Toward a Natural Resources Asset Management Plan for Kitsap County
Workshop Agenda

Date: March 31, 2021, 9:00-11:00 am PT

Goals: Develop a shared understanding and agreement on key structural elements of the Kitsap County Natural Resource Asset Management program and provide feedback on current efforts and work moving forward.

9:00 AM	**Welcome and Updates** - Elizabeth McManus (Ross Strategic, Facilitator) and Mindy Roberts (WEC) • Review overall project goals and accomplishments to date, including a brief discussion of priority assets and attributes • Overview of where we are going in 2021 Materials: Project fact sheet/accomplishments; 2021 overview with structural model and definitions
9:15 AM	**Data sources and management units for shoreline, streams, forests** – Matthew Medina (Kitsap County), Ryan Huffman (Kitsap County) • Review and discuss data management units for shoreline, streams, forests • Feedback on data sources and definitions that might be used to describe attributes • Discuss preferences and approach to incorporating data from Suquamish and Port Gamble S'Klallam monitoring, including how to accommodate availability of more granular data for some areas Materials: • Framework/visual of data management units for each asset type and description of management units • Matrix of priority attributes and descriptions for each asset
9:50 AM	**Port Gamble S'Klallam: Example of data from the Big Beef Creek watershed** – Sam Phillips, Paul McCollum
10:00 AM	**Break**
10:15 AM	**Describing levels of services for priority assets** - Mindy Roberts (WEC), Charlotte Dohrn (WEC), other TBD • Conceptual framework for level of service approach (brief review) • Discussion based on examples on how to calculate the levels of service, including how attribute scoring rolls up into the levels of service and how priority ecosystem services are identified Materials: • List of ecosystem services considered to date • Matrix of priority attributes and definitions • Attribute-data source table and descriptions • Examples of other asset management systems and/or environmental indices
10:55 AM	**Other Updates & Next Steps:** • Placeholder TBD: Updates from Tom Ostrom (Suquamish Tribe) • Actions

	• Upcoming workshops
11:00 AM	**Adjourn**

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Workshop Reference Materials

This packet includes reference materials that will help inform discussions during the Core Team's first workshop of 2021. The goal of the workshop is to develop a shared understanding and agreement on key structural elements of the Kitsap County Natural Resource Asset Management Program (KNRAMP) and provide feedback on current efforts and work moving forward. Some of the material we will discuss during the workshop revisits work from the previous two years; we want to make sure the group is aligned as we move forward with developing and implementing KNRAMP.

The documents included in this packet are:

1. Overview of years 1 and 2 accomplishments
2. KNRAMP structural model and definitions
3. Overview of management unit development
4. List of ecosystem services
5. Example environmental indices and asset ratings
6. Cartegraph highlights
7. Level of service concept examples
8. List of priority attributes and data sources and documentation of prioritization to date

Reviewing the material is not necessary – we want your input during the workshop regardless of your capacity in advance of the meeting! The majority of the documents are included as helpful reference material. That said, there are a couple of questions that would be helpful to consider in advance, if possible:

- What questions, concerns, or feedback do you have about the proposed approach to developing management units? (Document 3)
- Which, if any, of the prioritized attributes can be deprioritized (at least for now)? (Document 8)
- Are there any attributes not currently prioritized that should be? (Document 8)
- Are there data sources not listed for any attributes that you would recommend utilizing? (Document 8)

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Year 1 and 2 Accomplishments

Year 1 (2019)

- Developed a shared vision amongst project partners for the Kitsap County Natural Resources Asset Management Program *(Workshops)*
- Conducted stakeholder interviews and developed a synthesis to identify the challenges and opportunities for developing a natural resources asset management program *(Stakeholder Interview Synthesis)*
- Researched many examples of related projects to identify where the knowledge gaps were and then developed several in-depth case studies of the most relevant for lessons learned *(Case Studies)*
- Developed a briefing memo of potential levels of service for forest, streams and shorelines to spark initial thoughts and gather feedback *(Level of Service Briefing Memo)*
- Developed a policy document summarizing the political backstops for creating and implementing a natural resources asset management program *(Kitsap County Policy Document)*
- Developed a General Framework and Structural Set-up for natural resources asset management *(General Framework & Structural Set-up Flowchart)*
- Define natural assets and developed extensive lists of ecosystem services and attributes *(Ecosystem service and attribute lists for forests, streams and shoreline)*
- Identified data needs and gathered and cleaned available data; Fit data and framework to Cartegraph software and developed a test ecosystem service index using Chico Creek *(GIS at Work Creating an Ecosystem Services Index to Assess Natural Resources Performance)*
- Potential funding options for natural resources asset management program *(Funding and Financing Sources for Payment for Ecosystem Services)*
- Developed a year 1 report summarizing the work, outlining a general framework and illustrating how we've begun to apply it to Kitsap County *(Year 1 Report)*

Year 2 (2020)

- Started developing management units for forests, streams and shorelines
- Developed a literature review and potential level of service breakdown for forest riparian zones on buffer width, vegetation height/forest age, forest structure/stand development, length of edge/fragmentation
- Developed a literature review and potential level of service breakdown for marine shorelines
- Researched and designed a public engagement plan with input from the project team and stakeholders from the original interviews
- Held a workshop in June 2020 with stakeholders and partners from the original interviews to identify priority ecosystem services

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Structural Model and Definitions

Overview

This document provides a quick reference describing the structural model for the Kitsap Natural Resource Asset Management Program (KNRAMP) system as well as definitions of key terms.

