Spatial Relationships between Beneficial and Detrimental Nearshore Habitat Parameters in WRIA 9 and the City of Seattle

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Keywords: Shoreline modification, Marine Riparian, Amoring, Habitat inventory, Indicator, Wood accumulations

Introduction

The nearshore subcommittee of the Watershed Resource Inventory Area (WRIA) 9 Technical Committee undertook a photo interpretation project to map selected physical, biological, and anthropogenic shoreline conditions for a marine shoreline habitat inventory with funding support from the King Conservation District. The 90 mile project area extended from West Point (located just north of Elliott Bay) to Federal Way and included the shorelines of Vashon and Maury Islands. A compilation of existing nearshore habitat data identified the Washington Department of Natural Resources Shorezone Inventory of Washington (WDNR 2001) as the most comprehensive dataset encompassing the entire project area. However, the Shorezone Inventory database provided only some of the parameters of interest and at a more coarse resolution than was desired for identifying priority areas for conservation or restoration. Anchor Environmental conducted the nearshore mapping project for WRIA 9 Technical Committee, the City of Federal Way and the City of Seattle (Anchor Environmental 2004). Attributes were selected based on their relevance to nearshore habitat function for juvenile salmonids and the ability to classify their conditions using existing data sources or existing photos. Marine riparian vegetation (MRV), large woody debris (LWD), drift log accumulations, and shoreline armoring were among the attributes classified in this project. This paper summarizes the distributions of these attributes in WRIA 9. In addition, the relationships between natural features and shoreline armoring are presented.

Methods

Photo interpretation was completed using U.S. Geological Survey 2002 orthogonal aerial imagery (orthophotos) and Washington Department of Ecology 2000 aerial oblique photos. These photos were used separately or in combination to interpret attributes, considering photo quality and that some attributes were better interpreted by one source than the other. Early in the photo interpretation effort, a field verification survey was conducted to evaluate the data quality provided by photo interpretation. The field verification determined that the photo interpretation provided high confidence datasets for most of the attributes. For those attributes that it did not provide high confidence data, the photo interpretation methods were revised to improve data quality. Spatial data from photo interpretation and field efforts were largely consistent with one another with no indication of major spatial inaccuracies.

All attributes were mapped to a resolution of 100 feet with the exception of shoreline armoring in the City of Seattle which was mapped at a 50 foot resolution. That is, a discrete section of shoreline was delineated if 100 feet or more of the shoreline length had an attribute expression that was different from adjacent areas. If it was less than 100 feet, the section remained as part of the larger shoreline delineation. All attributes were delineated on separate GIS lines. MRV was classified by the dominant vegetation type within 200 feet of the ShoreZone Inventory delineation of the ordinary high water (OHW) mark. MRV was assigned one of the four following categories: mature trees, immature trees/shrubs (referred to herein as shrubs), grass/landscaped (grass), and none. The “none” category for MRV was applied if no vegetation occurred within the entire 200 foot riparian corridor that was inventoried. MRV was also further characterized by density (patchy or continuous), adjacency to ordinary high water (OHW) (separated or adjacent), and if it was overhanging the intertidal zone by 10 feet or more. Vegetation was characterized as separated from the shoreline if there were more than 30 feet between OHW and the start of the vegetation. Wood accumulations were characterized as LWD, drift logs or none. LWD was defined as tree trunks still attached to the shore by roots, lying across the intertidal zone and roughly perpendicular to the shoreline.

Drift log accumulations were defined as continuous multiple logs stacked in the intertidal or backshore areas. Drift logs are generally oriented parallel to shore and are no longer attached to the shore by roots. Shoreline armoring was delineated as present or absent. See Anchor Environmental (2004) for more details about the methodology of the inventory.

Results

This survey delineated nearshore habitat features throughout the entire 90 miles of the WRIA 9 marine shoreline (figure1). This includes 51 miles of shoreline along Vashon and Maury Islands and 39 miles of "mainland" shoreline along the eastern shoreline of Puget Sound. More than 57 miles (63%) of the WRIA 9 shoreline is armored. When the shoreline armoring along the mainland versus the islands was compared, 80% of the mainland is armored, while only 50% of the islands shoreline are armored. The City of Seattle, forming the northernmost portion of WRIA 9, had the most heavily armored shoreline (90%). The amount of armoring decreased as you move south along the mainland shoreline. The City of Federal Way was the jurisdiction within WRIA 9 that had the lowest percent of shoreline armored (42%).

