

Appendix B – A Proposal for Integrated Assessment Units

Our initial project was to integrate the spatial assessments of the Puget Sound Nearshore Ecosystem Restoration Project (The Nearshore Project) and nearshore elements of The Puget Sound Characterization Project (Watershed Characterization). This work led us to question how and why we complete assessments, and how we could improve assessment to tackle more complex ecological problems, adapt our strategies over time, link our strategies to on-the-ground activities, and better represent the Puget Sound landscape in a way that engenders collaboration and stewardship.

Our discussion led to this proposal to define a shared set of assessment units. A shared set of assessment units already exists among our current assessment efforts, and would provide a foundation for management of Puget Sound recovery that increases our ability to integrate between management sectors like salmon recovery, ecosystem process restoration, flood management and water quality.

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Why Focus on Shared Assessment Units?

A spatial assessment provides a view of the landscape by a particular stakeholder group, with a shared strategy and intent, at a particular place and time. Our spatial assessments compare ecological units—typically a piece of a drainage basin. As we consider the physical processes that control the dynamics of ecosystems, we have added new types of units, such as floodplains, drift cells, and estuaries. We sort them and compare them to each other as we decide how to expend effort, or as we predict the impacts of human activities.

Assessments rightfully have a limited shelf life, because assessments change when we learn something new, or when we develop new tools, or bring in new stakeholders, or refine our values. The process of shared assessment is a useful way to bring people together. It can also be an time consuming and expensive ordeal.

Three components make up all our spatial assessments:

1. **Assessment Units** – the units within which we summarize attributes to make comparisons.
2. **Underlying Data** – the geographic data we have collected that describes features of the landscape.
3. **Query Approach** – How we define and quantify the importance, suitability and risks of places.

Of these three, we are most likely to adapt our strategies by improving the underlying data and refining our query approach. By contrast, the proliferation of assessment units makes it more difficult to compare our work—we are less able to integrate our different views of the landscape. In order to strengthen our ability to assess and reassess landscapes among multiple stakeholder groups, there will be considerable value in stabilizing assessment units, and focusing our adaptive effort on improving our underlying data, and refining our strategic thinking.

Seven Units Make an Ecosystem

Ecological landscapes are not made of a single kind of place. That is why our three recent sound-wide assessments are so different—The Nearshore Project, Watershed Characterization, and Floodplains by Design projects each look at a different types of units. Each type of units provides a distinct set of services depending on their condition. Each of our assessments is weakened where we ignore the fundamental differences among units. Taken together, our assessments have identified seven distinct types of units to describe the components of the Puget Sound ecosystem from the cascade divide to Puget Sound shorelines:

1. **Mountain Watersheds** (*from Watershed Characterization*) – where confined channels erode hill slopes and precipitation falls as snow.
2. **Lowland Watersheds** (*from Watershed Characterization*) – where channels trickle through the topography of the glacial plateau and wetlands are common.
3. **Floodplains** (*from Floodplains by Design*) – where the collected flow of watersheds reworks benches and plains of alluvium.
4. **Deltas** (*from The Nearshore Project/Floodplains by Design*) – where larger rivers enter the Puget Sound and are affected by tidal flux.
5. **Beaches** (*from The Nearshore Project*) – where wave energy recruits and transports sediment from bluffs, forming a shallow intertidal shelf along the edge of Puget Sound.
6. **Embayments** (*from The Nearshore Project*) – where tides flood protected waters (frequently associated with a stream mouth or beach spit).
7. **Rocky Shorelines** (*from The Nearshore Project*) – where stable bedrock shorelines form shorelines.

