Conceptual Approach to Prioritization for Restoration and Conservation of The South Salish Sea, WA
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Report Version 1, September 22, 2016

The following outlines a scheme to identify and prioritize areas throughout the South Salish Sea for conservation and restoration planning.

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1. CONCEPTUALIZING RESTORATION STRATEGIES

The following excerpts from published documents outline and develop strategies for defining restoration. In general they invoke concepts of the degree of ecosystem impairment versus ecosystem dynamics and therein ecosystem resilience, self-maintenance and ecosystem recovery. These concepts have direct translation to the probability of restoration projects being successful over time. The concept implications are important considerations for managers to implement best-suited restoration strategies depending upon ecosystem conditions and desired restoration outcomes.

Influence of Disturbance (from Johnson et al. 2003)

The success of a restoration project will vary depending on the level of disturbance (anthropomorphic or natural) of the site and the landscape within which the site resides (NRC 1992). Using the findings of the National Research Council and a review of the literature on estuarine habitat restoration, Shreffler and Thom (1993) concluded that the strategies of restoration, enhancement, and creation should be applied depending on the degree of disturbance of the site and the landscape (Figure 2.3). For example, sites with a high degree of disturbance on both scales, in general have a low probability for restoration, and creation of a new habitat or ecosystem or enhancement of selected attributes would be the only viable strategies to apply in these situations. In contrast, where the site and landscape are essentially intact, restoration to historical (i.e., humans present, but insignificant disturbance) or pre-disturbance (i.e., before man) conditions would be viable options and the probability of success would be high.

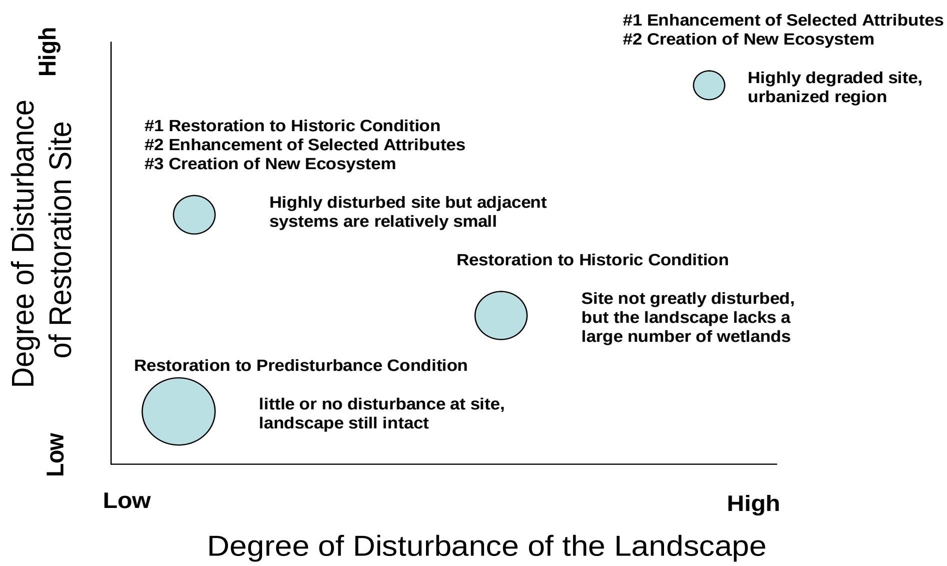


Figure 1. (Johnson et al. 2003 page 19, figure 2.3): Restoration Strategies for Estuarine Systems Relative to Disturbance Levels at the Site and in the Landscape (from Shreffler and Thom 1993). The relative chance of success increases with the size of the dot.

Defining Restoration Strategies (from Johnson et al. 2003)

The above concepts presented in Figure 1 are further defined by Johnson et al. (2003) in regards to restoration strategies.

Table 1. ***An Ecosystem-Based Approach to Habitat Restoration in the Columbia River Estuary***

Johnson et al. 2003, Table 2.3 (Page 15). Definitions of Restoration[1] Strategies.

Strategy	Definition	Comments
Conservation	Maintenance of biodiversity (Meffe et al. 1994).	Conservation biology is a synthetic field that applies the principles of ecology, biogeography, population genetics, economics, sociology, anthropology, philosophy and other theoretically based disciplines to the maintenance of biological diversity. Conservation can allow development to occur as long as biodiversity and the structure and processes to maintain it are not affected. Restricted development is an approach to conservation.
Creation	Bringing into being a new ecosystem that previously did not exist on the site (NRC 1992).	In contrast to restoration, creation involves the conversion of one habitat type or ecosystem into another.
Enhancement	Any improvement of a structural or functional ecosystem attribute (NRC 1992).	As noted by Lewis (1991), enhancement and restoration are often confused. The intentional alteration of an existing habitat to provide conditions that previously did not exist and which by consensus increase one or more attributes is enhancement. Shreffler and Thom (1993) found that, for estuarine systems, enhancement often meant enhancement of selected attributes of the ecosystem such as improving the quality or size of a tidal marsh or eelgrass meadow.
Restoration	Return of an ecosystem to a close approximation of its previously existing condition (e.g., Lewis 1991, NRC 1992).	Includes any form of restoration with the intent of improving habitat to a state closely approximating a historical or pre-disturbance condition.
Protection	Formal exclusion of activities that may negatively affect the structure and/or functioning of habitats or ecosystems.	Protection can also refer to protection of a species or group of species through management actions such as elimination of harm to a species directly or indirectly through damage of its habitat. Restricted development and land use ordinances can also be used to exclude unwanted activities as an approach to protection.

Strategy Definition Comments

[1] The term "restoration" generally refers to any or all of the five fundamental restoration approaches commonly reported in the literature: creation, enhancement, *restoration*, conservation, and protection. When used to refer specifically to *restoration* as a particular strategy, we will italicize the word; otherwise, assume the usage in the general sense.

No Intervention: In the no intervention approach, recovery is left entirely to natural processes. The outcome of this approach is unpredictable and may not resemble pre-disturbance condition (Class D restoration, Cairns 1991). The two possible trajectories of the no-intervention approach are natural recovery or further degradation. Although represented as two distinct trajectories, further degradation may lead to an alternative steady state, which in turn would progress toward natural recovery. Natural recovery is difficult to grasp because it rarely happens within the lifetime of a scientist or estuary manager and can really only be understood in terms of geological time.

Conservation for Natural Recovery: Conservation can be a practical and effective restoration approach. Conservation biology acknowledges that development of the nearshore and the adjacent upland has and will continue to occur. However, conservation is based on the premise that this development can be done in a way (e.g., using science-based development strategies) to minimize or avoid damage to the biodiversity of the system. Conservation represents a relevant approach for the CRE because there are portions of the system that are highly viable components remaining in the ecosystem, and there will continue to be pressure to develop the region surrounding the system. What is lacking to implement a conservation approach is fundamental information on the relationship between levels and types of development and their impact on biodiversity.

Creation of New Ecosystem: Creation of a new ecosystem involves bringing into being a new ecosystem that previously did not exist on the site (NRC 1992). This approach generally involves "implanting" a created habitat into a coastal shoreline where this type of habitat did not exist previously (Simenstad and Thom 1992). The goal of this approach is to emulate the present condition of an existing, functioning reference ecosystem. Creation of a new ecosystem involves elaborate reconstruction of both physical (e.g., topographic, hydrologic) as well as biotic (e.g., vascular plants) elements. Although created ecosystems may eventually become self-maintaining, there is considerable uncertainty in the outcome. Created ecosystems typically require ongoing management (Class C restoration, Cairns 1991; Simenstad and Thom 1992).

Enhancement of Selected Attributes: Attributes are characteristics that are correlated with and can serve as indicators of ecosystem structure and function. We have adopted the NRC (1992) definition of enhancement to mean any improvement of a structural or functional attribute. The NRC report (1992) highlighted the importance of considering both structural (state) and functional (process) attributes at population, community, ecosystem, and landscape levels as appropriate. In the Pacific Northwest, the Estuarine Habitat Assessment Protocol (Simenstad et al. 1991) was among the first scientific documents to promote an attribute-oriented approach to assessment of restoration, enhancement, and creation of estuarine habitats. Table 2.1 showed a sample list of selected structural and functional attributes for estuarine systems. As noted by Simenstad and Thom (1992), the probability of successful enhancement is greater if we first understand what processes are required to sustain the integrity of the attributes. Enhancement differs from restoration because only one or several attributes are improved rather than the whole system. Estuarine habitat attributes can be integrated as elements of modified habitats of urbanized estuaries and might increase fish and wildlife function despite the fact that they were not operating within the matrix of a natural habitat (Simenstad and Thom 1992).

Restoration to Improved, Pre-Disturbance, or Historical Condition: Intervention through *restoration* is intended to improve the existing condition to any degree. Pre-disturbance condition is the condition thought to have previously existed in the estuary prior to the onset of disturbance. From a practical standpoint, pre-disturbance condition is difficult to define precisely and is commonly referred to in the literature as the original, undisturbed condition (Jordan et al. 1997; NRC 1992; Cairns 1989). Historic condition is the condition known to have previously existed in the estuary from historic or recent paleoecological research. The goal of *restoration* to historic condition is to establish a community that is ecologically superior to the present degraded system and resembles the original system in certain carefully defined ways (Cairns 1988). Simenstad and Thom (1992) note that the opportunity for successful *restoration* to historic condition is high as long as the primary processes delineating the habitat type are still effective at that site (e.g., salinity intrusion, sedimentation sources and processes, corridors to other natural estuarine and upland habitats). If some, or all, of these processes have been altered or lost, the prospects for *restoration* to historic condition are greatly diminished.