KNRAMP Structural Model

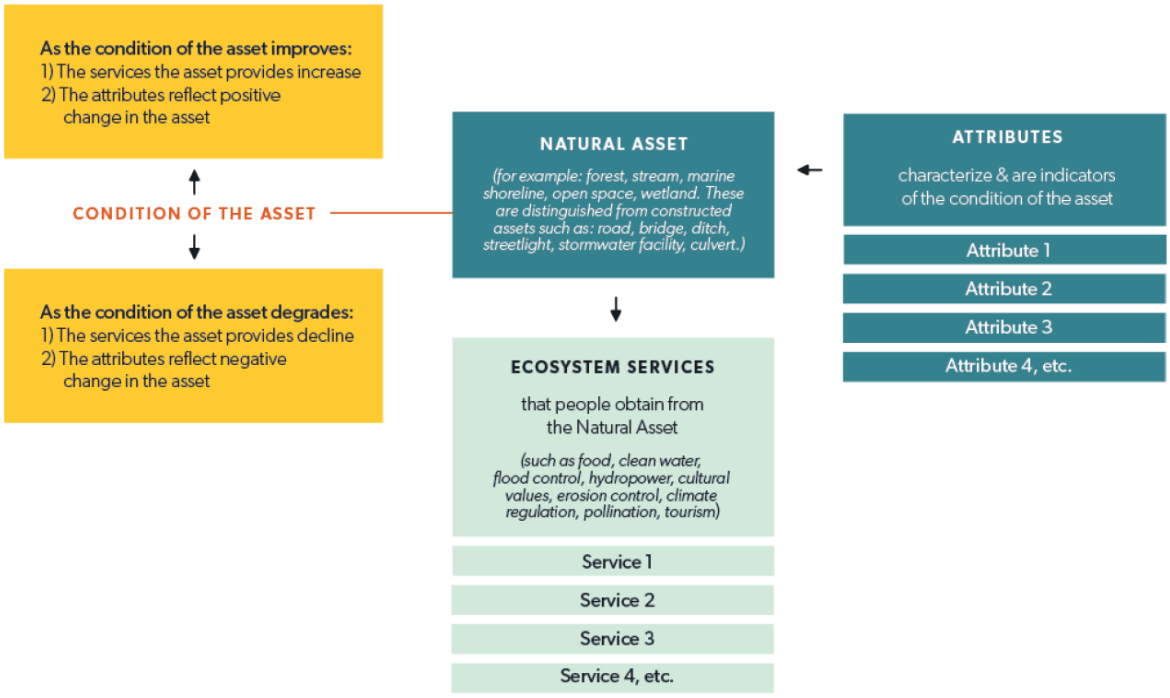

Figure 1. Diagram illustrating the concept of the Kitsap Natural Resource Asset Management system.

Key Terms and Definitions

Asset management: A system for prioritizing and implementing strategies for extending the service and lifetime of critical infrastructure.

Natural asset: This project is focused on streams, upland forest, and marine shorelines in Kitsap County.

Attribute: Attributes are physical features of the ecosystem that are measurable, regularly monitored, and help describe the condition of natural assets. Data describing the attributes included in KNRAMP must already exist and be accessible in a format that is compatible with the system.

Management unit: The KNRAMP system defines a geospatial assessment unit for each natural asset type. Management units cover the entire county. Level of service can be assessed at the management unit scale and/or aggregated over all management units within a watershed or other geographic boundary.

Level of service: A ranked metric usually used for capital facilities to define the kind and level of service that is required for meeting the needs of residents at current and projected demand.

Baseline level of service: The current level of service of a natural asset, defined by an index of attribute condition ratings.

Desired level of service: The level of service that community members would like to see for a natural asset. For example, the baseline level of service of an area of marine shoreline that community members value for the salmon habitat it provides may be low due to poor riparian habitat condition and shoreline armoring; the desired level of service for this shoreline may be higher (e.g., no armoring, native plants in the riparian zone).

Pressures: Activities that directly or indirectly change the condition of the ecosystem.

Process: The physical, chemical or biological, environmental events that influence organisms.

Structure: Components of the ecosystem that provide ecological function.

Function: The role that attributes plays in the ecosystem (i.e. flow control, shade, woody debris, etc.).

Service: The outcome of a function within the ecosystem (i.e. water quality, hydrologic control, pool refugia, erosion control etc.).

Ecosystem Service: the benefits that nature provides to people, either directly or indirectly (i.e. clean drinking water, sense of place, recreation, etc.).

Green Infrastructure: Assets that depend on ecosystem services, but may be engineered and artificial. Natural Assets are a form of green infrastructure, but not all green infrastructure are natural assets (Figure 3) Also referred to as ecological infrastructure.

Grey Infrastructure: Engineered assets built from concrete or steel.

Structural Model Drafts

The following figures show draft structural models developed for streams, shorelines, and upland forests. The diagrams show the relationship between attributes that characterize the three natural asset types, as well as the ecosystem services those assets provide.