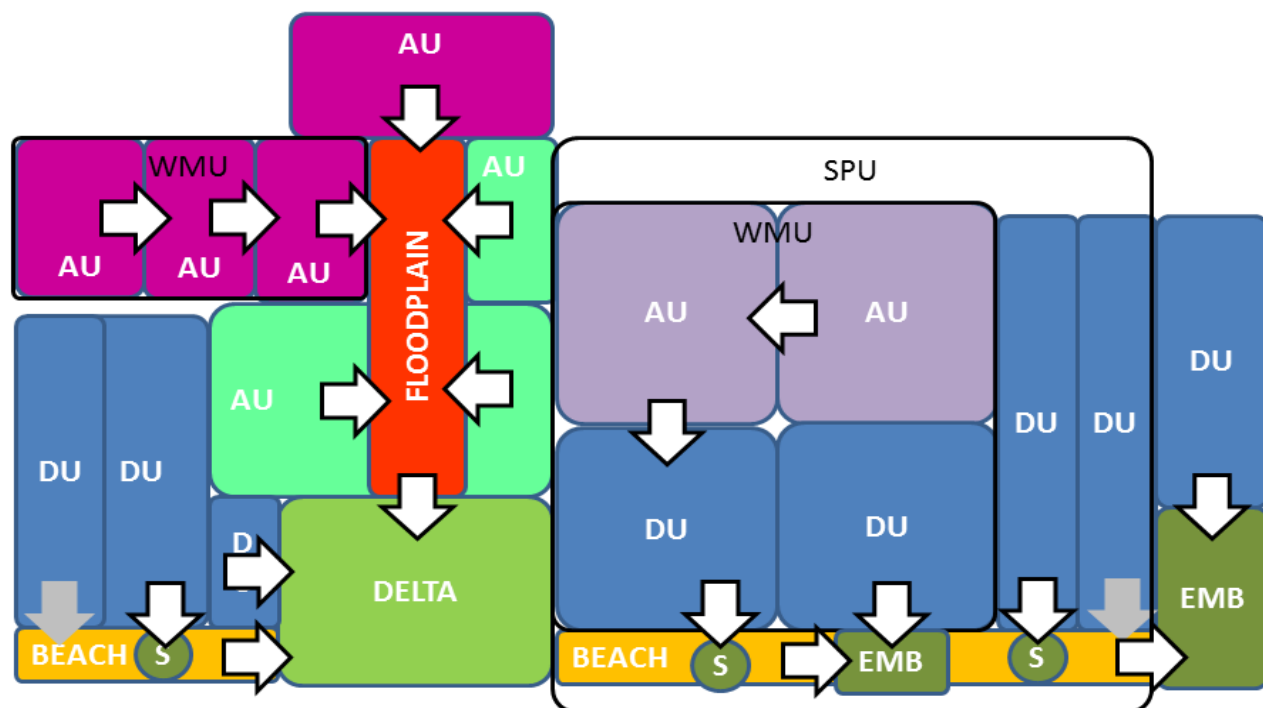
There are likely details that require refinement of this framework. The line between a small delta and a large embayment is blurry. We might consider a large lake as a permanently flooded floodplain unit, or as a body of water with its own beaches and embayments. We have neglected the deep water (where splitting units is more difficult). We might consider ‘urban systems’ as an eighth type of unit, where human structures have completely replaced natural ecosystem dynamics, sometimes at the scale of a lowland watershed.

However, these ‘landform units’ or ‘process domains’ or ‘kinds of places’ are each shaped by a set of physical processes, are inhabited by a unique biota, and are settled and developed in a similar pattern for similar purposes. They are each subject to a distinct syndrome of anthropogenic degradation, face similar stresses under climate change, and each require a similar approach to restoration and

protection. Our different types of systems are also related to each other—in that they nest within, surround, flow into, adjoin or otherwise form a mosaic (see Figure 1).

Usually our ecosystem management questions are focused on one kind of place. As we develop more sophisticated assessments that bring together stakeholder groups, we are driven to consider the relationships among places (for example: where are the lowland watersheds that dominate coho production associated with agricultural activity that flow into shellfish production estuaries where we could most effectively combine farm-based conservation and non-Chinook salmon recovery efforts?).

Figure 1 –A schematic map of relationships between potential assessment units. AU = Watershed Characterization assessment unit; WMU = watershed management unit; DU = Nearshore Project drainage unit; EMB = Nearshore Project embayment; S = Nearshore Project stream mouth. Colors correspond with sample maps at end.



Steps to Develop a Shared Framework

The sequence of work necessary to establish a shared set of units is technically simple and would draw upon and integrate the existing work of state and federal agencies. While the specific boundaries between units may vary among data sources, these differences are typically small—the important part of this proposal would be to establish a stable identity of landscape units. Small corrections or adjustments to unit boundaries can then be allowed, based on institutional needs, without undermining our ability to compare or integrate assessments.

STEP 1: AGREE THAT THIS IS WORTH DOING – We must first discover if there is agency support for developing a shared set of landform-based units for the management of ecosystems. The set of seven units proposed above is unlikely to be controversial. Individual institutions may be concerned about existing investments in their proprietary data sets, or the ability to nest within existing watershed

frameworks. There may be ways to establish a conceptual designation of units that serves as a bridge to integration, while supporting existing work products. Additional sub-types may be added to our proposed taxonomy as needed by partners without undermining the establishment of a population of shared ecosystem units.

