City of Bainbridge Island
Environmental Technical Advisory Committee

MEMORANDUM

TO: Planning Commission and City Council

FROM: ETAC

DATE: August 4, 2011

RE: Technical Framework for Riparian Protection Zones and Buffers

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RIPARIAN PROTECTION ZONES AND BUFFERS
Bainbridge Island Environmental Technical Advisory Committee (ETAC)

This paper provides a technical framework (or scientific basis) related to marine shoreline vegetation, marine riparian areas (MRA), and buffers used along marine shorelines to protect ecosystem functions. The framework is intended to inform the discussions and development of the Riparian Protection Zones (RPZ) and potential buffers proposed for the 2011-12 update of the Bainbridge Island SMP.

PART I: GENERAL MARINE RIPARIAN VEGETATION ISSUES

There is consensus in the scientific community that marine riparian[1] areas (MRA) are critical to sustaining a number of ecological functions (Desbonnet et al. 1994, Brennan and Culverwell 2004, Lemieux et al 2004, Brennan et al. 2009). Although marine riparian systems have not been subject to the same level of scientific investigation as freshwater systems, marine riparian areas and shoreline vegetation have been identified as integral and important parts of the marine nearshore ecosystem, and there is consensus that freshwater riparian buffer research is *generally* applicable to marine shorelines (at least one review panel has evaluated this applicability; see, Marine Riparian Technical Review Workshop, reported in Brennan et al., 2009). Though there are some uncertainties and data gaps (identified below), a growing body of evidence supports that riparian systems serve several similar functions regardless of the salinity of the water bodies they border.

Some of this uncertainty relates to the importance of site-specific conditions. That is, the relationship of ecological functions to stressors will vary depending on site conditions such as

[1] Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines (NRC, 2002).

wave energy, sediment size, presence of vegetation, amount of armoring, and other localized factors. Other uncertainties relate to gradients and areas of influence.

A listing of known ecological functions and areas of uncertainty regarding marine riparian vegetation are identified in Table 1. Table 2 lists some general issues related to management of marine riparian areas.

Table 1. Ecological Functions and Processes of marine riparian areas (MRA)

Ecological Functions	Level of Understanding	Data Gaps and Uncertainties
Water quality	• Trees, shrubs and herbaceous plants can trap and retain pollutants from the atmosphere, sediments, surface runoff and groundwater • Vegetation helps build and stabilize soils, which can slow the flow of surface and subsurface water and increase retention of pollutants ⅄ impervious or low-permeability surfaces adjacent to/within the MRA increase runoff ⅄ Effective filtration of pollutants is likely more of a watershed-level function	⅄ Most pollution control functions are derived from the freshwater literature, so there are uncertainties in the extrapolation to to marine systems ⅄ The extent to which fine sediment acts as a “pollutant” in terms of adverse effects on aquatic life is mainly drawn from stream literature, and fine material erosion is neither well quantified nor well understood in terms of potential effects on nearshore marine systems.
Fish and Wildlife habitat	1.A variety of fish and wildlife associations have been identified 2.Marine riparian areas (MRAs are used by terrestrial wildlife as habitat and corridors for movement 3. MRAs are used by aquatic-dependent and other wildlife to move between upland and aquatic systems (eg, raccoons, otters) 4.Overhanging vegetation in MRAs are used as perches for birds of prey including kingfisher and bald eagle	5.Wildlife functions of MRAs are generally not well documented 6.Need better understanding of wildlife interactions on Bainbridge Island shorelines