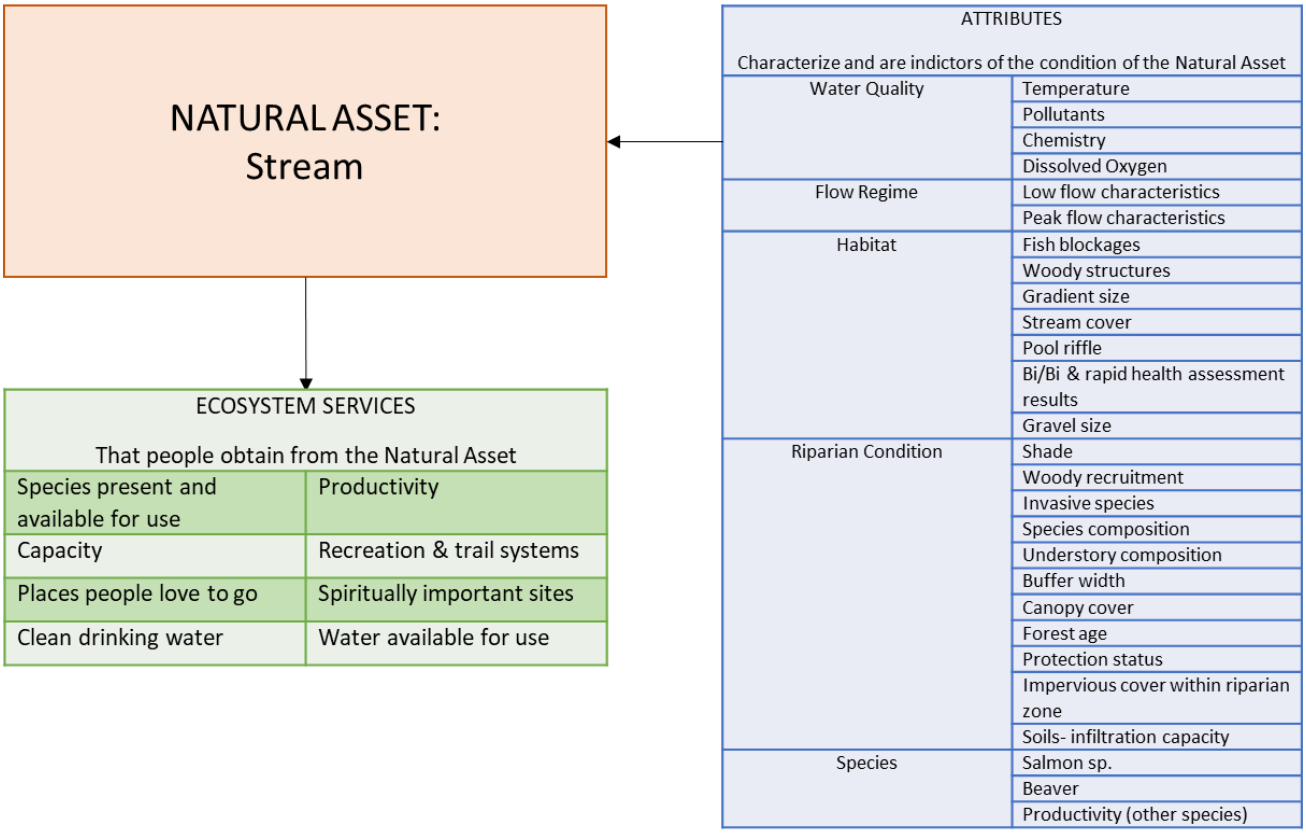

Figure 2. KNRAMP model for streams and riparian habitat

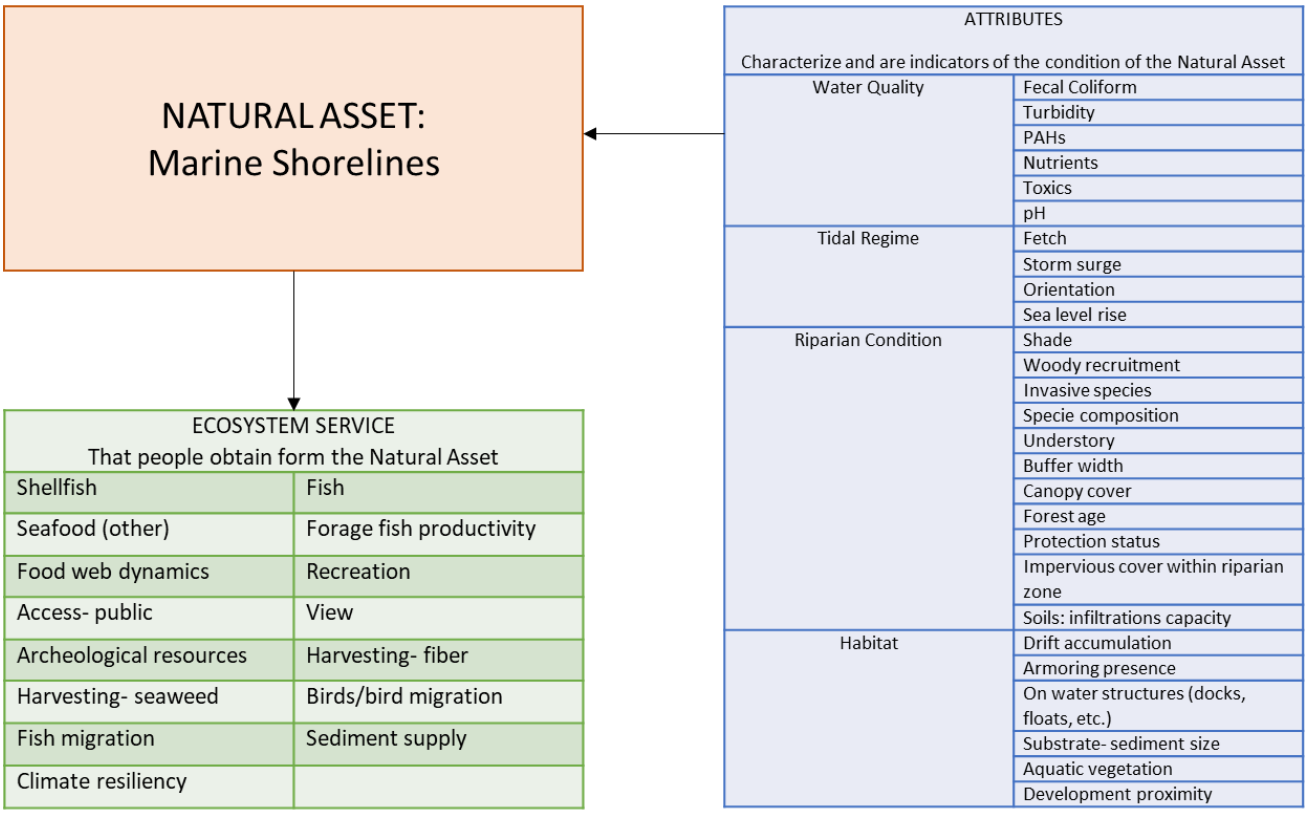

Figure 3. KNRAMP model for marine shorelines

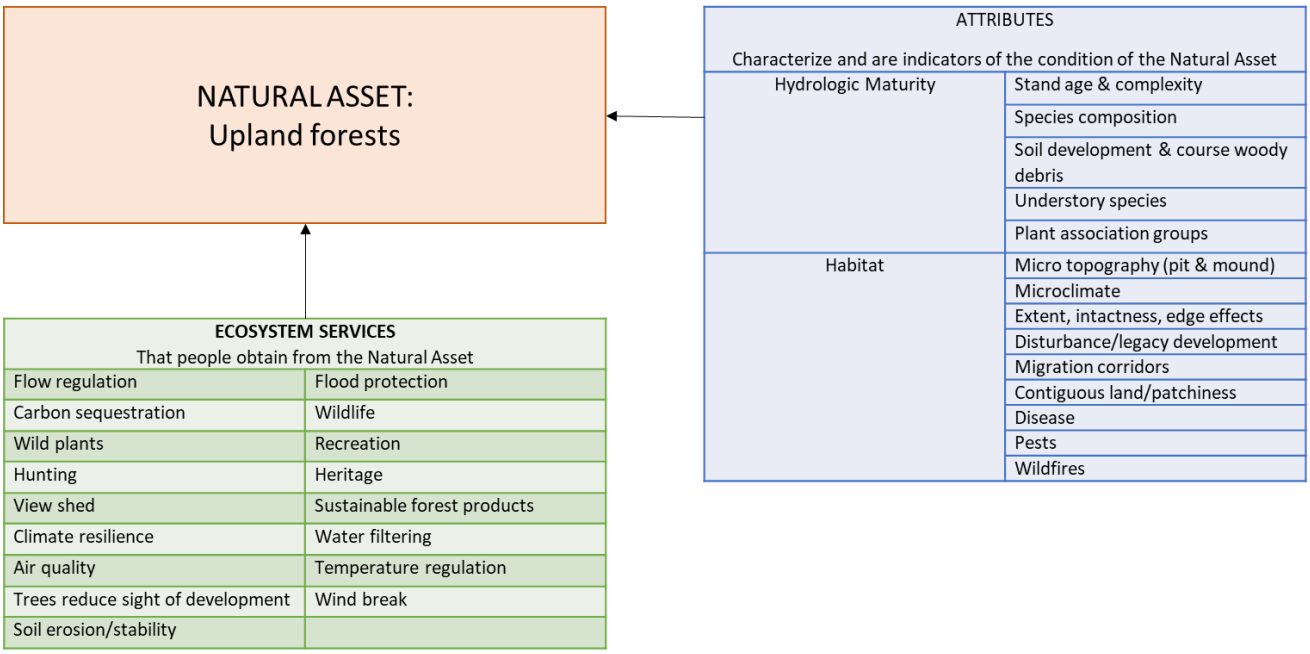

Figure 4. KNRAMP model for upland forests

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Management Unit Descriptions

Overview

The KNRAMP system defines a ~~geospatial management unit for each natural asset type~~ – streams/riparian, marine shorelines, and upland forest. Management units are the spatial foundation of the system and are defined across the county using a consistent approach. Each management unit will have an assessed baseline level of service and specified desired level of service; level of service information may also be summarized across management units within a watershed or other geographic boundary. This document provides a brief overview on the development of management units to date for each