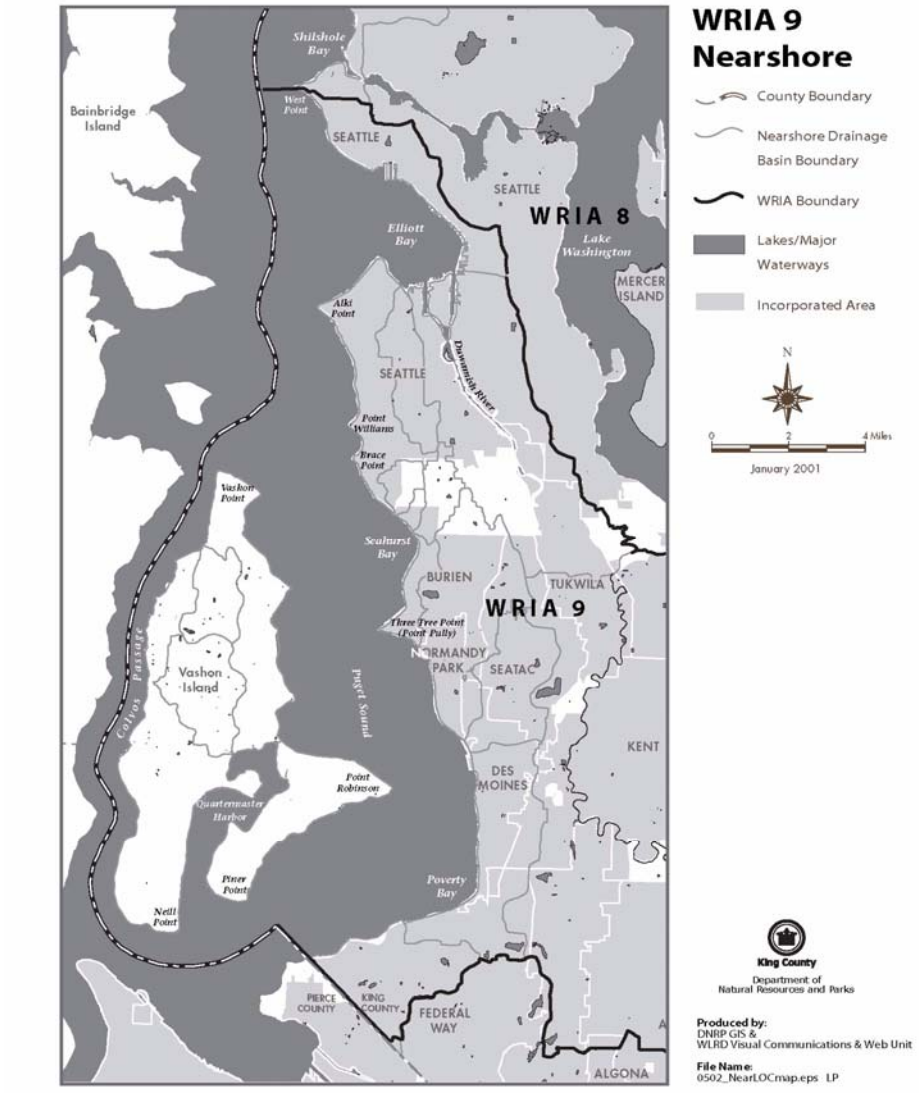

Figure 1. WRIA 9's marine shoreline.

Throughout WRIA 9, less than 60% of the MRV was characterized as trees (Figure 2). In fact, MRV was characterized as completely absent along 10% of the shoreline and landscaped grass was the primary vegetation along another 28% of the shoreline. Vashon and Maury Islands had the bulk of trees and shrubs, with 77% of its MRV in trees and shrubs, while the mainland's shoreline had only 41% of its shoreline vegetation composed of trees and shrubs. The mainland also had the largest amount of landscaped grass and no vegetation with 59% of its shoreline consisting of grass or no vegetation, while the islands had 23% of their shorelines composed of either no vegetation or grass.