Ecological Functions	Level of Understanding	Data Gaps and Uncertainties
Control of Erosion and Sediment Supply	• Slope stability: Riparian vegetation inhibits erosion through a variety of processes, such as soil anchoring or binding, intercepting rainfall, and decreasing soil water saturation. • Coarse sediment supply: Coarse beach sediment is critical habitat and substrate to important biota (*e.g*. forage fish and eel grass). Erosion of marine riparian bluffs is the dominant source of coarse sediment to most Bainbridge beaches. • Fine sediment control: Excessive fine sediment on beaches may inhibit important ecological functions.	1. These functions can influence each other: a decrease in slope stability can increase the sediment supply and vice versa. An increase in sediment supply can increase the beneficial coarse sediment supply but could also increase a possibly harmful influx of fine sediment. Natural riparian vegetation moderates these processes; it decreases but does not eliminate bluff erosion. The net effects of changes in sediment supply resulting from alterations to the MRA are likely to be site specific and even depend on ecological characteristics of inland areas. For example, stabilizing a high-ecological-function riparian area would be a higher priority if it is backed by urban development than if it is backed by an undeveloped forest, because sediment and habitat loss could be replaced in the latter case by upland habitat.
Shading and microclimate moderation	1. Overhanging vegetation close to the water surface provides thermal and structural refuge for fish and invertebrate species	2. The importance of vegetation shading is variable and dependent on shoreform and orientation; e.g., a steep bank may be more likely to have overhanging vegetation compared to a gradual shoreform such as a barrier beach. 3. presence of specific functions and species in localized settings 4. tidal fluctuations alter proximity of the water to shading
Food source	7. Terrestrial insects originating from upland and riparian vegetation are important food species for salmon 8. Detritus provides a potential food source in the nearshore environment. Detritus in wrack lines helps to retain moisture	9. Importance of detritus to nearshore functions and as part of food web is not well understood in Puget Sound 10. Difference between native and non-native vegetation and insect species in providing equivalent resources to the nearshore is not well understood (see below)

Ecological Functions	Level of Understanding	Data Gaps and Uncertainties
LWD function(s)	• Stabilizes upper beach sediment through sediment trapping • Unless anchored, LWD can be transient due to waves and tidal energy • Both naturally discharged logs with and without root wads and anthropogenically discharged logs (i.e., from log rafts) are present on our shorelines	• Effect of sea level rise on the presence of LWD and related ecosystem functions • Effect of removal of logs from marine waters/system (Coast Guard and US Army Corps) • Any differences in LWD functions between wood from different sources • Effect of transience of logs • Amount and type of structural complexity and support for habitat added, including beach vegetation and invertebrates • Amount and importance of the moderation of substrate temperatures

Further discussion of some of the functions and data gaps outlined in Table 1 is provided below.

Native and Non-Native Vegetation

We need a better understanding of the functional differences between native and non-native vegetation (i.e, does replanting of native vegetation in buffers, with or without accompanying removal of non-native vegetation, make a difference in the functions the buffer was meant to protect).

1. *Invasive* vegetation (i.e., knotweed at Wyckoff, pepperweed at Battle Point Spit, purple loosestrife in Murden Cove) can impact nearshore functions including outcompeting upper beach and riparian vegetation and altering sediment composition and structure
2. Can replanting of native vegetation be used as a Net Ecosystem Improvement (NEI) technique?
3. Are the terrestrial insects important to salmon also found on non-native vegetation (ornamental vs cultivar vs invasive plants)?

Recreational Activities

Recreational activities within the MRA can cause impacts including trampling of supra and intertidal vegetation, wildlife disturbance, and soil compaction. However, the extent of these impacts, and the numbers of people required for impacts to occur, specifically relative to Bainbridge island shorelines, is largely unknown.

General Data Gaps and Uncertainties Regarding Vegetation

Some major gaps/critical uncertainties in knowledge and management of marine riparian vegetation have been identified by Brennan et al. (2009):

- Studies/data on marine riparian functions for the Puget Sound region are very limited.
- Inventories (types, locations, size) of shoreline vegetation and community types or associations are lacking, and there is no monitoring or assessment of modification and loss.
- Protection, enhancement, and restoration standards for marine riparian vegetation are limited.
- Fish and wildlife inventories and dependencies on marine riparian areas are not well documented.
- Appropriate buffer widths and setbacks for protecting marine riparian and marine aquatic systems are poorly understood and inconsistently applied (if applied at all).
- An improved understanding of the exchanges (e.g., energy, matter) across and within these riparian transition areas is needed.
- Food web data are limited.
- Study of the potential effects of climate change and sea-level rise on marine riparian systems is lacking.