natural asset type, as well as a description of how management units are linked. Figures 1 and 2 below show example maps of the three types of management units for the Illahee watershed in Kitsap County; one example uses hexagons, the other uses catchments. All management units are in a vector data format (i.e., polygons). Management units continue to be designed with three main criteria: units do not use a scale that identifies individual landowners, the method for delineating units is repeatable; and the system requires the least maintenance while still providing utility.

Workshop Preparation

Please consider the information described below and come ready to discuss any **questions, concerns, or feedback** you have about the proposed approach to developing management units.

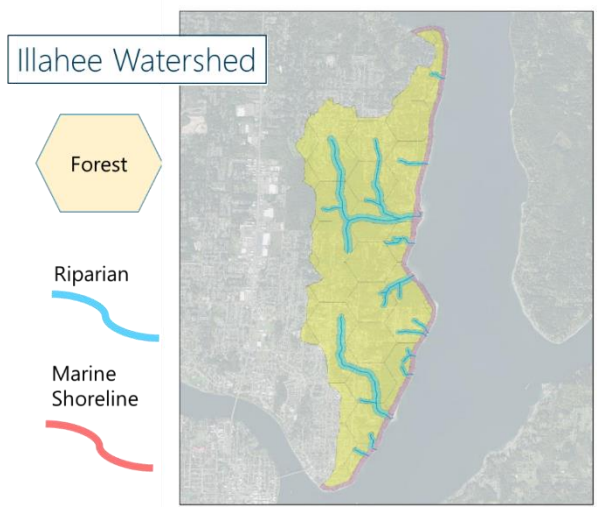

Figure 1. Left: Example of forest, stream/riparian, and marine shoreline management units delineated for the Illahee Watershed.