Protection to Maintain a Desirable State: Although indirect, protection can be an effective intervention tool. Protection helps prevent degradation of existing areas that are presently in a desirable ecosystem state. Protection is distinct from conservation because protection assumes no further development, whereas conservation does not.

In general, the above concepts for restoration strategies concern the degree of human disturbance in relation to the site scale versus the respective surrounding landscape scale. Another way to consider the above concepts is through a matrix table developed by Diefenderfer et al. 2007 and presented below in Table 2.

Table 2. Possible restoration strategies indicated by disturbance at site and landscape scales (Diefenderfer et al. 2007 Table 11, adapted from Thom and others 2005a). Level of Disturbance where L = Low, M = Medium and H = High.

		Landscape Scale		
	Level of Disturbance	L	M	H
Site Scale	H	Restore Enhance	Enhance Restore	Create Enhance
Site Scale	M	Restore Enhance Conserve Preserve	Enhance Restore Conserve	Enhance Create
Site Scale	L	Conserve Preserve	Conserve Enhance Restore Preserve	Enhance Conserve

The Action Strategies defined for Nearshore Zone & Nearshore Catchments are focused on the Conservation / Preservation those areas (from the Zone to Catchment to 'Neighborhood' scale) that remain relatively intact in terms of their level of disturbance / development and retain many of the ecological and biological forms and features that are agreed to be indicative of healthy ecosystem function(s) and supportive of the salmonid lifecycle. Within that Conservation / Preservation context, Nearshore Zones & Nearshore Catchments were selected based on the presence of beneficial and limiting attributes in addition to level of disturbance and deemed to be candidates for either straight *Preservation / Conservation* or for conservation with *Restoration / Enhancement* opportunities.

The intent of the *Coastal Catchments Analysis Project* it to provide a tool to assist Land Trusts, Enhancement Groups, and other groups in their selection of discrete sites for the placement of relatively small projects upon the landscape.

Zones & Catchments with high levels of disturbance at the Site and/or Landscape scales which would require the re-creation of ecological forms and features and their related processes at a relatively grand scale are beyond the intent of the Coastal Catchments Analysis Project.

2. THE PROBLEM IN DEFINING ECOSYSTEM PROCESSES

Restoration science continues to refine approach concepts that reinforce the importance for "process restoration", where ecosystems are recovered to a functioning self-regulated state through natural ecosystem processes. To illustrate using above text in defining "*restoration*":

> Simenstad and Thom (1992) note that the opportunity for successful *restoration* to historic condition is high as long as the primary processes delineating the habitat type are still effective at that site (e.g., salinity intrusion, sedimentation sources and processes, corridors to other natural estuarine and upland habitats). If some, or all, of these processes have been altered or lost, the prospects for *restoration* to historic condition are greatly diminished.

The above implies process-function links in defining and understanding ecosystem dynamics. A figurative illustration for thinking about ecosystem dynamics is provided by Diefenderfer et al. (2007) and presented below in Figure 2:

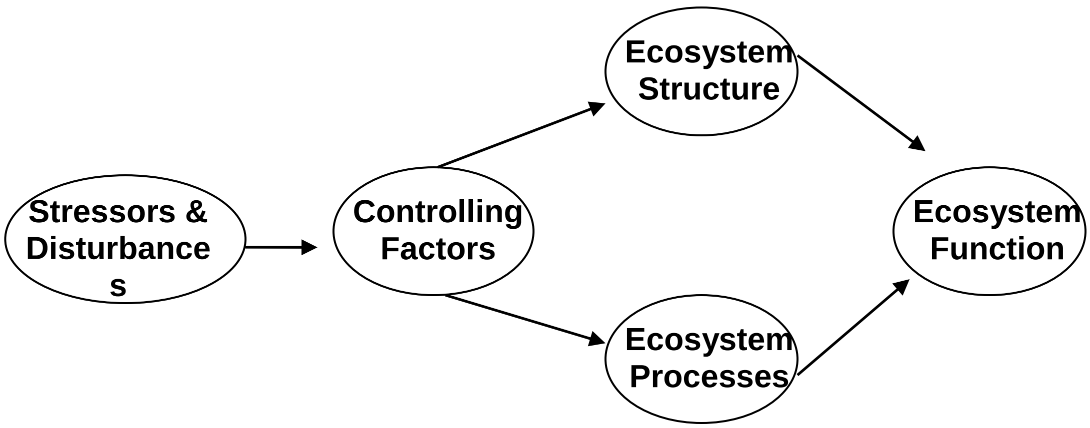


Figure 2. The major categories and structure of a typical conceptual model used in ecosystem analysis (from Diefenderfer et al. 2007).

The above encompasses concepts of disturbance, control factors, ecosystem structure and processes and ultimately ecosystem function as an endpoint. A common approach in defining and understanding ecosystems is through an indicator species of interest. There are numerous instances of these using salmonids which have been argued to be a keystone species. An example of this is provided by Averill et al. (2005):

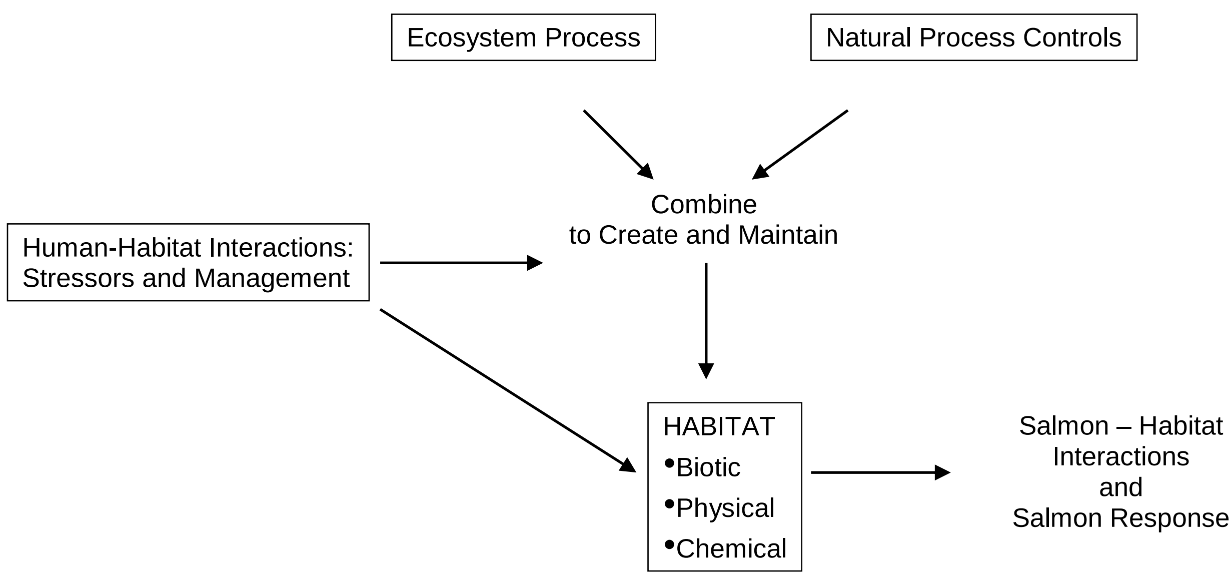


Figure 3. Conceptual model illustrating process-habitat relationships ultimately expressed in terms of salmon populations. From Averill et al. 2005.

In the above figure, the functional response outcome is salmon, which typically equates to population recruitment and production. While the above figurative concepts are insightful, it is more difficult to define and therein select environmental attributes that are most pertinent to achieving desired functional response outcomes. This is further confounded by trying to define ecosystem dynamics at spatial and temporal scales. Stream habitat can reflect influences expressed over several years if not decades whereas food resources in relation to juvenile salmonid production can be considered on an annual temporal scale, within discrete habitat areas. If our primary area of focus is the marine nearshore, more problematic is the influences of entire watershed basin effects in relation to restoration activities only within nearshore environments and how that ultimately equates to salmon population dynamics. Perhaps more problematic is the often touted and ultimate goal of nearshore restoration to recover and maintain natural ecosystem processes, albeit this statement goal is often accompanied with disclaimers that our actual understanding of dynamic ecosystem processes is rather limited.

3. BROAD INDICATORS AND PRIORITIES FOR INTACT ECOSYSTEMS THROUGHOUT THE PUGET SOUND NEARSHORE

A more general consideration of the Puget Sound nearshore can entail identification of attributes and priorities towards creating and maintaining "healthy" nearshore environments. These can be used in subsequent development of approaches for prioritization of restoration strategies. Using the Puget Sound Action Team "Environmental Quality and Economic Vitality, Indicators Report" (2006), indicators and approaches could be categorized as:

<u>Broad Indicators</u>

- Human population
- Land cover and land use (impervious area, forest cover, land use and human density)
- Shoreline armoring
- Shellfish water quality
- Freshwater quality
- Marine water quality

<u>"10 Keys to Preserving Healthy Waters, Healthy Watersheds"</u>

- Preserve forest cover
- Preserve natural drainages
- Preserve riparian areas
- Minimize impervious surface areas
- Limit shoreline armoring
- Prevent pollution
- Manage growth
- Plan for protection
- Rethink stormwater (i.e. low impact development and "soft" stormwater infrastructure)
- Manage wastewater

Although rudimentary, the above items provide general guidelines for defining ecosystem integrity and/or the degree of ecosystem impairment.