In addition to these uncertainties and data gaps, the correlation of nearshore stressors and functions specific to Bainbridge Island shorelines brought forward in the Battelle Nearshore Assessment (Williams, Thom and Evans, 2004 and subsequent documents) should be further tested, supporting the need for specific monitoring and assessment for the island.

PART II: MARINE RIPARIAN ZONES AND BUFFERS

General Discussion

Marine shoreline buffers are used to regulate development to protect the marine nearshore (and corresponding ecosystem functions) from the effects of land use activities, such as construction of buildings, driveways, and other infrastructure; the discharge of pollutants; and removal of vegetation. Marine riparian areas describe the terrestrial ecosystem directly adjacent to the marine nearshore that interacts with the aquatic environment and differs from marine shoreline buffers that connect to them on the upland side. Marine shoreline buffers may have variable widths, and use restrictions generally apply uniformly to the entire buffer area.

In previous deliberations on current marine shoreline science relative to buffers and vegetation, discussions have pointed toward a few approaches to protect vegetation and other ecosystem functions through the development and implementation of marine riparian buffers, and highlighted some accompanying concerns/issues:

1. Implement **different buffer widths for shoreline areas with different functions**. Several issues arise in developing and managing such a system:
    a. Need to know which functions are present in which shoreline areas;
    b. Need to define which functions are the most important in various shoreline segments to define the buffers. Some sort of prioritization may be needed where a shoreline has several competing functions that require different buffers. How would such a system work and what is the technical/scientific justification for how to prioritize?
    c. Also need to determine how much buffer is necessary to protect particular functions, as the range in the scientific literature is quite broad (see Herrera, 2011a; Brennan et al., 2009).

2. Define **one standard buffer width for all riparian areas** on the island. A primary issue with this approach is understanding which buffer width is scientifically defensible and would adequately cover the range of functions for each shoreline area. A choice would presumably have to be made between (1) applying the largest buffer needed for any area/function to all areas regardless of need, or (2) applying a smaller buffer – perhaps an average or one that covered the most common situations – even though it might be inadequate for some area/functions.

An evaluation of either a "flexible" or a single buffer approach should address the inherent primary issue regarding whether the standard buffer widths or any proposed buffer widths for the flexible approach are scientifically defensible. This is difficult at present due to the broad range of buffers suggested in the literature, as discussed below.

Based on studies of freshwater streams, necessary buffer widths vary considerably depending on the site-specific characteristics and the functions to be protected. For example, in order to achieve at least 80 percent effectiveness at removing pollutants from stormwater runoff, recommended buffers varied from as little as 16 feet to as large as 1,969 feet depending on the slope, depth and type of soil, surface roughness, density of vegetation and the intensity of the land use. Buffer widths for organic matter contributions (such as plant litter and terrestrial insects) range between 16 and 328 feet from the shoreline, depending on site conditions (Bavins et al., 2000, cited in Herrera, 2011b). Buffers to protect the large woody debris function important to habitat structure and shoreline stability were suggested to be between 33 and 328 feet (Herrera, 2011b). The participants in the Marine Riparian Technical Review Workshop panel noted above (Brennan et al., 2009) pointed to other buffer widths to support a number of specific riparian functions, including 98 feet for fine sediment control, and shade and microclimate control, 164 feet for the LWD function, 138 feet for fine sediment control, 90 feet for temperature moderation, 147 feet for LWD and litter fall functions, and recommendations for wildlife habitat protection ranged from 50 feet (specific to highly rural areas) to 328 feet.