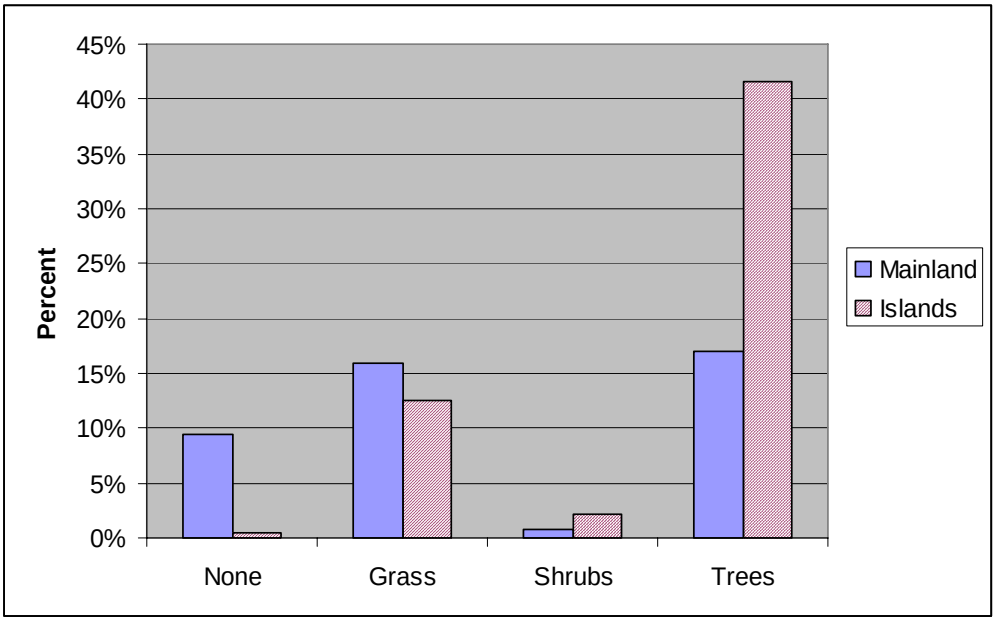

Figure 2. Percent of Dominant Vegetation Type along WRIA 9's Marine Shorelines.

When the MRV and armoring data are compared, several associations are apparent (figure 3). First, as expected, where there is no vegetation present, the shoreline is almost entirely armored. The one instance where the shoreline was not armored, and the MRV was classified as none, the area was a large barrier lagoon marsh which did not fit into the other three categories of MRV type. Grass was more prevalent in armored shorelines than in unarmored shorelines, with almost 39% of the armored shoreline categorized as being dominated by landscaped grass, compared to only 11% landscaped grass in unarmored shorelines. Shrubs mostly occurred in unarmored areas, however, they accounted for a small amount of the overall classification of MRV. The amount of MRV classified as trees showed a striking difference between armored and unarmored shorelines. Trees made up slightly over 80% of the unarmored MRV, while they only made up about 46% of the MRV along armored shorelines. Furthermore, when looking at tree adjacency to the shoreline, more than 50% of the trees along armored shorelines were separated from the shoreline (figure 4). In comparison, trees in unarmored areas were almost always adjacent to the shoreline. Tree density also revealed differences between armored and unarmored areas classified with trees as the dominant vegetation type. More than 74% of the trees in unarmored areas were continuous, whereas in armored areas, less than 17% had continuous trees (figure 5). A similar pattern was seen for overhanging trees, as 80% of the trees in unarmored areas overhung the intertidal zone (figure 6). By comparison, less than 13% of the trees in armored areas overhung the intertidal zone.

Approximately 64% of the shoreline within WRIA 9 had no accumulations of wood. Of the 36% of the shoreline with wood accumulations, drift logs and LWD were identified along 21% and 15% of the WRIA 9 shoreline, respectively (figure 7). Much of the LWD identified along the WRIA 9 shoreline occurs on Vashon and Maury Islands. LWD accumulations were identified along 23% of the islands' shoreline, whereas only 4% of the mainland shoreline had LWD. Drift log accumulations on the islands and the mainland were nearly identical (21% and 22%, respectively).

