Chapter 7
Shoreline Inventory and Characterization

Phase 2, Tasks 2.1-2.3
Shoreline Master Program Planning Process

Introduction

The inventory and characterization of your jurisdiction's shoreline are the foundation for the Shoreline Master Program (SMP). The SMP Guidelines require a scientific approach to developing the inventory and characterization. This chapter provides guidance on how to develop this approach.

The inventory includes existing data, information and descriptions of watershed and shoreline attributes that pertain to existing and emerging problems and issues in a jurisdiction. It describes existing shoreline conditions and development patterns, including attributes of a healthy ecosystem. The inventory is necessary to conduct the characterization.

The characterization is the description of the ecosystem wide and shoreline processes, shoreline functions, and opportunities for restoration, public access and shoreline use. The characterization identifies the current shoreline conditions, is a key product for developing the SMP, and is the baseline for measuring no net loss of shoreline ecological functions.

Developing the inventory and characterization helps to identify solutions to shoreline issues and directs the development of shoreline designations, policies and development standards. These are intertwined, iterative tasks that occur early in the SMP update process. An initial scoping task that identifies relevant inventory data and information is critical to this iterative process.

The inventory and characterization lead to an understanding of the relationship between shoreline processes and functions and the built environment. Together, they:

- Identify ecosystem wide processes and shoreline functions.
- Set a baseline for evaluating cumulative impacts of the draft SMP and determining no net loss of shoreline ecological functions.
- Identify potential sites for protection, restoration and public access.
- Guide development of the shoreline management strategy (Phase 3, Task 1, SMP planning process chart) that will lead to policies, regulations and environment designations that achieve no net loss of shoreline ecological functions.

(This chapter focuses on developing the inventory and identifying ecosystem processes and functions for the shoreline characterization. Information from the shoreline use analysis and public access report must also be included in your Inventory and Characterization report. These tasks will be explained in later chapters of the Handbook.)