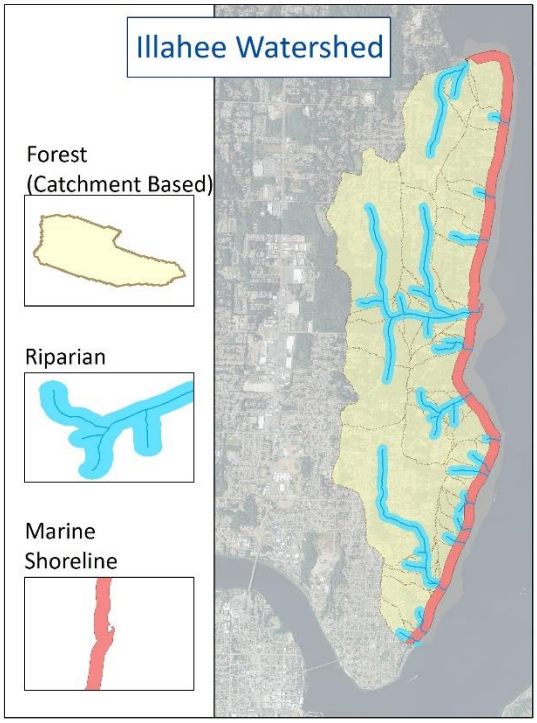

Figure 2. Right: Similar to Figure 1's management unit delineation, but with an alternative approach to forest management units, created using catchment boundaries rather than a hexagonal grid format.

Riparian/Stream Management Units

The management units for streams/riparian assets are based on the National Hydrography Dataset Plus High Resolution (NHDPlus HR). NHD data are commonly used in federal, state, and local environmental planning and management. The US Geological Society is very active in updating, maintaining and managing NHDPlus HR. NHDPlus HR includes a number of vector and raster components, including flowlines, waterbodies, catchment boundaries, elevation, flow direction, linear referencing and more. KNRAMP riparian management units will be nested within an NHD catchment.

- **Foundational data:** NHDPlus HR flowlines are the foundation for the riparian management units in the KNRAMP system. Lines are delineated from 2005 LiDAR elevation data at 10 meter resolution.
- **Linear segment delineation:** Streams are segmented by catchment boundaries.
- **Horizontal buffer:** The buffer width for each segment is one $SPTH_{200}$ (204 ft) of a Douglas fir (*Pseudotsuga menziesi*) from the flowline plus any intersecting geohazardous areas up to 400 feet.
- **Modifications for KNRAMP**: Merging and splitting catchments may be necessary

Marine Shoreline Management Units

The management units for marine shorelines are based on the Nearshore Geospatial Framework (2017). The framework provides an integrated dataset representing best-available information that can be used by nearshore managers to assist decision-making and nearshore recovery. NGF includes polygons constructed from net shore-drift cells and shoreforms. The shore-drift cells include contiguous stretches of directional drift and no drift areas. NGF data provides the basis for the most recent assessments of shoreline armoring, forage fish habitat, feeder bluff and other shoreline attributes.

- **Foundational data:** NGF net shore-drift cells are the foundation for the marine shoreline management units in the KNRAMP system.
- **Lateral segment delineation:** Lateral boundaries of these polygons are established by breaks between net shore-drift cells.
- **Horizontal buffer:** Polygons extend waterward to a depth of 10 meters; NGF includes four potential onshore buffers: 100 ft., 200 ft., 400 ft., 200m.
- **Modifications for KNRAMP**: At this stage, we do not anticipate modifying the units for the KNRAMP system.

Upland Forest Management Units

Option 1: Use a grid of hexagons as the management units for upland forests. Hexagons that each have an area of one square mile or less that overlay raster data (e.g., land cover) for Kitsap County. Hexagonal grids are commonly used in wildlife biology, aquatic sciences, and other applications because they are better suited to representing curves in the patterns of data and are preferable for analyzing connectivity; they also support visualizing information using a consistent shape rather than irregular polygons or other boundaries. Hexagons are clipped at the boundaries of watersheds to allow for summarizing level of service information at the watershed scale. Streams/riparian management units and shoreline management units intersect with the hexagonal grid.

- **Foundational data:** A customized hexagonal grid with 1 mi^2 spacing makes up the management units for upland forests.

Option 2: Use NHD catchments as the management units for uplands. These management units are based on hydrology and incorporate information including measures of forest and impervious surfaces in a catchment minus the visible surface water. Catchments are nested within watersheds and Hydrological Unit Codes (HUCs) which allows for measuring upland conditions across hydrologically connected areas.

- **Foundational data:** NHDPlus HR catchments are the foundation for the upland management units in the KNRAMP system. Lines are delineated from 2017 LiDAR elevation data at 10 meter resolution.
- **Modifications for KNRAMP**: Merging and splitting catchments may be necessary

Linking Management Units

Just as forest, streams, and shorelines are linked by ecosystem processes, management units for each asset type will also be linked. Management units for each asset type are nested in larger scale units. For example, upland and riparian units are nested within watersheds. Management units will also ideally be associated with each other (e.g., shore-drift cells associated with stream and upland units in a watershed). This will allow for different types of summary analyses (e.g., LOS of upper watershed catchments), and potentially in the future, the ability for relationships between management units to help provide information in the Cartegraph system about when management intervention might be needed.

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Priority Ecosystem Services

Introduction

The following ecosystem services have been identified through input from Core Team members, interviews with stakeholders and partners, and a workshop held in June 2020. These lists encompass a wide range of ecosystem services – the KNRAMP system will focus on a subset of services to make it more feasible to develop and implement the system, though many of the services are related and linked by attributes used to describe them. As a part of the June 2020 workshop, participants ranked ecosystem services in order of perceived importance for each natural asset type. The ecosystem services in this document are listed in the order scored by workshop participants.