4. A COURSE ASSESSMENT SCORING SCHEME FOR PRIORITIZING RESTORATION

Collectively, the above concepts convey coarse constructs by which to consider environmental restoration; however, they also convey the complexities involved in understanding and restoring natural ecosystems. Given this, we chose to develop and apply a tool that could facilitate the identification of restoration areas and therein strategies throughout Budd Inlet, South Puget Sound. Our approach foremost invoked a coarse depiction of current habitat conditions to be subsequently considered in context of broad conceptual restoration strategies (i.e. creation, enhancement, restoration, conservation and protection). This approach was favored on the premise that ecosystem dynamics are inherently complex whereas our understanding of such dynamics is thus far somewhat limited and imperfect.

Focusing on the South Salish Sea, it was necessary to first quantitatively define "ecosystem units". The primary ecosystem analysis unit chosen for this project was watershed catchment units defined by the Salmon and Steelhead Habitat Inventory and Assessment Program (SSHIAP, Northwest Indian Fisheries Commission). These are reach scale polygon units that represent the immediate drainage areas based upon channel gradient and confinement as delineated by a 30 meter digital elevation model. Use of the drainage unit ecosystem scale assumes that area delineations are not arbitrary but rather are determined according to existing landform features that discretely encompass a suite of somewhat unique ecosystem processes. This approach allowed us to define analysis units; furthermore, delineated unit polygons can be further defined according to strata. Note that significant edits were made to the source SSHIAP Catchments. The source data was modified to fill gaps/holes in the source data, derive a more uniform catchment size, and to include only catchments abutting the marine shoreline and those catchments within three neighbors (as one continues upland from the nearshore) of the shoreline typically within a distance of 1.5-3.5 miles. Many catchments including stream mouths were also modified to more realistically include the ecological features and functions immediately adjacent to these stream mouth features.
We chose to consider the South Salish Sea environment according to three geographic strata:

1. Upland Catchments (UC), defined as polygon unit catchments that are adjacent to unit catchments that share a marine nearshore border. UC strata units do not directly contribute to shoreline processes *per se*, but have potential influences on marine nearshore dynamics.

2. Nearshore Catchments (NC), defined as polygon unit catchments that include the interface between the terrestrial and marine nearshore environments.

3. Nearshore Zones (NZ) are strata units encompassing up to 200 meters of the shoreline as designated by the SSHIAP analysis. These NZ unit areas were delineated to capture and consider direct nearshore ecosystem processes. It is important to note that NZ units are not necessarily sub-units of respective NC units.

Two additional Catchment types, Upland & Interior, are also included for general / contextual purposes. Note that neither Upland nor Interior Catchments had ranks calculated or were assigned Action Strategies. Habitat Indices and other calculated attributes were included.

Delineation of three geographic strata by which to consider the South Salish Sea environment, and inclusion of Upland & Interior Catchment for the purpose of calculating Neighborhood % Total Development values as well as to provide additional landscape scale context, allowed for us to examine and compare attribute data at varying scales. Although our focus for this exercise foremost concerned nearshore environments, the three strata delineations allowed for consideration of the marine nearshore environment and potential relationships to the upland terrestrial environment. Interior Catchments (those abutting Upland Catchments continuing upland) are included for additional context within the Neighborhood Development scorings. Catchments for the nearshore as well as the adjacent uplands are scored to provide information on landscape scale conditions and impacts. Neighborhood associations can then be derived between nearshore areas and their contributing uplands as well as between uplands themselves. Restoration and conservation strategies are devised for individual catchments as well as for multiple catchments landscapes. Discrete individual projects can then be nested into the catchment strategies.

4.1. Quantitatively defining impaired versus intact ecosystems – land cover data

We wanted to apply available landscape analysis by which to evaluate ecosystem conditions throughout the South Salish Sea. This necessitated the use of information applicable throughout the entire landscape area of interest. Furthermore, our approach had a decided focus on salmon recovery and therein, environmental attributes that favor long-term viability of salmonid populations. We envisioned this exercise as a complimentary tool to similar resources such as the Nearshore Project Selection Tool (2009) for identifying nearshore areas of critical importance for juvenile salmon.

Suitable environmental attribute data was considered and a suite of which was selected for the purposes of characterizing and assessing ecosystem conditions. At the coarse scale the primary attribute data for determining the degree of human impacts (and therein ecosystem integrity) was derived from NOAA C-CAP land cover data (2010); this data allowed for us to quantitatively define the amount of human development (expressed in terms of impervious surface area types) according to the three unit strata types defined for this exercise (i.e. Upland Catchment, Nearshore Catchment and Nearshore Zone, or UC, NC and NZ strata). Our approach premise was that applied landcover data provided quantitative inference to the degree which natural ecosystem functions were impaired; being that such impairments were manifested in the amount removal / loss of natural vegetation cover, alteration of hydrologic regimes, etc.

The *Coastal Change Analysis Program* (C-CAP) is a GIS based dataset produced by the NOAA Coastal Services Center- http://www.csc.noaa.gov/digitalcoast/data/ccapregional/.
The program uses remote sensed imagery to produce a land cover dataset at a 30 meter resolution scale. The goal of the program is to “provide inventories of coastal intertidal areas, wetlands, and adjacent uplands”. In this exercise the 2010 C-CAP dataset was used. Available information for Thurston County includes land cover categories for: Development- High Intensity- HID, Medium Intensity- MID, Low Intensity- LID, Open Space Developed- OSD; Vegetated-Grasslands- GRS, Agriculture- AGR, Forested- FOR, Scrub/Shrub- SCB; Wetlands- Woody

Wetland- WDW, Emergent Wetland- EMW; Barren Land- BAR; and Open Water- WTR. For the purposes of this analysis land cover data was grouped into the following bins:

Developed- HID, MID, LID, OSD
Undeveloped- GRS, AGR, FOR, SCB, BAR
Wetlands- WDW, EMW
Open water- WTR

Analysis using the binned C-CAP information was performed for each of the catchment and nearshore zones. Analysis was run with and without the open water WTR attribute. It was initially believed that large lakes present in catchments would skew potential results for level of development. This was not the case except for one small catchment associated with Bigelow Lake in northeast Olympia.

4.2. Quantitatively defining impaired versus intact ecosystems – additional attribute data

We wanted to further refine quantitative assessment of the South Salish Sea environment by selecting available attribute data to be used within a GIS framework. Given our focus for environmental attributes perceived to favor juvenile salmon we correspondingly selected available attribute data previously identified and used for the Nearshore Project Selection Tool (2009); selected attribute data corresponds to the four essential nearshore eco-system functions beneficial to juvenile salmonids described by Simenstad (1982) and William and Thom (2001). The environmental habitat type-attributes identified and mapped included:

- Freshwater streams, specifically Technical Advisory Group designated Tier I & Tier II streams
- Pocket estuaries / Embayments
- Marine and freshwater marsh habitats
- Known forage fish spawning beaches
- Inter-tidal vegetation
- Priority nearshore-marine sediment sources
-

Additional landscape attributes deemed to be beneficial included:

- Protected Lands

Above attribute data was perceived as ‘positive’ ecosystem processes / functions, with particular benefits for juvenile salmon. Given that this exercise was intended to identify restoration strategies (i.e. conservation and/or protection) for discrete landscape areas, we also identified attribute data according to areas encompassing ‘protected’ parcels (e.g. city and county parks, land trust acquisitions, etc.).

We also wanted to assess human-induced ‘negative’ ecosystem stressors that indicate impairments / alterations to natural ecosystem processes. Besides land cover analysis (discussed previously), ‘negative’ attribute data entailed consideration of:

- Formally identified impaired waterbodies (WDOE 303d listing)
- Formally identified toxic sites / facilities
- Nearshore areas altered due to material fill (addition and/or removal)
- Shoreline armoring / modification
- Boat marinas
- Overwater Structures such a docks and pier
- Freshwater point-source outfalls (i.e. sewer, perched stream culverts) to the nearshore-marine environment
- Breakwaters & jetties

Above attribute data was considered according to varying scoring schemes by which to ultimately evaluate ecosystem conditions. Furthermore, the inclusion and consideration of attribute data depended upon analysis strata chosen for this exercise (i.e. UC, NC, and NZ polygon unit strata). In most instances attribute data was considered in terms of a presence / absence tally scoring scheme according to perceived positive (+) ecosystem attributes versus negative (-) ecosystem stressors / alterations. However, for consideration of wetlands, total wetland area respective of a given polygon unit was used and indicated in the Habitat Indices attributes. For consideration of salmonid presence in streams not designated Tier I or Tier II presence of salmonids was indicated in the Habitat Indices attribute. A summary of attribute data, information sources and assessment application respective of polygon strata type is summarized in Table 3.

We wanted to provide an additional quantitative metric to reflect real-world practicalities that land-owner agreements are necessary to accomplish environmental restoration projects. With this objective in-mind, all polygon unit strata type were considered according to the number of parcel ownerships per polygon unit of interest. This approach was favored to be indicative of the degree of consensus necessary for enacting restoration project activities.

4.3. Site versus landscape scale assessments

Polygon unit strata were also used to evaluate site versus landscape scale relationships. Scale comparisons were done using geographic proximity of polygon catchment units in relation to a given polygon catchment of interest. Within the GIS framework, for a given UC or NC polygon catchment unit, any adjacent polygon catchments sharing a common border were considered "neighbors"; neighboring catchment units were included regardless of whether they were of a UC or NC strata. Considering NZ strata units, adjacent neighbor polygon units were only considered at the NZ strata scale. To evaluate ecosystem conditions at the landscape scale, two quantitative approaches were used:

1. Total land development scores for polygon catchment units adjacent and sharing a common border with a given polygon catchment unit of interest were summed and then averaged by the total number of 'neighbor' polygons. This calculated value indicated the average total land development at the landscape scale respective of site scale (i.e. a given polygon unit of interest).