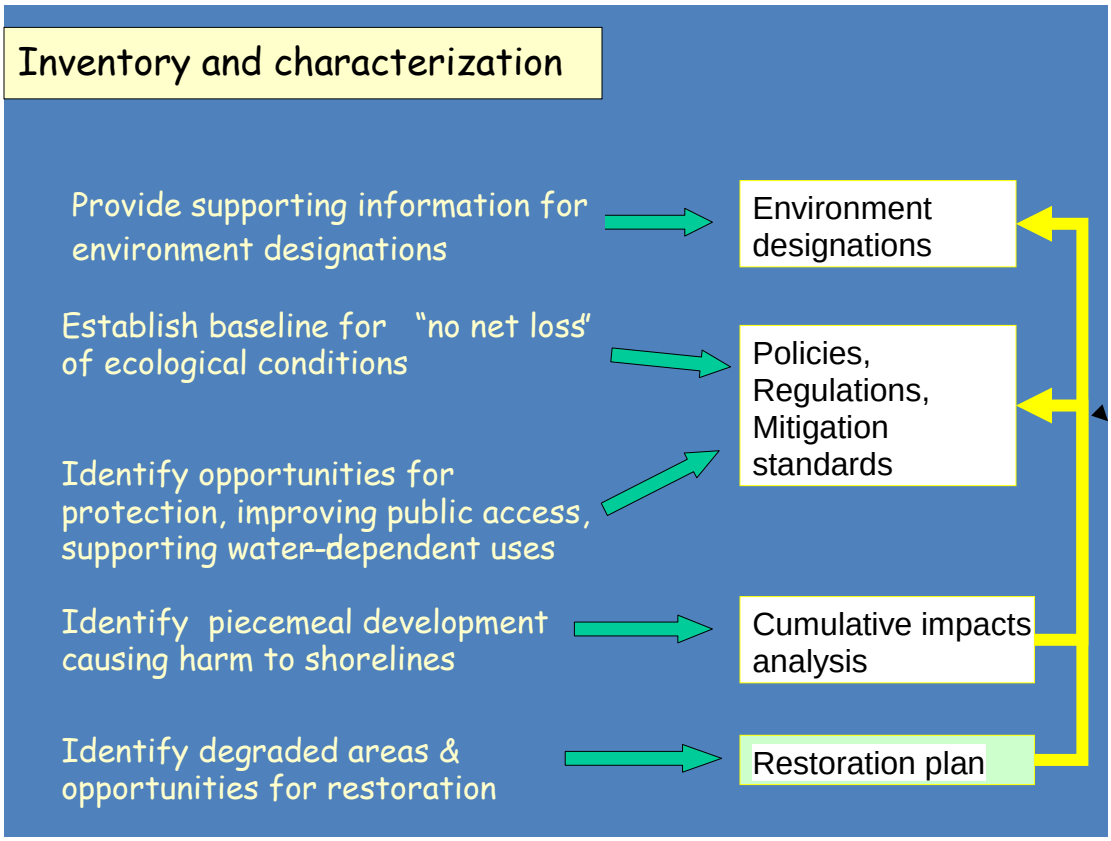

Figure 7-1: The shoreline inventory and characterization provide the foundation for the entire SMP update process.

Developing the Inventory

Identify Appropriate Data and Information

Much data and information are available, but not all of it is relevant to the issues for your jurisdiction or to development of the SMP. It's best to determine the issues before starting to hunt for data.

1) Scoping – Identify shoreline management issues, problem areas, emerging issues and opportunities for shoreline protection and restoration in order to help focus your data and information gathering. This will help you figure out what type and level of information is needed to prepare your shoreline characterization.

- Review basin plans, watershed/WRIA plans, Ecology's Coastal Atlas, local maps, and other regional and local assessments applicable to your jurisdiction to determine

what problems and issues, as well as relatively intact shorelines, are identified for the general ecosystem and the shoreline. (See Ecology's web pages at http://www.ecy.wa.gov/programs/sea/sma/data/report_table.htm and http://www.ecy.wa.gov/programs/sea/sma/data/maps_table.htm for lists of potentially relevant plans and documents.)

- Take into account what you already know from experience and what's been reported by the public. Are you aware of kayakers carrying their boats across a vacant lot to get to the water? Perhaps this is a potential public access site.

- Think in terms of problems and issues related to water flow or quantity, water quality and habitat. Potential issues for each of these categories are shown in the table below.

Table 7-1 Potential shoreline ecological issues

Water flow/quantity	Water quality	Habitat
Flooding	Storm water runoff	Loss of riparian vegetation
Channel movement/migration	Sediment in water column	Loss of upland habitat
Floodplain disconnected from streams	Erosion and sediments in streams	Habitat fragmentation
Potential flooding due to climate change and sea level rise	High temperature	Loss of eel grass, forage fish, shellfish, etc.
Upstream or local dams and levees	Nutrients and pathogens	Beach erosion

- Consider common management issues that may apply within your jurisdiction or surrounding area that affects your shoreline. These may include significant altered hydrologic regimes due to dams or irrigation, increased storm water runoff from high levels of impervious surface, or increased sediments due to upland clearcutting.

- Look at issues other than environmental issues. Which of the following are relevant to your community?

- **Land use**
  - Adjacent land use patterns that affect shorelines.
  - Areas of special interest (e.g., toxic/hazardous waste sites, priority habitats, eroding shorelines, redevelopment areas).
  - Land cover (impervious surfaces, forest cover etc).
  - Land and shoreline ownership, public tidelands and Public Trust Doctrine areas.
  - Pertinent plans and regulations: zoning, comprehensive planning, revitalization plans, historic districts, etc.
  - Public areas: parks, open spaces, trails (existing and proposed), existing and potential public access sites.
  - Shorelines of state-wide significance.
  - Shoreline modifications (bulkheads, docks, dikes, etc.).
  - Shoreline uses: residential, commercial, industrial, ports, water-oriented, non-water-oriented uses.
  - Transportation and utility systems.
  - Conditions and regulations that affect shorelines.
- **Environmental**
  - Significant natural resources: vegetation, topography, etc.
  - Degraded areas.
  - Drainage or hydrological systems, flood protection, irrigation, etc.
  - Critical areas.
  - Channel migration zones and floodplains.
  - Sites with potential for preservation or restoration.
- **Other**
  - Archeological and historical sites and cultural resources.
  - Past and current records, aerial photography in areas of rapid change.
  - Water depth and suitability assessment for commerce.

- Bring your list of shoreline issues and opportunities to local experts and the general public, and ask for input so that local knowledge can be included.

2) Identify appropriate data sources pertinent to shoreline issues.