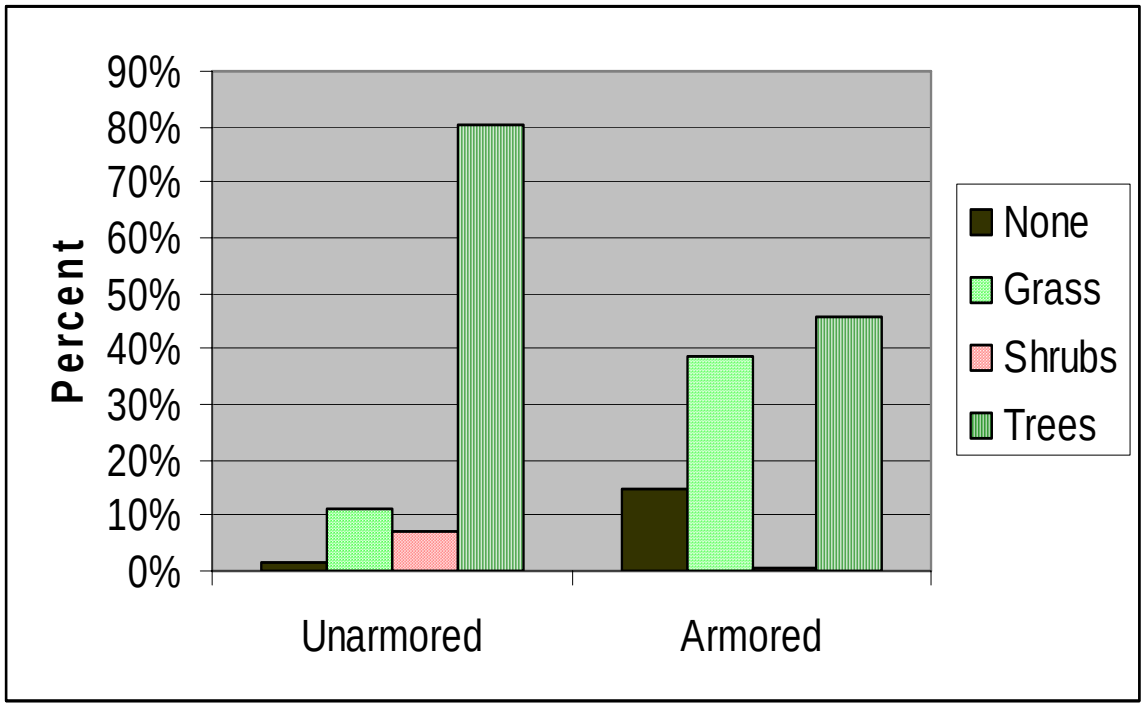

Figure 3. Percent of Armored and Unarmored Shorelines in Relation to MRV Type.

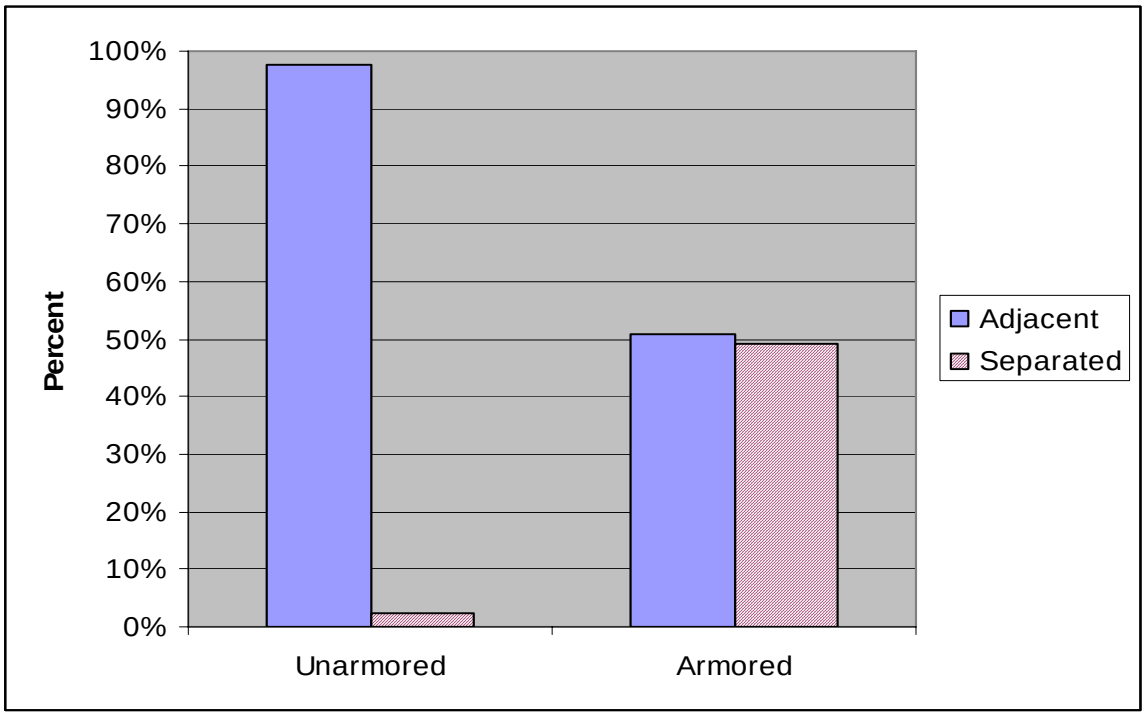

Figure 4. Percent of Armored and Unarmored Shorelines in Relation to Tree Adjacency.