Table 3. Summary of selected attribute data and associated quantitative scoring methods to assess ecosystem conditions respective of strata polygon catchments, throughout Budd Inlet, South Puget Sound Washington. Defined strata are Upland Catchment (UC), Nearshore Catchment (NC) and Nearshore Zone (NZ).

Strata Consideration	Attribute	Definition	Scoring Scheme	Data Source
POSITIVE (+)				
UC / NC / NZ	Freshwater Streams	Polygon unit containing fluvial freshwater stream(s) / River(s)	+ 0.5 Non-salmon bearing + 1.0 Salmon – bearing +1.5 Tier 1 Salmon-bearing	SWIFD / WDFW/SSHIAP (2012)
UC / NC / NZ	Wetlands	Marine and freshwater wetland areas	Percent unit area per polygon unit	NOAA C-CAP (2010)
UC / NC / NZ	Protected Parcel(s)	Areas with formal mandates for preservation and/or conservation including cit and count parks	Present (+1) or Absent (0)	Puget Sound Nearshore Partnership (PSNERP) (2010) The Nature Conservancy (2012) • SIT Review
NZ	Pocket Estuary / Embayment	Unique estuarine embayments with freshwater input	Present (+1) or Absent (0)	SSHIAP (2009)
NZ	Forage Fish Spawning beach	Nearshore areas with documented forage fish spawning	Present (+1) or Absent (0)	WDFW (2012)
NZ	Intertidal Vegetation	Part of the littoral zone above low-tide mark containing vegetation (seaweed, eelgrass, etc.)	Present (+1) or Absent (0)	WDNR (2012)
NZ	Priority Sediment Source	Areas defined as sediment sources to the marine nearshore interface	Present (+1) or Absent (0)	WDOE / Anchor Inc (2013)
NEGATIVE (-)				
UC / NC / NZ	Landcover Type	Impervious surface area type-development	Percent of polygon unit area	NOAA C-CAP (2010)
UC / NC / NZ	303 (d) Category 4 and 5 Listed Waterbodies	Water quality impairment(s) classification	Present (-1) or Absent (0)	Washington Department of Ecology (2012)
UC / NC / NZ	Toxics site / facility	Identified site areas contaminated with toxins of concern	Present (-1) or Absent (0)	Washington Department of Ecology (2012)
NZ	Shoreline Armoring / Modification	Nearshore alteration-armoring such as seawalls and revetments	Percentage of NZ catchment unit border	Puget Sound Nearshore Partnership (2010) • SIT Review
NZ	Fill	Addition and / or removal of material in the marine nearshore	Percentage (+/-) of NZ catchment unit area	Puget Sound Nearshore Partnership (2009)
NZ	Marina	Boat basin offering dockage and possible other services for boats	(-1) Small marina classification (-2) Large marina classification	Puget Sound Nearshore Partnership (2009) • SIT Review
NZ	Dock / Launches	Single dock(s) and boat launch(es)	Present (-1) or Absent (0)	Puget Sound Nearshore Partnership (2009) • SIT Review
NZ	Freshwater Outfall	Known marine discharge point source for a sewer system and/or freshwater stream containing a culvert outlet	Present (-1) or Absent (0)	Puget Sound Nearshore Partnership (2010)

2. A second quantitative approach was used to indicate transition areas in terms of total land development. This was calculated by taking the sum of the numerical differences for total percent land development between a given polygon unit of interest and each adjacent neighbor polygon. Scores from this approach were interpreted as a relative difference where positive values indicated, in general, a landscape that is less impaired versus a polygon unit of interest, whereas negative scores indicated a surrounding landscape that is relatively more impaired versus a given polygon unit of interest.

The two approaches detailed above were used to provide some inference to site versus landscape scale relationships in terms of the degree of land development and therein the degree of ecosystem integrity / impairment.

5. RESULTS

Assessment data was first considered according to land cover analysis in relation to polygon unit strata type. Throughout the greater Budd Inlet area, a total of 46, 61 and 46 polygon catchment units were defined for Upland Catchments, Nearshore Catchments and Nearshore Zone unit strata type, respectively. Within and between strata unit types, there was considerable variation both in terms of polygon unit area and respective calculated total land development (Figure 4).

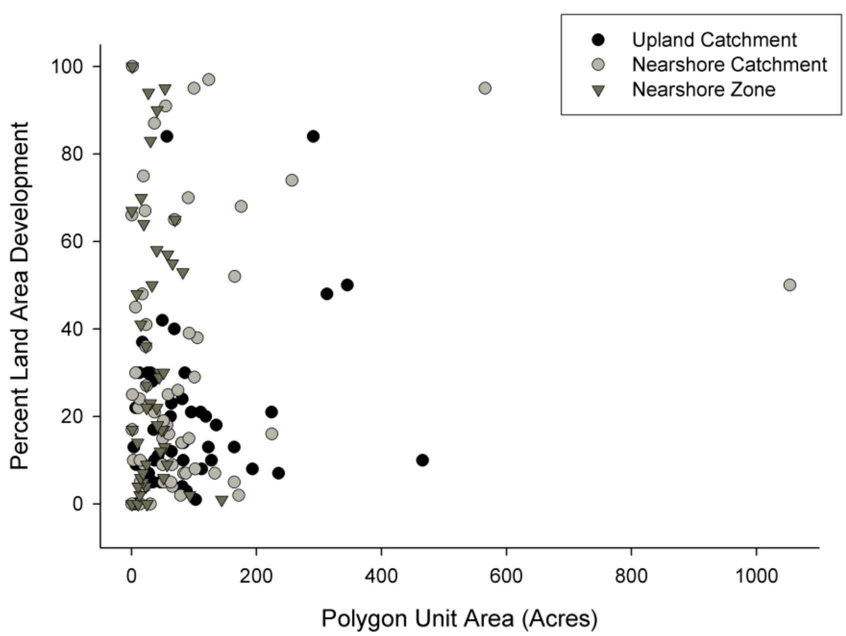
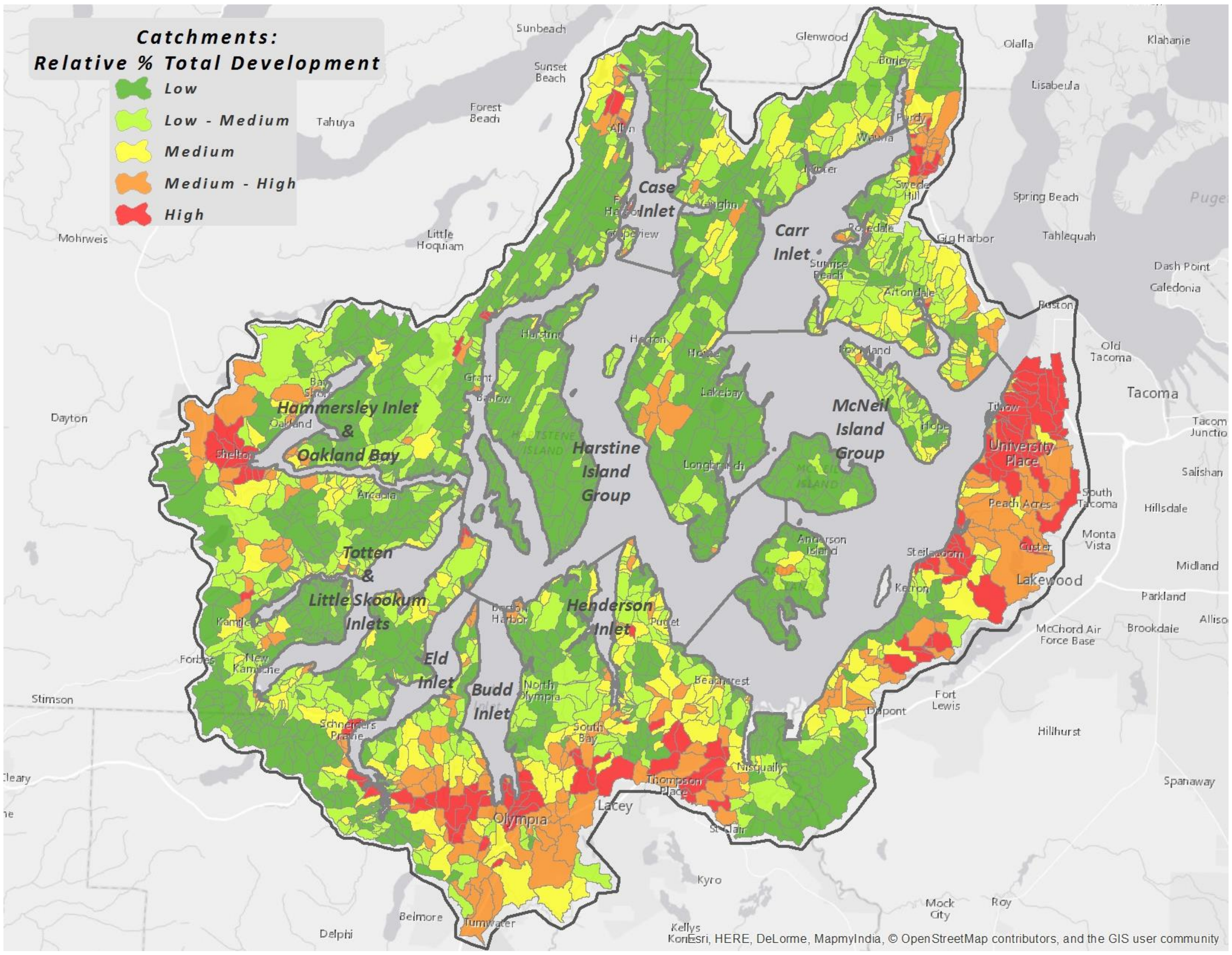


Figure 4. Polygon unit area respective of strata versus percent total land development (NOAA C-CAP 2006) throughout the greater Budd Inlet area, South Puget Sound, Washington.