STEP 2: DEFINE MID-SCALE PROCESS UNITS— We do not need to start from scratch. We can use existing assessment units to define an initial spatial framework that represents our current knowledge. There are many small discrepancies where different assessments identify a different dividing line between watersheds. Exact delineation of units is less important than conceptually identifying the units themselves. Due to the relatively young age of shoreline spatial work, this may be a ripe opportunity to establish units before the proliferation of different approaches begins. Even if different assessments use slightly different unit boundaries, the difference in metric value is likely to be negligible compared to other sources of spatial or conceptual error that are part of any assessment methodology. We can revise lines over the next generation, but the essential places will remain conceptually the same as they have for thousands of years.

The following suggestions for unit sources are based on an initial review of existing spatial data:

- **Mountain Watersheds** (*Watershed Characterization WMUs where Type=M*) - These are the headwater tributaries to floodplains or in some cases flow to lowland watersheds.
- **Lowland Watersheds** (*Watershed Characterization WMUs where Type=L or C, except where clipped by Floodplains, or where using Nearshore Project DUs to more precisely identify coastal drainages*) - These are coastal stream basins or lowland stream basins that flow into large river floodplains. Clipping to floodplains may change the size of those units that currently overlap with floodplains. A final division between floodplains and watersheds could inform future work, while still associating the results of Watershed Characterization that don't separate floodplains from other watershed units. Watershed Characterization lumps Many Coastal systems for the purpose of maintaining an even unit size. In these systems Nearshore Project DUs (drainage units) are a more accurate representation of lowland hydrology. Lowland Watersheds flow into floodplains, embayments or beaches.
- **Floodplains** (*Floodplains by Design FPU.*) – Floodplains receive flow from Lowland and Mountain watersheds, and flow into downstream floodplain units or Deltas. Some Floodplain units are lakes. We will need to compare Floodplain units to the units used by counties for flood management planning.
- **Deltas** (*Nearshore Project DPUs.*) Current Nearshore Project DPUs could be made more accurate based on current elevation models and observation of freshwater tidal flux, however the designation of final Delta/Floodplain lines will likely remain fuzzy for some time to come. Deltas receive flow from upstream systems, and may receive sediment from adjacent beaches.
- **Beaches** = (*GSUs where CellType = LtR, RtL, CZ, or DZ and dissolved by SPU.*) Beach system boundaries include a strip of shoreline 200m uphill from the estimated mean high water line, and extending off shore to the depth of light penetration. There are some cases where beach zones not identified by the Nearshore Project have been identified by Shipman et al. (2014), or where

historical drift cells have been essentially split by large marinas (where we have essentially constructed artificial rocky headlands). Beaches drift into other Beaches, Deltas or Embayments. The division of beaches into Nearshore Project SAUs (shoreline accounting units) and associating units based on drift could resolve the overlap issues that plague current SPU analysis.

- **Embayments** (*Nearshore Project DUs where $ZU > 1$ and Cell Type = NAD, and where Shoreform is in the Embayment class, potentially including stream mouths.*) The inventory and classification of Puget Sound sub-estuaries is a piece of work identified by the Nearshore Project (Section 4.4 of Cereghino et al. 2012) that would support salmon recovery planning in the nearshore. Where dense clusters of estuary features are found (as in the South Sound) some kind of clustering algorithm would create units that better support ecosystem management would be useful (but might result in some small beaches being absorbed into an Embayment management units). Embayment units receive flow from Lowland Watersheds and may receive sediment from adjacent Beaches.
- **Rocky Shorelines** (*Nearshore project Those SPUs with no beach or embayment, where Cell Type = NAD and shoreform = PL, RP, or PB.*) Rocky shorelines are small or large shoreline segments that are relatively static compared to other shorelines, and are geographically isolated in the mid-sound, San Juan Islands and along the Strait of Juan de Fuca.