The broad ranges of buffer widths shown to protect riparian functions in the scientific literature imply a high level of uncertainty, which can be magnified when multiple ecosystem functions are considered in the marine riparian areas of Bainbridge Island. Further studies and monitoring can reduce that uncertainty in the future; however, at this point in time we cannot define Bainbridge Island buffer requirements with any practical precision. It is possible that a buffer covering the full 200 ft width of the Shoreline Management Act (SMP) jurisdiction may not be adequate in some cases (such as for filtration of some pollutants such as phosphorous). It is also possible that buffers much smaller than 200 ft can provide adequate protection. It is clear that the uncertainties apply to both the low and the high ranges of required buffer widths associated with the specific ecosystem functions relative to specific locations on Bainbridge Island (and the buffer widths required to protect those functions).

Given that there is substantive evidence that human activities can impact ecological functions of riparian zones and the marine nearshore, and the importance of the Precautionary Principle in dealing with uncertainty in ecological science and in the regulatory language of Washington State, a good argument can be made for going beyond absolute minimum buffers to protect ecological functions. Indeed, it can be argued that from the goal of protecting marine nearshore and riparian functions, a larger burden of proof should be placed on justifying lower buffer ranges. One must still depend on the ranges cited in the literature for guidance.

Table 2 represents the range of Riparian Protection Zones (RPZ)[2] and Marine Shoreline Buffers by Use Designation suggested by Herrera Environmental Consultants (Herrera, 2011b) for the 2011 update of the Bainbridge Island SMP. Given the uncertainties defined in the literature, other factors are incorporated in the decision process. In the case of the buffer numbers suggested for Bainbridge Island, the decision system used other variables to produce buffer values that fall within the range of various buffer widths from the scientific literature. These included

- Existing development regulations
- Future land use
- The City's existing environmental buffers
- Existing shoreline character (physical & biological) and nearshore assets

[2] Riparian Protection Zones are a term used by Herrera (2011b) to describe management zones beginning at OHW and intended for protection of riparian vegetation and functions seaward of the buffer zones. The RPZ correlate and overlap with marine riparian zones found in the literature, but may not matchup exactly with MRZs.

- Recently adopted marine shoreline management plans from Puget Sound jurisdictions
- A review of the distance of existing residential structures from the OHWM (to consider the City’s desire to limit the number of new non-conforming structures).

Given the current state of buffer delineation science, and the experience of other local jurisdictions in Washington State, it is likely that until more concrete scientific information on the effectiveness of different buffers for protection of ecosystem functions is available, this decision process represents an appropriate, if not the preferred method, of defining buffer widths.

Table 2. Suggested Range of Riparian Protection Zones (RPZs) and Marine Shoreline Buffers by Use Designation[a] (From Herrera, 2011b, Table 1).

Existing Distances from Shoreline to Primary Residential Structures (use designations are **bold**)	Riparian Protection Zone (inner buffer zone)	Minimum Standard Buffer (encompasses inner RPZ and outer marine shoreline buffer)	Maximum Standard Buffer (encompasses inner RPZ and outer marine shoreline buffer)
Urban Mean 59.8 feet Median 20.1 feet STD 72.1 feet	Minimum 30 feet from OHWM	Minimum 30 feet from OHWM [c]	30 feet from OHWM [c]
Shoreline Residential Mean 69.7 feet Median 60.2 feet STD 46.2 feet	Minimum 30 feet from OHWM up to standard buffer width	Condition: Shallow lots [b] or high bluff Standard Buffer: 50 feet from OHWM [c]	Condition: 65% coverage of native forest and shrub vegetation in RPZ [d], low bank, marshes, lagoons, spit/ barrier / backshores Standard Buffer: 75 feet from OHWM
Shoreline Residential Conservancy Mean 88.2 feet Median 86.3 feet STD 55.9 feet	Minimum 30 feet from OHWM up to standard buffer width	Condition: Shallow lots [b] or high bluff Standard Buffer: 75 feet from OHWM [c]	Condition: 65% coverage of native forest and shrub vegetation in RPZ [d], low bank, marshes, lagoons, spit/ barrier / backshores Standard Buffer: 115 feet from OHWM for developed lots 150 feet from OHWM for undeveloped lots
Island Conservancy Mean 144.9 feet Median 180.8 feet STD 62.9 feet	Minimum 30 feet from OHWM up to standard buffer width	Condition: Shallow lots [b] or high bluff Standard Buffer: 100 feet from OHWM [c]	Condition: Deeper lots [b], low bank, marshes, lagoons, spit / barrier / backshores Standard Buffer: 150 feet from OHWM
Natural Mean 145.3 feet Median 169.7 feet STD 53.8 feet	Minimum 100 feet from OHWM up to standard buffer width	Condition: High bluff Standard Buffer: 200 feet from OHWM [c]	Condition: Low bank or feeder bluff, marshes, lagoons, spit / barrier / backshores Standard Buffer: 200 feet from OHWM [c]