A geographical depiction of total land development versus individual polygon catchment units reveals, in general, a gradient change with limited development along much of the marine shoreline in rural areas as well as on the many islands within the South Salish Sea and significant land development along the marine shoreline south of the Tacoma Narrows (University Place & Lakewood), the uplands in the vicinity of Lacey, the greater Olympia vicinity including southern Budd Inlet, Shelton, as well as the more rural communities of Allyn and Purdy (Figure 5). A quantitative depiction of this gradient transition in percent land development can be considered using site versus landscape scale calculations. This can first be depicted comparing percent total development versus the summed average of percent total development for polygons adjacent to a given polygon of interest (Figure 6).



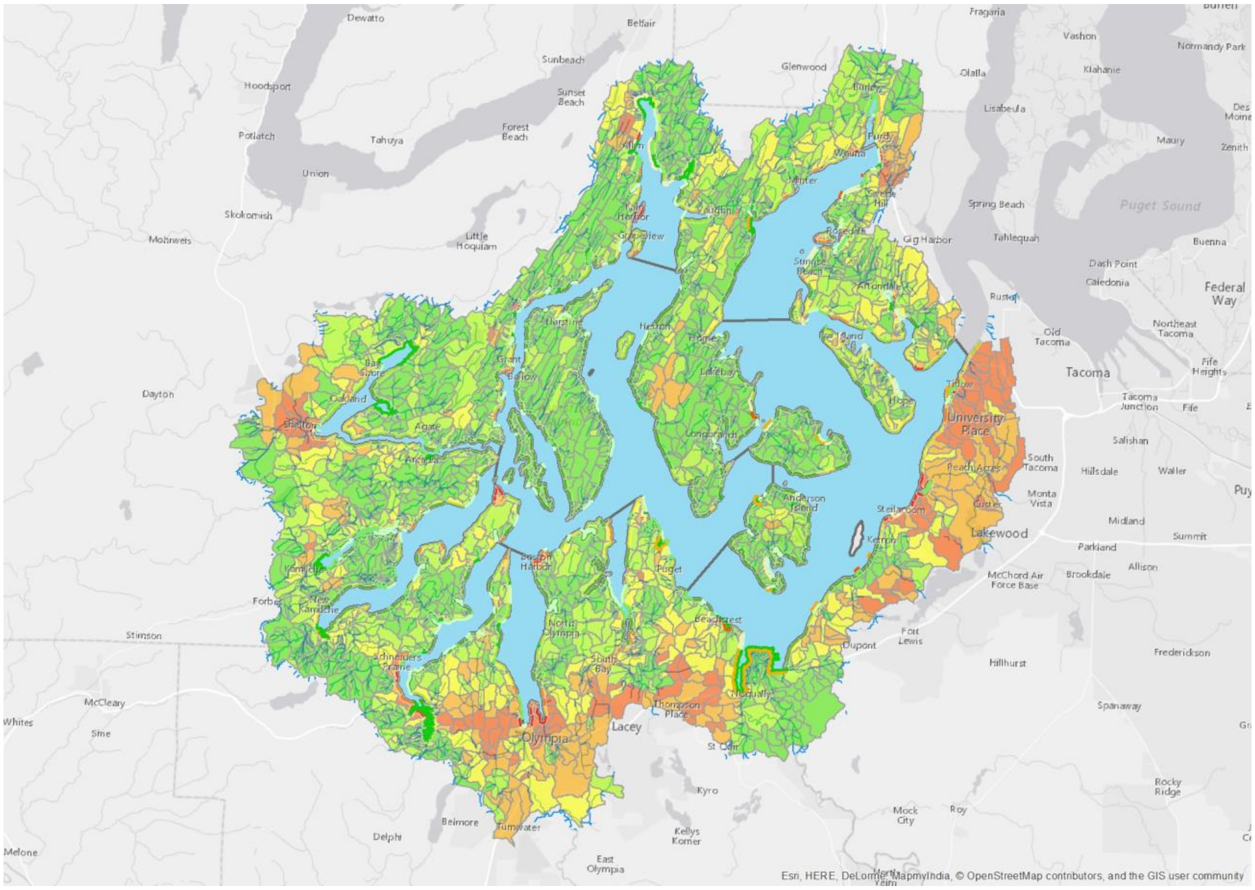


Figure 5. Map of the South Salish Sea study area with color shaded depictions of percent cover land relative development respective of strata area polygons.

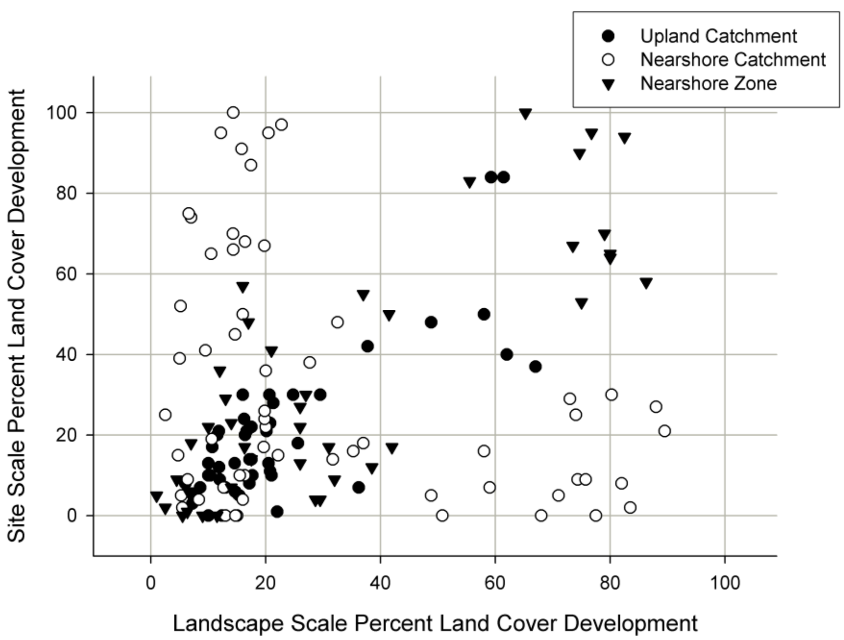


Figure 6. Relationship between total land development at the site scale versus the summed average of total development for polygons areas adjacent to given polygon unit of interest.

To further define transition areas in terms of land cover development, we can consider relative sum differences between a given polygon of interest and adjacent neighboring polygons (Figure 7). Results from this kind of analysis can be used to indicate ecosystem integrity with some inference to ecosystem resilience to human-induced stressors.

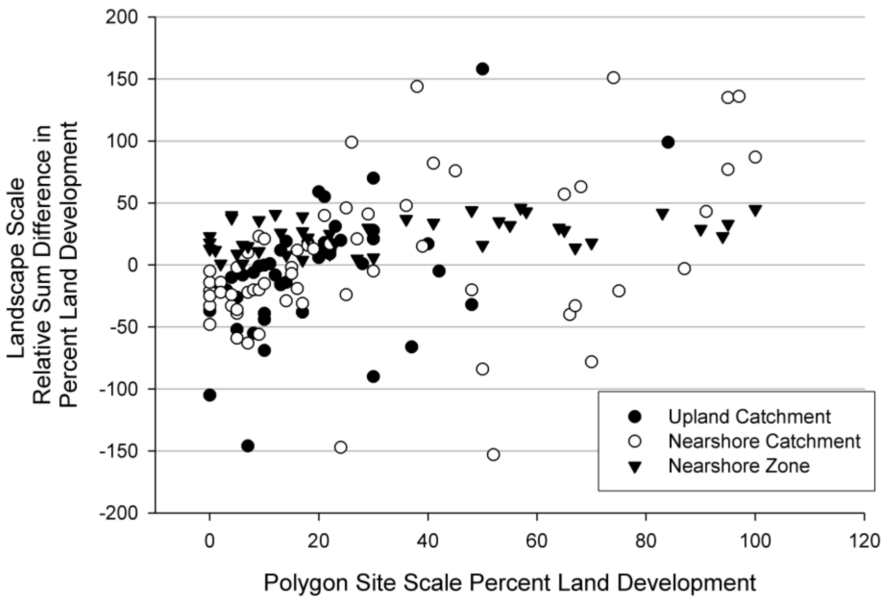


Figure 7. Relationship between total land development at the site unit scale versus the relative summed difference of respective adjacent neighbor polygon units. Positive values on the y-axis indicate landscape conditions with more development as compared to individual polygon units of interest, whereas negative values on the y-axis indicate relative landscape conditions with less development.

Results presented thus far can be used to translate quantitative scores into general restoration strategies. For example, if we consider Figures 6 and 7 and relate these to Table 4, restoration planners can begin to broadly indentify appropriate restoration strategy plans respective of discrete areas.

Table 4. Matrix for identifying restoration strategies determined upon environmental conditions (degree of disturbance) at the landscape versus site scale (Diefenderfer et al. 2007 Table 11, adapted from Thom and others 2005a). Level of Disturbance where L = Low, M = Medium and H = High.