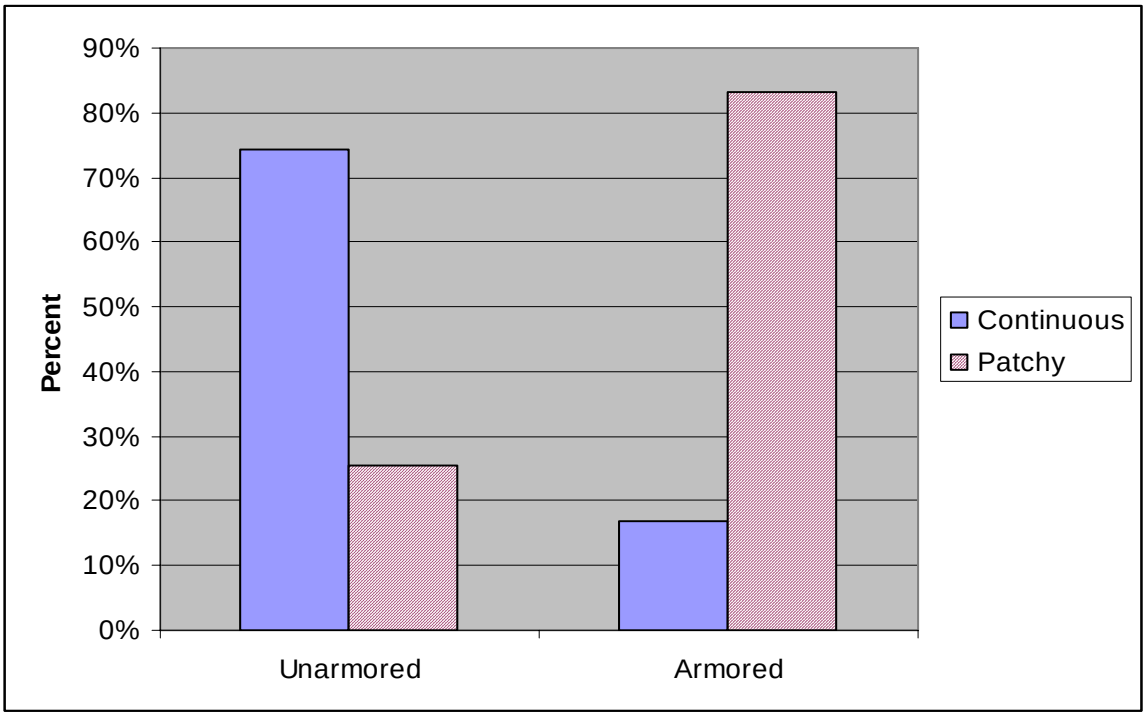

Figure 5. Percent of Armored and Unarmored Shorelines in Relation to Tree Density.