STEP 3: DEVELOP PROVISIONAL SMALLER SCALE UNITS AND DEFINE ROUTING – Multi-scale assessment methods are common, necessary for answering more complex questions, and useful when shifting from assessment to project development. Smaller ‘habitat units’ support analysis of habitat services that are provided at smaller scales than proposed for process units. Watershed Characterization, The Nearshore Project and Floodplains by Design each provide potential smaller scale units for describing local conditions. There are numerous situations where you would consider surrounding environments when assessing potential targets for management. The routing system described in Figure 2 and implied in the unit definitions proposed in Step 2, would need to be encoded into the assessment unit matrix so that query language could be developed to describe conditions in related units.

STEP 4: ASSEMBLE DATA AND METRICS – Existing assessments all provide concepts and metrics that are useful for describing places. Because the dynamics and services of each unit type are different, a different set of concepts and metrics, specific to unit type, will likely be consistently referenced in future assessments. An inventory of existing assessment narratives, concepts, and best available metrics would set the stage for continuity of future investigations, improvement of underlying data, and refinement of metrics. A framework for identifying data types and suggestions for development of metrics consistent with an assessment narrative are discussed in the body of this report.

STEP 5: DEVELOPMENT OF A RAPID ASSESSMENT TOOL – The application of a shared assessment framework could ultimately culminate in the development of a shared assessment tool—an on-line mapping and query engine for developing and sharing assessments. A step-by-step wizard would allow any user to develop a narrative, identify concepts, develop a set of units, and select metrics and a query methodology for the purpose of identifying locations that align with their objectives and values. Such a query could be saved, shared with others, and adjusted over time. Alternately, another user could identify a place, and by considering that place in terms of previously saved assessments, could better understand how that location is viewed by different stakeholder groups. Existing project data are

typically stored as points or more rarely, polygons, and could be associated with assessment units to describe collective effort.

Advantages and Disadvantages of an Integrated Spatial Framework

There are arguments for and against this course of action—whether a shared framework is useful, cost effective, or even viable. A robust critique of our current assessment approach requires consideration of assessment as a social process with an institutional context. In the process of attempting integration of Watershed Characterization and The Nearshore Project the advantages seem clear to this workgroup. Regardless, we have attempted to respond to some arguments against integrated assessment units.

Arguments For:

- The need to use spatial data to identify important places in the landscape for achieving our objectives will continue into the future. Our challenge is to make that process more effective and efficient.
- Assessments that can integrate the functions of different kinds of systems are able to bring together diverse stakeholders. By making the assessment process nimble, we are able to integrate stakeholders towards common cause more easily.
- By stabilizing units, we can devote more effort to improving data and models, while allowing people to better combine and compare work, while reducing the cost and increasing the value of reassessment.
- The differences between existing assessment units are minor, and do not substantially affect the accuracy of assessment, particularly since most of our assessments rely on very conceptual models that already contain sources of error far greater than the differences in assessment unit boundaries.
- This proposed approach is derived from existing assessments and can support multiple management sectors that are concerned with the hydrologic landscape (water quality and quantity, salmon recovery, flood management).
- A shared unit system strengthens and links existing attempts to develop cohesive adaptive management strategies (for example, Chinook recovery monitoring and adaptive management, pressure assessment, and Vital Signs tracking)

Arguments Against:

- Assessments are essentially a waste of energy that could otherwise be applied to on-the-ground activity—the last thing we need to do is encourage more assessments. ***(While this may be true in some circumstances, a shared framework may reduce redundant reassessment).***
- If we define a system of assessment units that changes our recent assessment units, it might suggest that our recent assessments are somehow less meaningful. ***(This could be resolved by linking and valuing past assessment metrics as part of a framework).***
- Specific actors may have specific or exclusive authority over a management topic such that designing a shared system constitutes some relinquishment of that authority or responsibility. ***(If this is in fact true, authority over unit boundaries could be delegated to specific entities.)***

- Because of the number of different parties involved in assessment work, development of a shared tracking and reporting system based on clear spatial units, is unlikely and unsustainable—we must accept a level of organization similar to what we are experiencing now. ***(While this may be true, there is ample evidence of increasing coordination and information sharing among regional ecosystem management partners. Share units would only support that trend.)***

Test of Concept

The following maps were developed in one afternoon through the ad hoc intersection of the Nearshore Project, Floodplains by Design, and Watershed Characterization data sets, and demonstrate the concept of an integrated spatial framework, and how we will be able to use existing work, with a minimum of new effort.

Figure 2 – Exploratory Analysis of Puget Sound Landscapes. All maps are at equal scale, showing dramatic differences in the composition and configuration of Puget Sound landscapes when we consider ecosystem unit type.