	DISTURBANCE LEVEL	LANDSCAPE SCALE (LS) LOW		MED		HIGH	
SITE SCALE (SS)	HIGH	SS Restore	LS Enhance	SS Enhance	LS Restore	SS Create	LS Enhance
	MED	SS Restore / Enhance	LS Conserve / Preserve	SS Enhance / Restore	LS Conserve	SS Enhance	LS Create
	LOW	SS Preserve / Conserve	LS Preserve / Conserve	SS Conserve / Preserve	LS Restore / Enhance	SS Conserve	LS Enhance

One approach we favored for translating concepts in Table 4 in relation to results from our project exercise was to use ranked quartiles for percent land development both at the site and landscape scale. Color gradients depicted in Figure 5, a geographic map of Budd Inlet, use such quartile scores for percent total land development respective of polygon unit areas.

Our analysis approach also included additional attribute data to further assess ecosystem conditions. One such attribute of perceived importance is the degree of nearshore armoring. Results from this analysis suggest a somewhat inconsistent relationship between the amount of landcover development and degree of shoreline armoring (Figure 8).

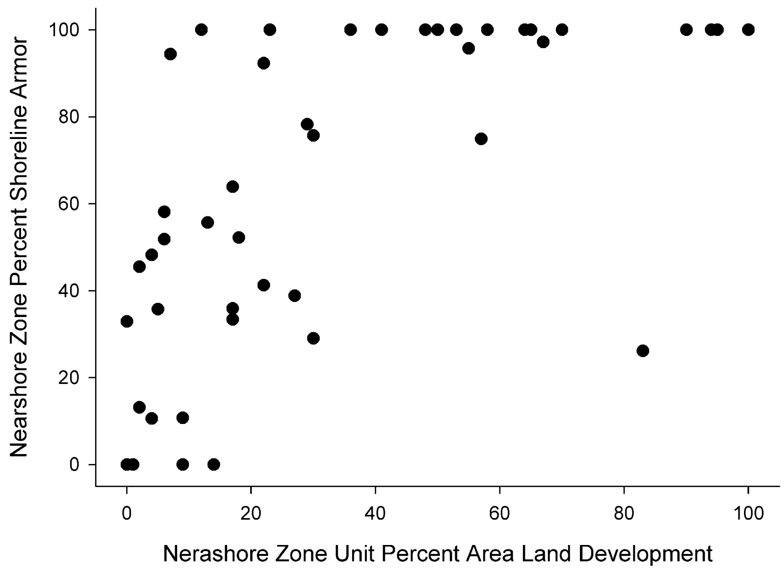


Figure 8. Relationship between percent area of development within nearshore zone polygon units versus the respective amount of shoreline armoring throughout Budd Inlet, South Puget Sound, Washington.

Similar to shoreline armoring analysis, similar quantitative metrics can be evaluated such as the amount area of wetlands present and proportional percent of fill material removed and/or added. Using our assembled GIS dataset, further insight can also be obtained by considering attribute data categorized in the form of positive ecosystem attributes (particularly for juvenile salmon) and ecosystem stressors such as known water quality issues, marinas, etc. Restoration planners can easily evaluate such coarse attribute metrics to infer ecosystem conditions and therein restoration issues and/or opportunities. To illustrate, consideration of compiled data from our project tool could resemble what is presented in Table 5.

Table 5. Conceptual presentation of summary attribute data for determining and prioritizing restoration efforts in Budd Inlet, South Puget Sound, Washington. In this example, the site scale is in a state of 'medium' disturbance whereas the surrounding landscape is relatively undisturbed, or 'low disturbance'.

NZ_Nearshore Zone

Site Scale = medium disturbance
Landscape Scale = low disturbance
Restoration Strategies = Restore / Enhance / Conserve / Preserve

Site Scale
Site Scale
Landscape Scale

Polygon Unit ID	Sum Positive Attributes	Negative Attributes	Rank Size	Parcel per Square Mile	Comments	Potential Project Number ID(s)
1860	4+		27/48	1901	Landscape rank score high (i.e. low development)	24,89,90
1866	3.5+		12/48	501	Landscape rank score high (i.e. low development), 10% wetlands	87
1869	3.5+		40/48	1075	Landscape rank high, 0% shoreline armoring, priority sediment source	43,44
1875	5+	303(d)	7/48	33	Priest Point Park, 0% shoreline armoring	82
1888	1.5+		15/48	1446	Landscape rank score high, 9% wetlands area, 29% shoreline armoring	91
1891	5+	303(d), toxic site	19/48	1109	Landscape rank score high (Ii.e. low development)	33,34,35,36,48,88
1898	2+		10/48	1163	Landscape rank score high (Ii.e. low development)	92,93

6.0 LITERATURE CITED

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7.0 Attributes Filter Data Dictionary

Nearshore Zone (NZ)- zone from Shorezone shoreline inland 200 meters
Nearshore Catchment (NC)- catchments abutting Shorezine shoreline
Upland Catchment (UC)- catchments inland of nearshore catchment

Field name	
OBJECTID	ArcGIS Internal ID
SHAPE	ArcGIS Internal Geometry
CATCHMENT_ZONE_ID	*Catchment Zone ID*: Unique feature ID / identifier Used for GIS joins & relates. Note that Shoreline, Nearshore Zone & Nearshore Catchment IDs match
CATCHMENT_TYPE	*Catchment Type:* Type of catchment; defined as Nearshore Zone, Nearshore, Upland, Island or Interior *note: Not included in online version of database

Domain: *CatchmentType: Type of Catchment*

1 : Nearshore	2 : Upland
3 : Interior	5 : NearshoreZone

- The *Nearshore Catchments* Feature Class includes ALL *Nearshore* & *Island* Catchments

DEVELOPMENT (SYMBOL) CLASS *Development Class:* Classification of a Zone or Catchments' Percent Total Development relative to others in its' *Analysis Area.*

- Defined by applying the Natural Breaks (Jenks) Graduated colors classification symbolization to each Analysis Areas' subset of Zones or Catchments. That being so, users should be aware that Symbol Classifications are not the same in differing Analysis Areas. For example, and *Development Class* of 'High' in a relatively undeveloped Analysis Area, say Totten Inlet, may have a Total Development of 30 % will not be same as the classification in a relatively developed Analysis Area such as the McNeil Island Group which includes the more urbanized areas south of Tacoma where a Zone or Catchment with a Total Development of 30% may have a *Development Class* of 'Medium'.

ANALYSIS_AREA *Analysis Area:* Nine areas defined in South Salish Sea

Domain: *AnalysisAreaDomain: Analysis Area(s) for Catchment/Zone*

10: Budd Inlet	*60: Case Inlet*
11: Budd Inlet & Eld Inlet	*61: Case Inlet and Harstine Island Group*
12: Budd Inlet & Harstine Island Group	*62: Case Inlet and McNeil Island Group*
13: Budd Inlet and Henderson Inlet	*63: Case Inlet and Carr Inlet*
20: Eld Inlet	*70: McNeil Island Group*
21: Eld Inlet and Totten & Little Skookum Inlets	*71: McNeil Island Group and Carr Inlet*
22: Eld Inlet and Budd Inlet	*72: McNeil Island Gorup and Harstine Island Group*
23: Eld Inlet and Harstine Island Group	*73: McNeil Island Group and Henderson Inlet*
24: Eld Inlet and Totten & Little Skookum Inlets and Harstine Island Group	*74: McNeil Island Group and Carr Inlet and Harstine Island Group*
30: Totten & Little Skookum Inlets	*80: Harstine Island Group*
31: Totten & Little Skookum Inlets and Hammersley Inlet & Oakland Bay	*81: Harstine Island Group and Case Inlet*
32: Totten & Little Skookum Inlets & Eld Inlet	*82: Harstine Island Group and Hammersley Inlet & Oakland Bay*
33: Totten & Little Skookum Inlets & Harstine Island Group	*83: Harstine Island Group and Carr Inlet*
34: Totten & Little Skookum Inlets and Eld Inlet and Harstine Island Group	*84: Harstine Island Group and McNeil Island Group*
40: Hammersley Inlet & Oakland Bay	*85: Harstine Island Group and Henderson Inlet*
41: Hammersley Inlet & Oakland Bay and Totten Inlet	*86: Harstine Island Group and Eld Inlet*
42: Hammersley Inlet & Oakland Bay and Harstine Island Group	*87: Harstine Island Group and Totten & Skookum Inlets*
50: Carr Inlet	*88: Harstine Island Group and Budd Inlet*
51: Carr Inlet and McNeil Island Group	*89: Harstine Island Group and Eld Inlet and Totten Inlet*
52: Carr Inlet and Harstine Island Group	*90: Henderson Inlet*
53: Carr Inlet and Case Inlet	*91: Henderson Inlet and Harstine Island Group*

	92: Henderson Inlet and McNeil Island Group
	93: Henderson Inlet and Budd Inlet

Zones / Catchments have been assigned *Analysis Areas* in this manner to allow for inclusion of neighboring Zones / Catchments for a given catchment of a given *Analysis Area*. For example, a Zone or Catchment is within the Budd Inlet *Analysis Area* and abuts the defined *Analysis Areas* border between Budd Inlet & Eld Inlet. The naming convention used allows for selection queries to be used to select all Zones or Catchments within an Analysis Area as well as all Zones or Catchments determined to be neighbors to those within a given Analysis Area.
For example, a query for *Analysis Area >= 10 AND Analysis Area < 20* would select/return all Zones or Catchments within the Budd Inlet Analysis Area as well as all Zones or Catchments that abut them.
To select all Zones or Catchments that would be considered to be within an Analysis Areas 'Neighborhood' write a definition query or selection that includes all Analysis Area Domain values that include the Analysis Area you are attempting to select.
For example, a query for *Analysis Area = 10 OR Analysis Area = 11 OR Analysis Area = 12 OR Analysis Area = 13 OR Analysis Area = 22 OR Analysis Area = 88 OR Analysis Area = 93* would select all catchments within the Budd Inlet Analysis Area and their neighbors that are within neighboring Analysis Areas.
Note that All Ranks calculations & Action Strategies definitions are determined ONLY within each Analysis Area and do NOT include those Zones or Catchments that are neighbors to those within a given subset. For example, the rankings for Budd Inlet Analysis Area would be only for Zones or Catchments whose Analysis Area definitions begin with 'Budd Inlet'and exclude any Zone or Catchment that has an Analysis Area definition of 'x and Budd Inlet'.