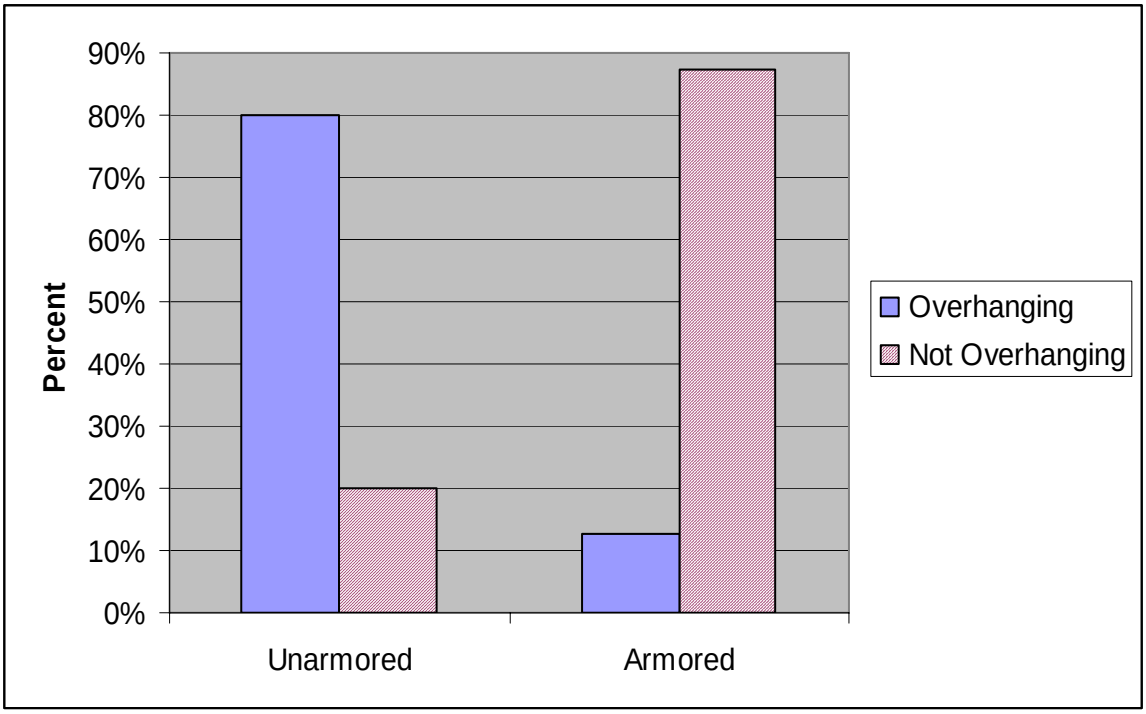

Figure 6. Percent of Armored and Unarmored Shorelines in Relation to Overhanging Trees.

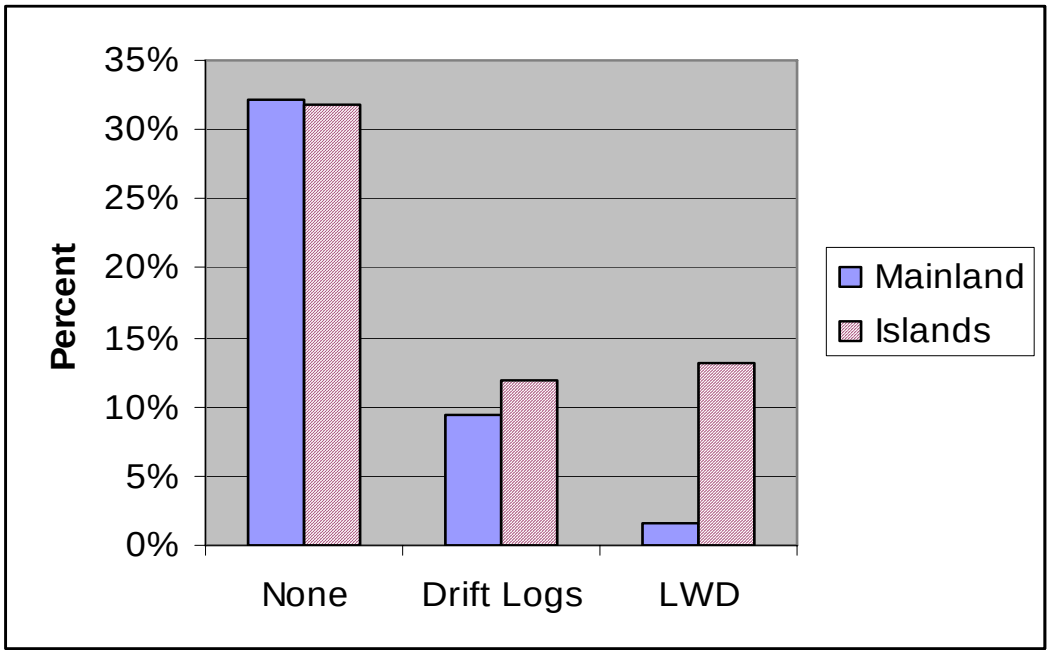

Figure 7. Percent Wood Distribution along WRIA 9's Marine Shorelines.

