute to altered hydrology or other long-lasting impacts. Deep ruts from ORVs or machinery may be present, or livestock pugging and/or trails are widespread. Water will be channeled or ponded.

Water Quality	Excess nutrients, sediments, or other pollutant have an adverse affect on natural water quality	No evidence of degraded water quality. Water is clear; no strong green tint or sheen.	Some negative water quality indicators are present, but limited to small and localized areas. Water may have a minimal greenish tint or cloudiness, or sheen.	Negative indicators or wetland species that respond to high nutrient levels are common. Water may have a moderate greenish tint, sheen or other turbidity with common algae.	Widespread evidence of negative indicators. Algae mats may be extensive. Water may have a strong greenish tint, sheen or turbidity. Bottom difficult to see during due to surface algal mats and other vegetation blocking light to the bottom.
Rank Factor: SIZE					
Key Ecological Attribute: *Size*					
Relative Size	Indicates the proportion lost due to stressors.	Site is at or minimally reduced from natural extent (>95% remains)	Occurrence is only modestly reduced from its original natural extent (80-95% remains)	Occurrence is substantially reduced from its original natural extent (50-80% remains)	Occurrence is severely reduced from its original natural extent (<50% remains)
Absolute Size	Absolute size may be important for buffering impacts originating in the surrounding landscape	Very large (> 200 ac/80 ha)	Large (75-200 ac/30-80 ha)	Moderate (5-75 ac/2-30 ha)	Small (< 5 ac/2 ha)

Level 3 EIA
Level 3 metrics would include more quantitative measures of the metrics listed above. In addition, further consideration might be given to:

- Soil Bulk density can reduce the soil's water holding capacity, infiltration rate, water movement through the soil, and limit plant growth by physically restricting root growth.
- Soil organic carbon is strong metric of soil quality due to its sensitivity to environmental disturbance.
- Nutrient Enrichment (C:P) and (C:N) ratios

Triggers or Management Assessment Points
Ecological triggers or conditions under which management activities need to be reassessed are shown in the table below. Since the Ecological Integrity rankings are based on hypothesized thresholds, they are used to indicate where triggers might occur. Specific details about how these triggers translate for each metric can be found by referencing the values or descriptions for the appropriate rank provided in the Table above.

Table 2. Triggers for Level 2 & 3 EIA

Key Ecological Attribute or Metric	Trigger	Action
Any metric (except Connectivity)	▪ C rank ▪ Shift from A to B rank ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.
Any Key Ecological Attribute	▪ any metric has a C rank ▪ > ½ of all metrics are ranked B ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.

Protocol for Integrating Metric Ranks
If desired, the user may wish to integrate the ratings of the individual metrics and produce an overall score for the three rank factor categories: (1) Landscape Context; (2) Condition; and (3) Size. These rank factor rankings can then be combined into an Overall Ecological Integrity Rank. This enables one to report scores or ranks from the various hierarchical scales of the assessment depending on which best meets the user's objectives. Please see Table 5 in Rocchio and Crawford (2009) for specifics about the protocol for integrating or 'rolling-up' metric ratings.

Supporting documents for the EIAs can be found at:
http://www1.dnr.wa.gov/nhp/refdesk/communities/eia.html

Documentation about Ecological Systems can be found at:
http://www1.dnr.wa.gov/nhp/refdesk/communities/ecol_systems.html

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