PER_TOT_DEV — *% Total Development:* NOAA C-CAP development score: SUM of High Intensity Development, Medium Intensity Development, & Low Intensity Development

R_PER_TOT_DEV — *Rank % Total Development:* Rank of Nearshore Catchments' & Nearshore Zones' *% Total Development* within each Analysis Area
*note: Only Nearshore Catchments & Nearshore Zones ranked
*note: Not included in online version of database

NBHS_AVG_TDEV — *Nbhd % Tot Dev:* Average of a catchment's / zone's neighboring catchments' / zones' *% Total Development*

R_NBHS_TDEV — *Rank Nbhd % Total Development:* Rank of Nearshore Catchments' & Nearshore Zones' Neighborhood % Total Development within each Analysis Area

*note: Only Nearshore Catchments & Nearshore Zones
*note: Not included in online version of database

COR_PER_TOT_DEV

Corresponding % Total Dev: Corresponding *% Total Development* Score for a Nearshore Catchment or Nearshore Zone. Each Nearshore Zone is essentially the result of a 200m clip of it's Nearshore Catchment
*note: Corresponding feature will have the same *Catchment / Zone ID*
*note: Gives an indication of whether development is more concentrated in the immediate nearshore (200m) or upland
*note: Not included in online version of database

COR_NBHS_TDEV

Corresponding Nbrhd Avg % Tot Dev:
Corresponding *Nbrhd Avg % Tot Development* score for a Nearshore Catchment or Nearshore Zone.
*note: Corresponding feature will have the same Catchment / Zone ID
*note: Not included in online version of database

SRC_MI_CO_PTDEV

S*ource PTDev minus Corresponding:* Result of Nearshore Catchment % Total Dev score minus its' corresponding Nearshore Zone % Total Dev score, or vice versa
A negative value indicates that a given zone/catchment is less developed than it's corresponding catchment/zone & development is more concentrated there.
A positive value indicates that a given zone/catchment is more developed than it's corresponding catchment/zone & development is more concentrated there
*note: Not included in online version of database

REL_NBHS_TDEV

Relative Nbrhd % Total Dev: Result of the sum of the difference between a given Catchment / Zone & each of its' neighboring Catchments / Zones divided by the number of neighbors
A negative value indicates that a given zone/catchment is less developed than its' Neighborhood.
A positive value indicates that a given zone/catchment is more developed than its' Neighborhood.

R_REL_NBHS_TDEV

Rank Relative Nbrhd % Total Dev: Rank of *Relative Nbrhd % Total Dev* score within each Analysis Area
Ranked from most negative number to most positive.
*note: Only Nearshore Catchments & Nearshore Zones

* Note > Not attributed

AREA_ACRES	*Area: Acres:* Area of Catchment / Zone in acres
AREA_SQMLS	*Area sq ml:* Area of Catchment / Zone in square miles
R_AREA_ACRES	*Rank Area acres:* Rank of Area in acres within each Analysis Area. Ranked from most acres to least *note: Not included in online version of database
SHORELINE_LENGTH_F	*Shoreline Length (ft):* Shoreline length in feet
SHORELINE_LENGTH_M	Shoreline Length (ml): Shoreline length in miles *note: Not included in online version of database
R_SHOELINE_FT	*Rank Shoreline ft:* Ranking of shoreline length within each Analysis Area. Ranked from most shoreline to least *note: Only Nearshore Catchments & Nearshore Zones *note: Not included in online version of database
SHORELINE_MOD_FT	*Shoreline Mod ft:* Length of shoreline modification by armoring, bulkheading, rip-rap, etc along the zone's / catchment's shoreline *note: Only Nearshore Catchments & Nearshore Zones *note: Not included in online version of database. Length of shoreline modification can be calculated by multiplying P_SHORELINE_MOD times SHORELINE_FT
P_SHORELINE_MOD	*% Shoreline Mod:* Percentage of the Zone / Catchment's shoreline that is modified. Result of Shoreline Mod ft divided by Shoreline Length (ft) *note: Only Nearshore Catchments & Nearshore Zones
R_SHORELINE_MOD_FT	*Rank Shoreline Mod ft:* Ranking of % shoreline Modification for each Zone / Catchment within each Analysis Area. Ranked from lowest number of feet of modified shoreline to the most number of feet or modified shoreline. *note: Only Nearshore Catchments & Nearshore Zones *note: Not included in online version of database.
PARCELS_ACRE	*Parcels per acre:* Number of parcels intersected by Zone / Catchment divided by the Area Acres
PARCELS_SQML	*Parcels per sq ml:* Number of parcels intersected by Zone / Catchment divided by the *Area Sq Ml*

*note: Not included in online version of database.

R_PARCELS_PA — *Rank Parcels per acre:* Ranking of # of parcels /SqAcre within each Analysis Area
Ranked from fewest parcels per acre to most parcels per acre
*note: Only Nearshore Catchments & Nearshore Zones
*note: Not included in online version of database.

PER_WETLANDS — *% Wetlands:* % Wetlands as defined by NOAA C-CAP

R_PER_WETLANDS — *Rank % Wetlands:* Ranking of % Wetlands within each Analysis Area
*note: Only Nearshore Catchments & Nearshore Zones
*note: Not included in online version of database.

PER_FORESTED — *% Forested:* % Forested as defined by NOAA C-CAP

R_PER_FORESTED — *Rank % Forested:* Ranking of % Forested within each Analysis Area
*note: Only Nearshore Catchments & Nearshore Zones
*note: Not included in online version of database.

COMBINED_RANKS — *Combined Ranks:* Score derived by summing the results of the RANKING of each ranked attribute which had been divided by the greatest Rank of that attribute within each Analysis Area. A lower score indicates a more beneficial score of a Zone / Catchment's intrinsic habitat health and function.

SUM_BEN_LIM — *Sum Beneficial & Limiting:* Summed result of a Zone's / Catchment's *Sum Beneficial* and *Sum Limiting* attributes. Generally, a more positive number indicates more intact ecological structure and function where-as a more negative number indicates the presence of more stressors to environmental health & function. Refer to *Sum Beneficial* and *Sum Limiting* attributes for actual scores for each.

SUM_BENEFICIAL — *Sum Beneficial:* Sum of Beneficial / Positively attributed characteristics:
Embayment / Pocket estuary, Forage Fish, Intertidal Vegetation, Protected Lands, Streams & Salmonids, Feeder Bluffs / Priority Sediments

EMBAYMENT — *Pocket Estuary:* Pocket estuary/embayment in unit-SSHIAP

FORAGE_FISH	*Forage Fish:* Documented forage fish spawning- WDFW
INTER_VEGE	*Intertidal Vegetation:* Intertidal Vegetation present in unit- WDNR
PRIORITY_SEDS	*Priority Sediments:* Feeder bluff present in unit – WDOE
HIST_FEEDER	*Historic Feeder Bluffs:* Feeder bluff was historically present in unit - WDOE
STREAM_SALMON	*Streams & Salmon:* Priority Stream & Fish Distribution data- Tier 1, Non Tier 1, Non Salmon Streams-SSHIAP *Note that only Tier I & Tier II streams are attributed as 1.5 & 1 respectively. **It should also be noted that additional streams with documented salmonid presence are not captured in this attribute**. The feature class *SWIFD (Statewide Integrated Fish Distribution)* includes documented presence information on all salmonid distribution as well as other fresh water fish species. Also, the Water_Salmon (alias: Salmonid Habitat) attribute indicates actual and all known salmonid use/presence.
PROTECT_LAND	*Protected Lands:* Parcel in unit designated as protected- PSNERP. *Note that the source data as provided to PSNERP by the Nature Conservancy includes many public lands that may not be thought of as protected lands in the classic sense, such as power lines, gas pipeline easements and the like. It is strongly suggested that users review Protected Lands designations Additional Protected Lands were added to the feature class thru a review of county parcels databases. *Note that many protected tidelands /aquatic parcels are immediately adjacent to Nearshore Zones & Nearshore Catchments. For those Zones & Catchments being so adjacent the value for Protected Lands is ‘0’ and a Notes General has been added to allow for review of those Zones and Catchments immediately upland from a protected tideland(s). Also, many Zones & Catchments contain a very small portion of a protected land(s). Those are also attributed as ‘0’ = Not containing Protected Lands
SUM_LIMITING	*Sum Limiting:* Sum of Negatively attributed ShoreZone attributes: Boat_Ramp, OverWaterStructure, Breakwater_Jetty, Marina, Outfall, 303D Waters, Toxic Facility Clean-Up.

*Note that shoreline modification and nearshore fill are not included – they are included in the database as separate feature classes. Shoreline modification can be selected through the P_SHORELINE_MOD alias: % Shoreline Mod attribute.