Streams

- **Key species presence:** the presence or absence of key species such as salmon for harvest, cultural use, or for prey for species like orcas; fish barriers and/or beaver as indicators of habitat quality and function
- **Key species productivity:** the abundance of key species like salmon for harvest, cultural use, or for prey for species like orcas, in adequate quantities, overtime, and available for future generations to use
- **Connectivity between groundwater and surface water:** functional connectivity with groundwater aquifers to provide for adequate base flows in streams and so surface flows are not draining aquifer reserve; supports year round streamflow, nutrient transport, and wetland habitat
- **Flood regulation:** the ability for streams to transport water, sediment (size and amount), and large woody debris; beaver presence; assimilation of stormwater, wastewater and other water flows and pollutants associated with those
- **Habitat and other species:** sediment substrate, large woody debris, cool water, and indicator species that describe stream health like benthic macroinvertebrates
- **Support for adequate water supplies:** adequate water for cities, irrigation, domestic use, and to support species and habitat functions
- **Climate resilience:** including flood control, water supply and cool water habitat
- **Recreation/trail systems**: access and maintained areas for people to enjoy and utilize nature for mental, physical, and social health
- **Connectivity:** no fragmentation of the stream corridor, barriers, degree to which the network is complete or incomplete*

Marine Shorelines

- **Forage fish:** the presence and abundance of forage fish to support species like salmon and marine food webs in general; some species culturally harvested
- **Habitat:** habitat supports marine vegetation such as eelgrass and kelp
- **Sediment supply:** feeder bluffs supply sediment to replenish beaches and maintain habitat quality, can be evaluated by considering the presence, absence, and quality of shoreline armoring
- **Shellfish:** the ability/availability to grow and harvest shellfish safely for sustenance, commercial, and cultural use; dependent on adequate water quality
- **Climate resiliency:** shoreline management supports practices that make the shorelines more resilient to things like erosion and sea-level rise
- **Fish migration, shallow water:** habitat supports fish species at different life stages and histories
- **Fish-seafood:** the ability/availability to grow and harvest fish/seafood safely for sustenance, commercial, and cultural use
- **Cross-directional connectivity to the shoreline:** encompasses services related to forage fish, sediment supply, and fish migration in shallow water
- **Marine riparian:** habitat filters water and contaminants, controls sediments, provides shade, inputs large woody debris and organic matter, and other functions.
- **Wetlands and estuaries:** provide habitat, filter water
- **Complexity of shore forms:** lagoons, and aesthetic nature of shorelines, eelgrass
- **Water quality:** related to many ecosystem services, including recreation, shellfish harvest, quality habitat
- **Recreation:** availability and accessibility of places to enjoy activities like walking, swimming and boating for mental, physical, social health
- **Public access:** accessibility to all for multi-use activities
- **Archaeological resource:** storage about scientific information about people that lived here harvesting fiber, seaweed, plants used for eating
- **Birds/bird migration:** various types of bird species are supported for activities like bird-watching and other biodiversity benefits
- **View:** availability to experience the iconic aesthetic of shorelines, unencumbered by unsightly structures/development
- **Carbon sequestration:** shoreline vegetation traps and stores carbon
- **Tourism:** aspects of the shoreline that bring in outside economic activity from visitors are supported- species like the iconic salmon and orca, seafood, etc.; aesthetics

Forests

- **Wildlife preservation, corridors and habitat blocks**: there is contiguous habitat for animals to live and migrate, wildlife preservation to allow for certain species to thrive
- **Aquifer recharge:** supporting infiltration to ensure sufficient ground water supplies and adequate base flows for salmon and other species
- **Flood prevention, regulation and detention**: habitat is able to withstand changing and intensified weather conditions so people and nature are safe and resilient
- **Water filtering**: adequate availability of trees to serve as natural sponges, collecting and filtering rainfall to release it slowly into streams and rivers so our waterways are safer and healthier for use, aquifer recharge, watershed preservation for supply and streamflow benefits
- **Climate resilience:** adequate forest habitat to help stabilize the climate by storing and sequestering carbon, etc. species diversity and composition shifts and resilience to climate change, providing shade, etc.
- **Key species presence**: presence or absence of key species
- **Wild plants**: habitat supports biodiversity of native plants for harvest, animals and the ecosystem
- **Temperature regulation**: adequate availability or trees to regulate microclimate condition which is important for things like making streams safer for fish (heat storage, humidity regime, etc.)
- **Carbon sequestration**: there is enough habitat in adequate condition to maintain carbon stores in existing forests, help mitigate some GHG emissions through expanding forests, and create more resilience in the face of climate change
- **Sustainable forest products**: availability of trees/working forests for sustainable harvest and use
- **Soil erosion**: adequate availability of trees to provide stability to soils
- **Recreational:** availability and accessibility of places to enjoy activities like hiking, camping and biking for mental, physical, social health
- **Air quality**: adequate availability of trees to remove pollution from the air so it is safer for people and animals to breathe
- **Heritage**: natural resources are available for spiritual and cultural use
- **View:** availability of trees to mask unsightly structures/development
- **Hunting:** availability of prey and accessibility to land for hunting game for food, sustenance, sport, etc.
- **Wind break**: adequate availability of trees to provide wind regulation
- **Forest structure**: canopy, understory*

* indicates that ecosystem service was not ranked during the workshop

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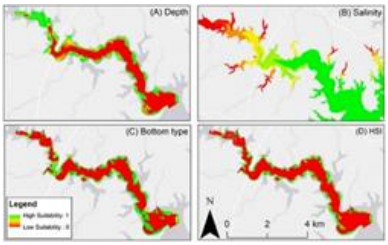
Examples of Environmental Indices and Asset Ratings

Overview

This document provides a few examples of environmental indices and asset ratings and how they are calculated. These examples may be helpful reference for initial discussions during the workshop regarding how attribute data will be used to determine a level of service for natural assets at the management unit scale.