a. The suggested minimum and maximum buffers are based on existing distances to residential structures from the shoreline in addition to science-based recommendations for shoreline and nearshore protection. The suggested ranges could be refined further based on additional GIS based analysis of City shoreline conditions.
b. Shallow lots measure 200 feet or less from the OHWM and deeper lots measure greater than 200 feet from the OHWM.
c. Or 50 feet from edge of geologic hazard; whichever is greater.
d. 65% coverage of native forest and shrub vegetation in the RPZ based on the 2009 aerial image or an approved clearing permit since 2009.

In general, the buffers suggested in Table 2 are within the low to mid range of those values identified for different buffers in the scientific literature, and are similar in size (if not smaller) than buffers defined for other jurisdictions. Bainbridge is unique in that while much of the shoreline is developed, the island is a mix of urban and natural areas, and is probably more comparable to the other *county* SMPs than those of cities; this would argue not only for the flexible approach (different buffers for different areas), but would argue against the use of minimal buffers such as those proposed for certain cities in Puget Sound. Whether these buffers will ultimately be protective of the ecosystem functions along the Bainbridge Island nearshore will depend on filling in the data gaps and narrowing the range of uncertainty through some sort of monitoring program, which ETAC believes is critical to any long-term management of shorelines and marine riparian areas.

Table 3 identifies some general issues related to the development of RPZs integrated with buffers for Bainbridge Island and notes both the level of understanding about these general issues and associated data gaps or uncertainties.

Table 3. General issues related to protection and mitigation of Riparian Protection Zones and Buffers

Issue	Level of Understanding	Data Gaps and Uncertainties
Importance of riparian areas and need for Riparian Protection Zones (RPZ)	• Riparian areas are important to the health of most marine nearshore ecosystem functions. • Use of RPZ concept can allow protection of immediate riparian areas and some flexibility in the use of buffers beyond the RPZ	2. Understanding the interaction of multiple functions within riparian protection zones 3. Understanding and appropriately identifying how RPZ functions vary with shoreform 4. Defining (and ranking/prioritizing) the most important functions for different RPZs that would translate to the need for specific buffers
Use of freshwater buffer standards as a basis for marine buffer standards	• Scientific consensus that freshwater riparian buffer research is generally applicable to marine shorelines	• Uncertainty related to direct applicability for certain specific functions (pollutant control, woody debris, etc), and specific application to Bainbridge shorelines
Size of buffers required to protect ecosystem functions	11. Appropriate Buffer widths vary based on site-specific characteristics and functions to be protected	12. Broad range of buffer widths from the literature based on function – need more specific data for marine riparian buffers and specific protected functions for Bainbridge Island to refine
Monitoring	• Required for understanding effectiveness of buffers over time, particularly when flexible buffers used • Important to addressing data gaps and uncertainties related to ecological functions and stressors • Many of the shorelines of Bainbridge Island (as other Puget Sound shorelines) are missing baseline information	• Identifying the most effective monitoring design • Involvement of property owners • Review of consultant work (such as “critical areas stewardship plans”) • How to manage • Funding/staffing • Missing baseline information

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