Finding the appropriate data and information sources will involve asking "questions" about the problems and issues present for a jurisdiction and then linking the issues to the likely data sources. Some examples to help you get started thinking about this are provided in the table below:

Table 7-2 Shoreline issues and data-related questions

Issue	Questions
Beach erosion	Has the source of the sediment supply to the beach been changed? Have bulkheads reduced the movement of sediment to the beach?
Flooding	What are the storm runoff processes? What are potential land management impacts to storm runoff processes in the watershed? Are floods increasing in magnitude and frequency? Have depressional wetlands been filled or altered?
Channel movement	Are there potential hazards such as avulsion, erosion or flooding due to channel migration?
Loss of eel grass	Are there overwater structures such as piers and docks or buildings that prevent eelgrass growth? Have the number of fish species and numbers of fish declined?
Disconnected floodplain	Are there hydromodifications such as levees, rip-rap, dikes and revetments? Has there been historical channel dredging?
High water temperatures	Is riparian shade missing? Have water quantities in streams been reduced, resulting in higher temperatures?
Sea level rise	What are the projections for sea level rise in your area? What buildings and facilities might be affected by sea level rise?
Loss of upland/riparian habitat	Is riparian vegetation that provides ecological functions, including habitat for aquatic and terrestrial species in place or missing?
Water quality impairments	What type(s) of water quality problem is present (use 303d listing or other water quality sampling/reports)? What is the cause of the water quality problem (point, non-point)? If the cause is not clear, what type of data/information (indicators such as impervious surfaces) would assist the characterization in identifying potential causes?
Loss of woody debris	Are sources of large woody debris missing or is woody debris unable to reach the water due to shoreline armoring?
Public access	Are there extensive stretches of the shoreline without public access? Are new public access sites planned in park plans or other documents?
Current shoreline use	Are there small, platted and undeveloped shoreline lots? Are property owners proposing redevelopment of lots with small cabins? Do use conflicts exist, e.g. residential/aquaculture; public access and industry; recreational moorage and fishing fleets.
Water dependent use	Does your community need deep moorage? Is there demand for boat moorage or shipping facilities?
Aquaculture	Are there potential sites for aquaculture? Do existing aquaculture operators plan to expand?

Identify appropriate data and information that is relevant to your community and reasonably available from studies or other data such as aerial photos or maps.

Many data sources are listed on Ecology's website. These sources include the Washington Coastal Atlas, DNR Shorezone data, FEMA maps, WDFW's Intertidal Bait Fish Spawning Beach Survey, DNR Kelp Bed Inventory, Salmon and Steelhead Statistical Inventory, among others. (Check the web pages at http://www.ecy.wa.gov/programs/sea/sma/data/maps_table.htm and http://www.ecy.wa.gov/programs/sea/sma/data/report_table.htm.)

Adjacent jurisdictions that are updating or have recently updated their SMPs may have information relevant to your shoreline. Counties, in particular, should address ecosystem

processes on a regional scale in their characterization. Counties should provide inventory and characterization information for unincorporated urban growth areas. Local comprehensive, regional or subarea plans may list some shoreline issues and recommend restoration activities.

Also, check with local experts and your technical advisory teams. Don't forget to consider anecdotal information from citizens, advisory group members and others.

3) Gather data from identified sources. Data should be relevant to your community.

Take the relevant data from the sources. You may need only a small portion of a watershed report but all the information on a FEMA map. Existing data and information likely will be adequate but new information may need to be compiled from existing data. For example, you can determine the general location of channel migration using a time series of aerial photographs and maps. (See Ecology's website at http://www.ecy.wa.gov/programs/sea/sma/cma/index.html for examples.)

Identify any data gaps and assess the importance or value of filling data gaps. Proceed carefully before pursuing new data gathering or data interpretation efforts. In most cases, field work should be limited to field verification of existing data and to address key data gaps. Conduct additional analysis or research, if possible, to fill data gaps critical to effective shoreline management. Look for new sources of data, as needed, to fill any gaps. (Note: Ecology's grant does not cover new research.)

After a thorough search of existing reports and data submit the draft annotated bibliography and data source list to Ecology.

4) Prepare maps displaying appropriate and relevant information.

Develop maps at an appropriate scale to display the important and relevant inventory information. These maps will be used in your work and some will be used for public and Ecology review. Much information is available in digitally mapped form.

Available maps show raw data and information, such as land use, impervious surfaces, forage fish areas or critical areas. However, you may need to develop maps from information extracted from reports, photos or hard copy maps. For example, you can map areas of erosion using soil and geology erosion data, use historical photos to map channel migration areas, or use reports listing public access sites to map these sites.