Spatial overlap between wood accumulations and shoreline armoring revealed similar patterns to those identified for MRV and shoreline armoring (figure 8). Almost 90% of the armored shoreline had no drift log or LWD accumulations. In comparison, only 22% of unarmored shorelines had no drift log or LWD accumulations. LWD accumulations were almost entirely absent from armored shorelines, with only 1.1% being present. While LWD accumulations made up 37.8% of the unarmored shorelines. Drift log accumulations made up slightly over 10% of the armored shorelines, whereas they made up over 40% of the unarmored shorelines.

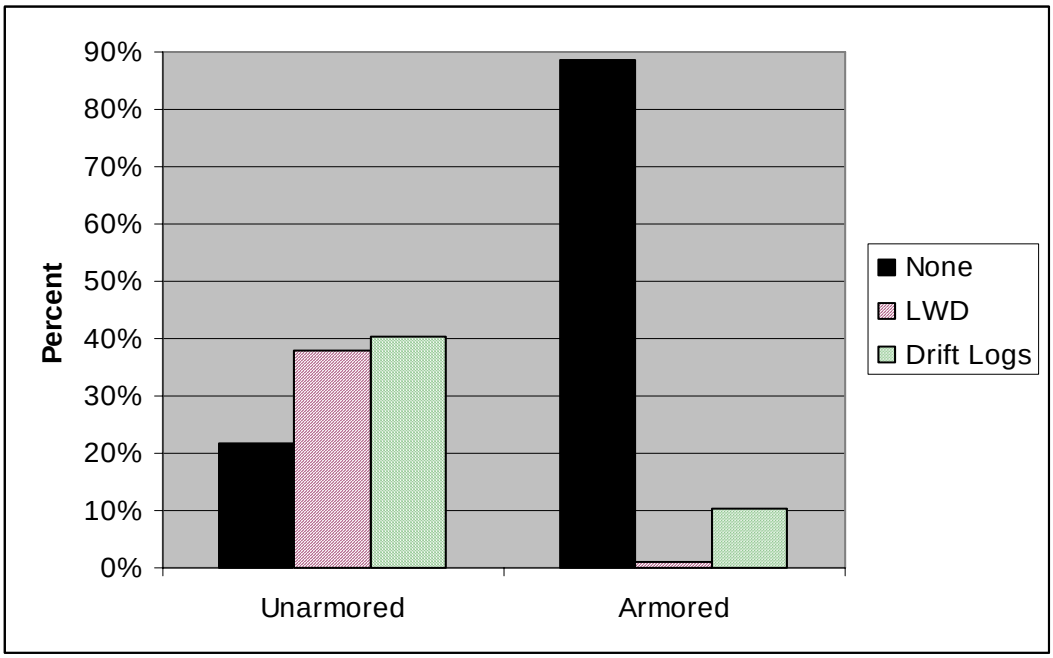

Figure 8. Percent of Armored and Unarmored Shorelines in Relation to Woody Debris Distribution.

Discussion and Conclusions

This survey examines the co-occurrence of shoreline armoring and other shoreline modifications along the marine nearshore of WRIA 9. In many instances, the relationships identified confirm and quantitatively document commonly held understandings of the types of alterations that occur in combination with shoreline armoring.

The Central Puget Sound Basin is one of the most heavily urbanized areas within Puget Sound (Berry et al. 2001). This survey documented the widespread distribution of shoreline armoring in WRIA 9. Many of the armoring and other shoreline modification distribution relationships described in this paper, reveal a striking contrast between the mainland shoreline and the Vashon and Maury Islands shorelines. The islands have less modified shoreline features and more natural habitat parameters than are available along the mainland. As expected, the City of Seattle, having the largest population, a major seaport, and being the oldest city in WRIA 9, was the most armored. Somewhat unexpected was the trend toward decreasing amounts of shoreline armoring as one moves south along the mainland shoreline, particularly given Federal Way's close proximity to the City of Tacoma, another major seaport and large population center.

This delineation of shoreline features in WRIA 9 indicates that areas with shoreline armoring often have different MRV and wood accumulations than unarmored areas. Frequently, when a shoreline property was developed for residential or industrial purposes, the shoreline was armored and the vegetation cleared to provide a view or maximize workable space. The differences in MRV are not caused by the shoreline armoring, rather alterations to MRV are associated with shoreline armoring. The armoring in these areas is just an indicator of other changes that have occurred on the landscape.