DOE_303D	*Impaired Waters:* Department of Ecology 303d listed water in unit- WDOE *Note that the WDOE_303DImpairedWaters feature class is defined as a polygon feature class even though it defines a stream characteristic. As such some adjacent zones / catchments will be selected when utilizing GIS overlay / intersection geoprocessing funtions. Those zones / catchments were NOT designated as Impaired Waters and as such have a WDOE_303D ImpairedWaters value of '0'.
TOXICS	*Toxic CleanUp:* Department of Ecology toxic cleanup site in unit- WDOE Note that the WDOE GIS file is a point layer. In reality, many toxic clean-up sites are significantly larger than a point location
MARINA	*Marinas:* Boat marina present in unit- PSNERP & aerial Photo review defined as Large, Medium, or Small. *Note: Additional limiting effects of marinas were added to the database using the Washington Department of Health's *Shellfish Commercial Growing Areas* GDB. Zones & Catchments within a Shellfish Closure Zone had their Marina attribute calculated to -2, -1.5, or -1 according to the size of the marina.
OV_H20_STRUCTS	*Overwater Structures Present:* Overwater Structures including piers, docks, houses, & bulkheads. Temporary/seasonal structures not included. PSNERP Additional review of aerial photos & WDOE Shorline photos were done to supplement the feature class *note: Not included in online version of database. Presence of Overwater Structures can be selected via the OVERWATER_STRUCTS_PM alias; Overwater Structures per ml attribute.
OV_H2O_STRUCTS_C	*Overwater Structures: Count:* Overwater Structures Total count *note: Not included in online version of database.
OV_H2O_STRUCTS_PM	*Overwater Structures per mile*: Over Water Structures per mile in unit. Indication of density. Multiply *Overwater Structures per mile* times shoreline length for total number.

OUTFALLS	*Outfall(s):* Water(storm) outfall(s) present in unit- PSNERP The source data appears to be incomplete.
BOAT_RAMP	*Boat Ramps:* Boat ramp present in unit – WRCO/WDFW & aerial photo review * note: Only ramps deemed to be significantly affecting shorezone ecological function included *note: Not included in online version of database.
BOAT_RAMP_C	*Boat Ramps Count:* Count of boat ramps in unit. *note: Not included in online version of database.
BOAT_RAMPS_PM	*Boat Ramps per mile:* Boat ramps per mile of shoreline within Catchment / Zone. Indication of Density
BREAKWAT	*Breakwater:* Breakwater/Jetty present in unit – PSNERP & aerial photo review
P_NEARSHORE_FILL	% Nearshore Fill: % of Catchment / Zone designated as Nearshore fill – PSNERP / NOAA TSheets
PARCELS_C	*Parcels: Count:* count of parcels intersected by Catchment / Zone *note: Not included in online version of database.
NEIGHBORS_C	*Neighbors: Count:* Number of neighboring Catchments / Zones *note: Not included in online version of database.
SUM_NEIGHS_DIFF	*Sum Neighbors Differences:* The SUM of the differences of a Zone's / Catchment's % Total Development and each of its' neighbors' % Total Development. Value used to calculate the Nbhd % Total Development: Sum Neighbors Differences divided by Neighbors Count *note: Not included in online version of database.
NGHBR_LIST	*Neighbors: List:* List of neighboring Catchment / Zones' *Catchment / Zone ID*s *note: Not included in online version of database.
NOTES_GEN	*Notes: General:* Notation on action(s) taken or follow-up action needed *note: Not included in online version of database.

NOTES_GIS	*Notes: GIS:* Notation on action(s) taken or follow-up action Needed *note: Not included in online version of database.
SHAPE_Length	ArcGIS internal measure of a Zone's / Catchment's polygon arc length *note: Not included in online version of database.
SHAPE_Area	ArcGIS internal measure of a Zone's / Catchment's polygon arc area in square feet *note: Not included in online version of database.
ACTIONSTRATEGY	*Action Strategy:* The Action Strategy recommendation for a given catchment. Twenty percent (20%) of each Analysis Areas' Zones/Catchments were designated for either Conservation / Preservation OR Restoration / Enhancement using the ArcGIS Tool *Sort.*
Con_Pres	*Conservation Preservation:* Zone or Catchment has been defined as a priority for conservation / preservation See the documentation for a description on how this selection was made *note: Not included in online version of database. A layer of Zones / Catchments designated for Restoration / Enhancement consideration has been defined and included in the online map viewer.
Rest_Enhance	*Restore Enhance:* Catchment has been defined as a priority for Restoration / Enhancement See the documentation for a description on how this selection was made *note: Not included in online version of database. A layer of Zones / Catchments designated for Restoration / Enhancement consideration has been defined and included in the online map viewer.
Salmon	*Salmon:* Zone / Catchment has a Tier I or Tier II stream
Wetlands	Wetlands: Zone / Catchment has significant wetlands

Positive Attributes

PROTECTED	Parcel in unit designated as protected- PSNERP
STREAM	Freshwater stream in unit- SSHIAP
POCKET_EST (NZ only)	Pocket estuary/embayment in unit- SSHIAP
FORAGE_FISH (NZ only)	Documented forage fish spawning- NPST
INT_VEG (NZ only)	Intertidal vegetation present in unit- NPST
PRI_SEDIMENT (NZ only)	Sediment source designated as *priority* in unit- NPST
SUM_POS_ATTR	Sum of positive attributes

Fill and Armor

P_ARM (NZ only)	Linear % of unit modified by shoreline armoring- PSNERP
RANK_P_ARM (NZ only)	Sequential ranking of shoreline armoring percent
FILL (NZ only)	Percent of unit designated as fill- PSNERP

Negative Attributes

ECY_303D	Department of Ecology 303d listed water in unit- WDOE
FACILITY	Department of Ecology toxic cleanup site in unit- WDOE
MARINA (NZ only)	Boat marina present in unit- PSNERP
DOCK_BOAT (NZ only)	Dock or boat mooring present in unit- PSNERP
OUTFALL (NZ only)	Water outfall present in unit- PSNERP
RAMPS	Boat Ramp that appear to have effects on shorezone drift
BREAK_JET	Breakwater / jetty within 20 meters of unit
SUM_NEG_ATTR	Sum of negative attributes

DEFINITIONS

Positive Attributes

PROTECTED: Protected parcel

Code:

rating	score
Present	1
Absent	0

STREAMS_SALMON: Stream in unit or Tier I or Tier II stream in unit

Code:

rating	score
Tier I stream Present	1.5
Tier II stream Present	1
Stream Present	0.5
Absent	0

*Note does NOT include all salmonid presence.

POCKET_EST: Pocket estuary or embayment in unit

Code:

rating	score
Present	1

Absent 0

FORAGEFISH: Documented forage fish spawning present in unit

Code:

rating	score
Present	1
None	0

INT_VEG: Intertidal vegetation documented in unit

Code:

rating	score
Present - patchy	0.5
Present - continuous	1
Absent	0

PRI_SEDIMENT: Identified priority sediment source in parcel

Code:

rating	score
Present	1
Absent	0

Fill and Armor

P_ARM: Percent of unit that has been modified by shoreline armoring. A value used to weight the unit by multiplying the linear percentage of armoring in the unit by the length of the unit.

Fill: Percent of existing unit that consists of nearshore fill. A value used to weight the unit by multiplying the square feet percentage of fill in the unit by the square feet of the entire unit.

Negative Attributes

ECY_303D: 303d listed waters present as designated by WDOE

Code:

rating	score
Present	-1
Absent	0

FACILITY: toxic cleanup site present as designated by WDOE

Code:

rating	score
Present	-1
Absent	0

MARINA: Designated boat marina(s) within 20 meters of shoreline

Classified as Large (> 50 slips), Medium (30-50 slips), or Small (<30 slips)

*Note: Additional limiting effects of marinas were added to the database using the Washington Department of Health’s Shellfish Commercial Growing Areas GDB. Zones & Catchments within a Shellfish Closure Zone had their Marina attribute calculated to -2, -1.5, or -1 according to the size of the marina.

Code:	rating	score	
	Present	Large	-2
		Medium	-1.5
		Small	-1
	Absent		0

DOCK_BOAT: Designated dock or small boat moorage

Code:	rating	score
	Present	-1
	Absent	0

OUTFALL: Designated water outfall (not stream)

Code:	rating	score
	Present	-1
	Absent	0

RAMPS: Boat ramp that appears to have effects on shorezone drift

Present	-1
Absent	0

BREAK_JET: Breakwater / jetty within 20 meters of unit

Present	-1
Absent	0

Action Strategy Designations

The designating of Action Strategies was completed to give an initial indication of Catchments / Zones that could be considered candidates for a project or action including preservation or restoration.

There are four designations with two being recommended Action Strategies and the other two being more of an indicators of environmental health and biological function which we have called Habitat Indices.

The two Action Strategies are;
Conservation / Preservation and ***Restoration / Enhancement.***

The two Habitat Indices designations are;
Salmonids and ***Wetlands***

The four designations may be most beneficially considered and applied by combining / overlaying. As in, Catchments / Zones designated as *'Conservation / Preservation'* and as *'Salmonids'* would be a good starting point for a grouping of areas to consider for a land purchase to protect a high value & high functioning property that is used by salmon. Or Catchments / Zones designated as *'Restoration / Enhancement'* and *'Wetlands'* would be a good starting point to review areas with potential as a wetlands enhancement project.

To emphasize, the designations are conceived as a good starting point to open a collaborative conversation between biologists and managers about where on the landscape to consider a particular action or project. It would be at this point that biological expert opinion would be applied to provide insight as to where and particular action or project would have the greatest beneficial impact and the greatest probability for success.

Note that the GIS feature class Projects is included. This dataset represents the previously completed projects as provided by the Washington Recreation and Conservation Office and includes most of the projects submitted through the Habitat Work Schedule.