Evaluate whether the scale of data is appropriate to answer your questions. If the scale is not appropriate, use your judgment to determine whether the data is helpful.

Compile Inventory Information

Compile complete inventory information to meet the requirements of the Guidelines and scope of work (Task 2.1). At this point in the update process, Ecology will be checking to see whether you are on track or missing any critical data sources.

The inventory products that must be submitted to Ecology include:

- A draft list of inventory data sources (digital copy) for Ecology review and comment prior to preparing complete inventory. (Product 2.1)
- Digital working maps of inventory information displayed at appropriate scales. (Product 2.1) Map layers should include a vicinity map, shoreline jurisdiction, shorelines of statewide significance, public access locations, land use, natural resources, critical areas, channel migration zones, floodplains and other relevant information. Layers may be combined as appropriate. Maps with more than one layer must be legible.

Conducting the characterization

Understand ecosystem processes and functions

Analyzing the information and data gathered for the inventory will help you to characterize the shoreline. The characterization identifies ecosystem processes within the greater watershed and ecosystem functions along the shoreline. The Guidelines recognize that SMA shorelines can't be properly managed in isolation from activities taking place upstream, up drift or within adjacent land areas outside of shoreline jurisdiction. It's important to understand ecosystem processes and how they affect ecological functions of the shoreline.

An **ecosystem** is a natural system consisting of all plants, animals and microorganisms (biotic factors) in an area functioning together with all the non-living physical (abiotic) factors of the environment. **Ecosystem-wide** *processes* refer to dynamic physical and chemical interactions that form and maintain natural landscapes. Processes include the *movement of water*, *sediment*, *nutrients*, *pathogens*, *toxins* and *wood* as they enter into, pass through, and eventually leave, the watershed.

WAC 173-26-020-12:

Ecosystem wide processes:

"…are the suite of naturally occurring physical and geologic processes of erosion, transport, delivery, and deposition; and specific chemical processes that shape landforms within a specific shoreline ecosystem and determine both the types of habitat and the associated ecological functions."

Ecosystem or watershed processes occur over larger landscapes that include both the shoreline and watersheds draining to the shoreline. Processes determine both the type and level of performance of shoreline functions. These processes occur at many geographic scales, from watersheds (100's to 1000's of square miles), to smaller sub-watersheds (10's to 100's of square miles), to shoreline reaches (parts of a mile to miles).

Ecosystem-wide processes are characterized by the following variables:

- Precipitation.
- Geology, topography, and soils.
- Land cover and land use including major vegetation types, predominant land use (residential, commercial, forestry, etc.).

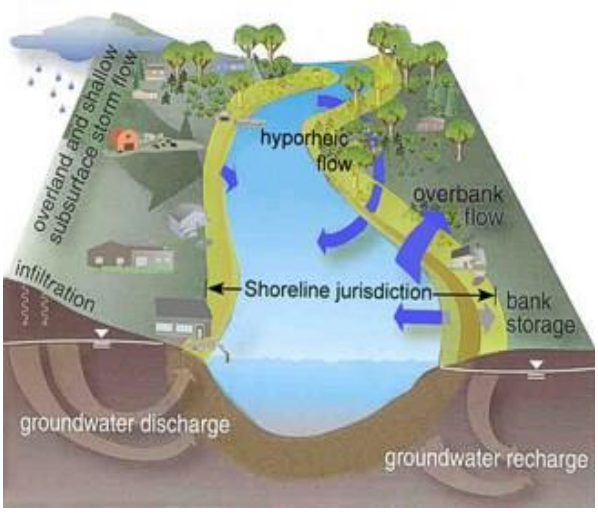

Figure 7-2 Ecosystem processes

Shoreline ecological functions include the service performed by physical, chemical and biological processes that occur at the shoreline. The Guidelines group these into water quality, water quantity and habitat functions.

Water quality functions may involve the removal of sediment, toxics and nutrients. The storage of flood waters in a flood plain is an example of a **water quantity** function.

Habitat functions include the physical, chemical and biological structure necessary to support the life cycle needs of aquatic invertebrates, amphibians, birds, mammals and native fish. Natural erosion and the transport of sediment within a river basin or along a marine shoreline form habitat such as side channels or coastal lagoons.