However, in the case of LWD accumulations, and in many cases of drift log accumulations, the armoring itself appears to be the primary cause of the differences seen in the shoreline. Armoring within WRIA 9 is frequently located at or below OHW. Thus, the armoring is physically located where drift logs or LWD would normally accumulate in the shoreline. In essence, armoring has cut off the backshore from interacting with intertidal area and has created an area unable to retain drift logs or allow for LWD to accumulate (figure 9).

While these data document physical and structural changes that have occurred to the shoreline through development and the concurrent armoring, it is not clear what the biological responses to these changes have been. Williams et al. (2001) suggested that marine riparian areas provide the following functions to marine nearshore areas: protect water quality, create bank stability, provide wildlife habitat, provide unique microclimates, provide shade, supplies nutrients, and supplies LWD to the nearshore. They also suggested that LWD and drift logs serve to: provide nutrients to the nearshore, provide refuge, nesting and foraging opportunities for fish and wildlife, encourage plant growth, and stabilize beaches.

While they suggested possible marine riparian functions, other recent work has tied nearshore condition to changes in biological response. Sobocinski (2003) showed that unarmored beaches had higher densities of beach hoppers (Talitridae) and insects. Toft (2005) found similar results with an armored site having overall lower densities in riparian insects compared to an adjacent unarmored site. Toft et al. (2004) found that unarmored sites had over twice as much terrestrial riparian prey items in Chinook diets, as armored sites (due to lower amounts of riparian vegetation).

As noted above, we are just beginning to quantify and understand some of the biological responses to the changes seen in the shoreline MRV and woody accumulations. Assuming that historic shoreline condition (pre-European pre-settlement) are represented by our data on unarmored shorelines with trees, the WRIA 9 shoreline has changed dramatically over the last 150 years. While this paper adds to the knowledge of how past development practices have impacted the shorelines and begins to quantify the changes seen along much of the Central Puget Sound shorelines', much more work needs to be done to investigate the links between these changes and biological responses.

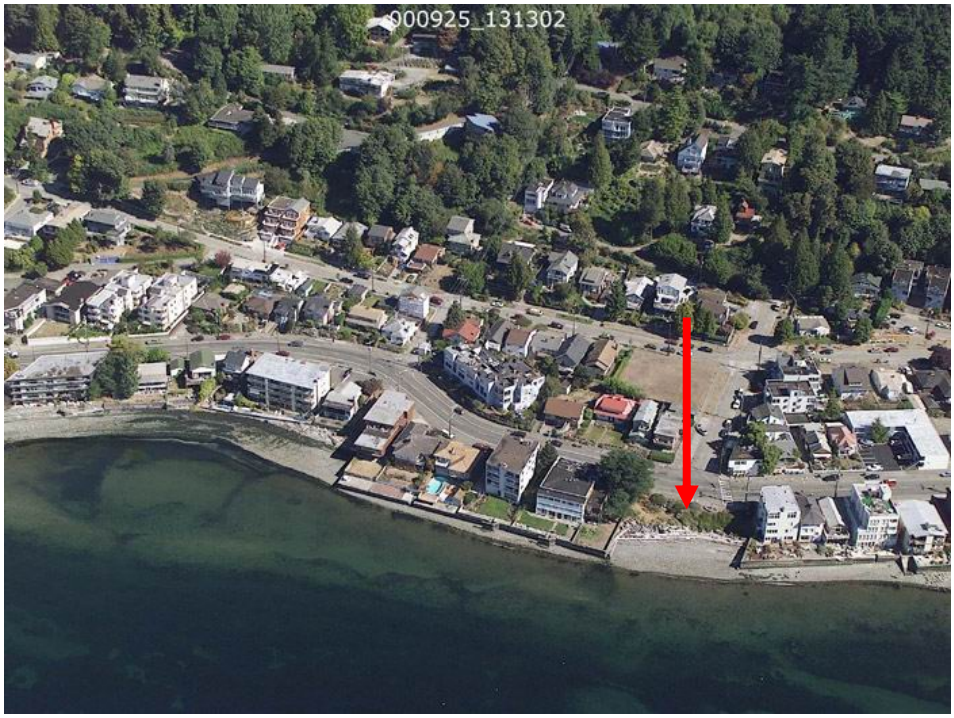

Figure 9. This WADOE image of West Seattle shows armoring at differing tidal heights. The arrow shows drift logs accumulating on an armored stretch of shoreline where the armoring is above OHW, compared to the adjacent armoring which is below OHW.

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