Examples

Habitat Suitability Indices



Habitat suitability index (HSI) models are increasingly used to guide environmental restoration and management planning. These tools combine spatial data with species biology to provide estimations of where conditions are most suitable. For example, HSI models are used to identify areas to prioritize native oyster restoration and conservation activities on the east coast and west coast. In the example pictured on the left, three environmental variables (depth, salinity, and bottom type) are reclassified from zero to one based on thresholds for eastern oyster biology. In the final panel, an overall suitability index is calculated using the geometric mean of the suitability scores for the three environmental variables. In this case, a geometric mean was selected so that areas that score as unsuitable for any of the three variables will generate an unsuitable score in the final HSI; this is a practical choice when restoration investments are costly and oysters will not survive where conditions are unsuitable for any of the variables.

Watershed Index Online

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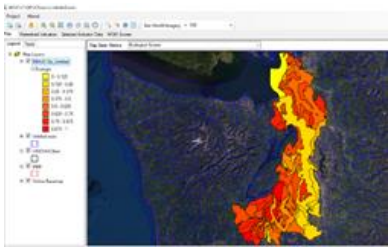
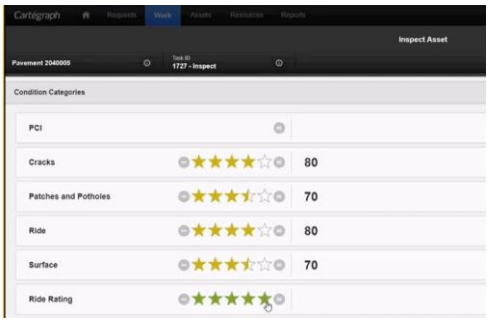


The Watershed Index Online (WSIO) is a tool developed by the EPA to assist resource managers and others with evaluating, comparing, and prioritizing watersheds. The tool was created because individual projects were calculating similar metrics around the country, and EPA identified an opportunity to provide readily available, nationally consistent indicators on a useful planning scale. The database and tool includes hundreds of indicators, grouped into ecological, stressor, and social indicators. Indicators are measured at the HUC12 scale. Ecological indicators include % forest in the watershed, forest cover change, presence of protected/rare species, carbon storage, and others. Stressor indicators include % urban development in the watershed, % agriculture, % streams near impervious cover, and others. Social indicators include protected lands, surface drinking water population served, nonpoint control projects, and others. The tool allows the user to select which indicators to include in analysis. WSIO uses a min-max normalized scoring for each indicator and indicators are combined using a simple or weighted

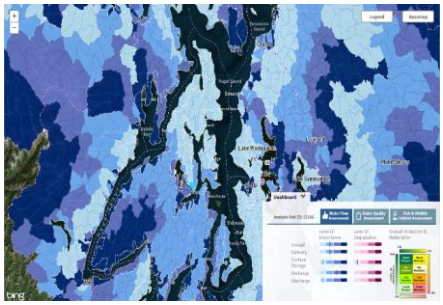
average to calculate an ecological, stressor, and social score. An overall watershed index score is also calculated.

Pavement Condition Index – Cartegraph



Cartegraph allows for many different approaches for calculating a condition index for an asset. For example, for pavement assets, condition categories (i.e., attributes) may include pavement condition index, cracks, patches and potholes, ride, surface, ride ranking. A condition score is assigned for each category; scores can be on a scale from zero to five, or defined using other types of indices or degradation relationships. Condition categories are averaged (weighted or unweighted) to calculate an overall condition index for the segment of pavement evaluated.

Watershed Characterization Project



The Watershed Characterization Project is a tool created for the Puget Sound basin for resource managers and planners to access the water flow and quality, fish and wildlife habitat to determine areas that are important for protection and restoration. Assessment units are between 1-10 sq. miles. The conditions of assessments units are expressed in quantitative indices. Water flow assessment measures the level of importance, level of degradation and the scale of priority for restoration or protection of key attributes, water delivery, surface storage, recharge and discharge. The water quality index measures the export potential, degradation and priority areas for restoration and protection for key attributes, sediment, phosphorus, metals, nitrogen, and pathogens. Lastly, the fish and wildlife habitat indices aggregates data from the previous indices and categorizes it as unique aquatic and terrestrial indices. The attributes an indices were chosen because key relationships between ecosystem processes, structure and function.

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Cartegraph Highlights

Overview

This document includes some quick reference information and highlights of Cartegraph's interface and key functions. This information will not be specifically discussed or reference during the workshop.

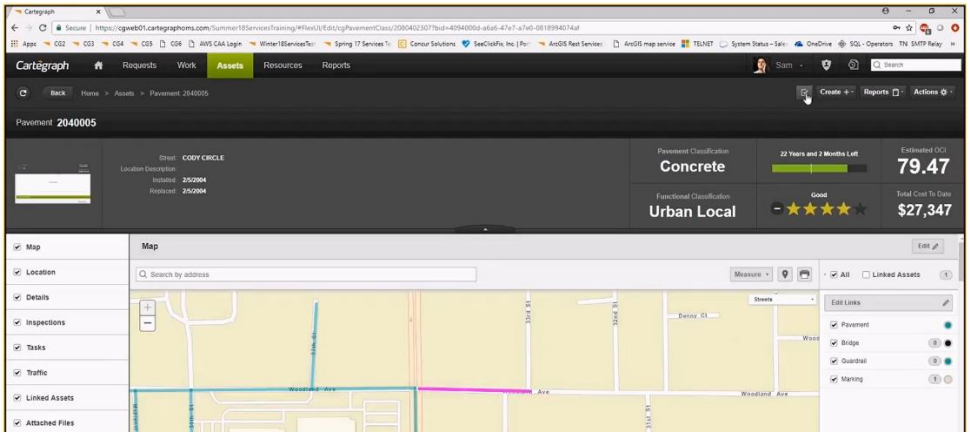
Cartegraph has four primary tabs that organize the primary functions of the software:

- **Requests:** Where task for work to be performed are stored and problems are tracked
- **Work:** Tracks tasks, resource entries, work orders, and cost breakdown
- **Assets:** Where you can view and assess your asset inventory and condition at multiple scales
- **Resources:** Used to manage labor, equipment, rates, materials, locations/orders, costs, etc.
- **Reports:** Generate reports

In addition, users can create a customized dashboard that can summarize relevant information for immediate analysis and sharing. Cartegraph is integrated with Esri products (e.g., ArcGIS Online), allowing for asset data to be uploaded into Cartegraph using web services and data to be stored in ArcGIS Online. Asset data can be routinely retrieved from web resources using a webservice to facilitate data updates between the source and Cartegraph.

Asset Management Functions

At this point in the project, we will primarily use the **Asset Management** features in Cartegraph, though the other functions (e.g., work) may be used when the system is implemented to monitor and track management interventions. The screenshot below shows the Asset Tab view, with a section of pavement highlighted for assessment.



From this view, users can interact with asset layers (e.g., pavement), and use the map or other tools to filter and select assets. Users can create tasks associated with assets, add notes or information to assets, and create new assets in this window. Each asset has an Overall Condition Index (OCI), which is represented as a score out of 100. The OCI is estimated based on ratings assigned across condition categories (e.g., cracks and potholes, ride rating). Assets can be linked or associated with containers (e.g., roadway), which are assigned a condition based on their components.

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Level of Service Concept Examples

Overview

Last year, WEC conducted literature reviews on shorelines and riparian habitat and developed initial, conceptual ideas for how to determine the level of service (LOS) of these natural assets. The riparian example focuses on four attributes, and the shoreline example includes five attributes/combinations. These examples provide a foundation for defining level of service in future workshops.

Riparian Level of Service Concepts

Proposed Level of Service Recommendations for Riparian Management Zones

Protection Pathway

Restoration Pathway

Buffer Width (Science Synthesis)

	A	B	C	D	E
Feet	246-300+	150-245	98-149	66-97	<65
Meters	75-90+	45-75	31-45	20-30	<20
	Minimal to no impacts to microclimate conditions	90%+ effectiveness for water quality, minimized impacts to terrestrial wildlife	80-90% effectiveness for water quality	70% shade minimum, 80%+ fine sediment control	Expect water temperature increases, increased tree mortality from wind throw

Vegetation Height/Forest Age (Douglas Fir Class II Site Index)

	A	B	C	D	E
Age	80+	60-79	40-59	20-39	1-20
Feet	195+	170-194	121-169	71-120	1-70
Meters	59+	51-58	37-50	22-36	1-22
	Hydrologic maturity, full recovery from disturbance impacts, approaching old growth	Lessened impacts to summer stream flows	Moderate reduction of summer stream flows	Heavy reduction of summer stream flows	Effective shade (70%+) for small streams, heavy reduction of summer stream flows

FFR Desired Future Conditions Target age 140+

Forest Structure/Stand Development Stage (Oliver & Larson Model)

	A	B	C	D	E
Stand Structure	Old growth/ Multi-aged community	Understory Reinitiation	Stem Exclusion	Stand Initiation	Converted/ Unforested
	Conifer dominated overstory & understory (with natural regeneration), mult-aged		Alder and Hardwood dominated overstory (with natural regeneration), even aged		No - few trees providing riparian shade, impervious area

Protection Pathway

Restoration Pathway

Length of Edge/Fragmentation (Ecology Model)

	A	B	C	D	E
Feet	**<500**	**500-750**	**751-1000**	**1001-1250**	**1250-1500+**
Meters	**<152**	**151-228**	**229-305**	**306-381**	**381-457+**
	Temperature impact <.12C	Temperature impact <.24C	Temperature impact <.36C	Temperature impact <.48C	Temperature impact <.6C

Marine Shoreline Level of Service Concepts

Armoring of feeder bluffs-

LOS	A	B	C	D	E
Management	No Armoring	Soft shore armoring		Hard armoring	
Ecosystem Services	Forage fish spawning			Species decline/absent	
	Eelgrass beds			Habitat decline/absent	
	Kelp beds			Habitat decline/absent	
	Fine sediment			No fine sediment	
	Erosion control			Erosion	

Overwater structures-

LOS	A	B	C	D	E
Management	No overwater structures	Fish friendly docks		Many overwater structures	
Ecosystem Services	Forage fish spawning			Species decline/absent	
	Eelgrass beds			Habitat decline	
	Kelp beds			Habitat decline	

Marine riparian buffer and nearshore structure setback-

LOS	A	B	C	D	E
Management	Buffer and setback			Buffer, no setback	No buffer or setback
Ecosystem Services	LWD present			LWD absent	
	Shellfish harvestable			High levels of bacteria	

Marine riparian buffer-

LOS	A	B	C	D	E
Management	Large buffer	Medium buffer		Small buffer	No buffer
Ecosystem Services	Forage fish spawning			Species decline/absent	
	LWD present			LWD low or absent	
	Adequate temperature for fish			Inadequate temperature for fish	
	Shellfish harvestable			High levels of bacteria	

Nearshore structure setback-

LOS	A	B	C	D	E
Management	Large setback	Medium setback		Small setback	No setback
Ecosystem Services	Forage fish spawning			Species decline/absent	
	LWD present			LWD low or absent	
	Adequate temperature for fish			Inadequate temperature for fish	
	Shellfish harvestable			High levels of bacteria	