The Guidelines list ecosystem-wide processes and ecological functions in *WAC 173-26-201 (3) (d) (i)(C) and (D).* **Be aware that these two Guidelines sections tend to mix processes and functions, which can be confusing.**

WAC 173-26-020-11:

Shoreline ecological functions:

… "shoreline functions" means the work performed or role played by the physical, chemical, and biological processes that contribute to the maintenance of the aquatic and terrestrial environments that constitute the shoreline's natural ecosystem."

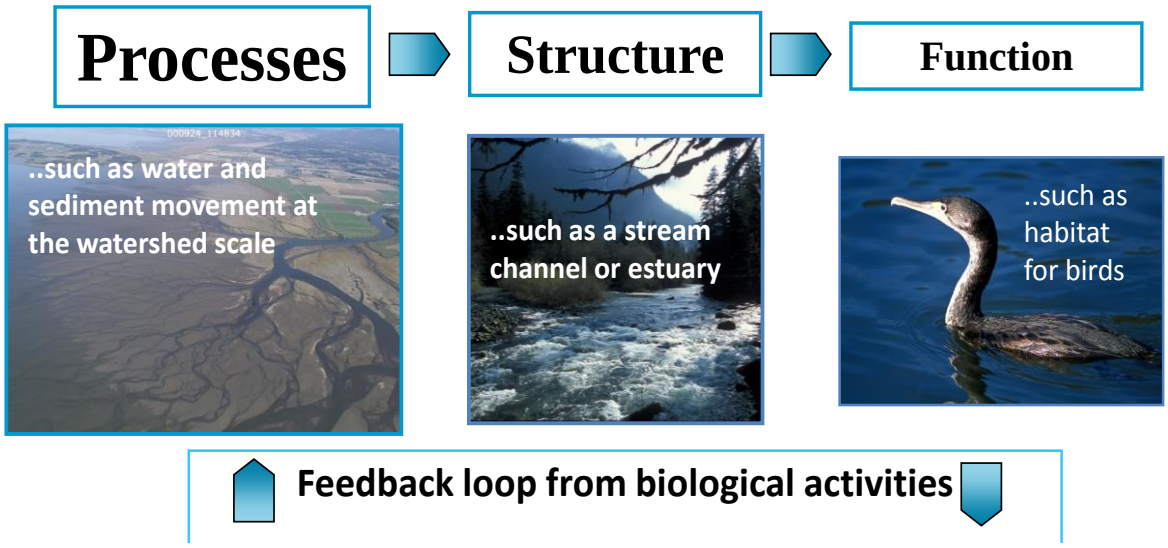

Figure 7-3: Relationship between watershed processes, structure and function. Watershed processes such as the delivery, movement and loss of water, sediment, and large woody debris play a direct role in forming the structure of aquatic habitat, which in turn governs the type and performance of functions present at a site scale.

The following table also helps to explain the relationship between processes and functions. Ecology recommends that you use a table format during the analysis to guide you in identifying ecosystem wide processes, ecological functions and their relationship to one another.

Table 7-3 Ecological Function Groups and Ecosystem-wide Processes

Ecosystem-wide process	Ecological function group	Ecological Function
Hydrologic – movement of surface and subsurface water	Water quantity functions	Storage of surface water in floodplains and depressional wetlands
Movement of sediment, toxics, nutrients and pathogens	Water quality functions	Removal of sediment, toxics, nutrients and pathogens (fresh water and tidal floodplains & depressional wetlands)
Movement of water, sediment and large woody debris	Habitat functions	Aquatic habitat for invertebrates, native fish, amphibians, birds and mammals.

Analyze data and information

A comprehensive shoreline characterization should integrate findings through a narrative and associated maps to inform planning decisions specifically faced by your jurisdiction. The characterization should:

- Identify the ecosystem-wide processes that affect ecological functions within shoreline jurisdiction.
- Determine the relationship of the ecosystem-wide processes to the shoreline functions and identify which functions are healthy, which have been altered and which have been eliminated.
- Identify measures to protect and restore these ecological functions and/or ecosystem-wide processes
- Establish a baseline for adaptive management and cumulative impact assessment.

You will then be able to identify shoreline management measures that lessen impacts to shoreline functions, including protection of existing shoreline resources and restoration of resources.

Recommended steps for conducting the characterization include the following:

1) **Determine contributing watersheds and shoreline reaches**.

   Determining the watersheds that influence the shoreline is the easier of these two tasks. These watersheds are likely already mapped. Review existing watershed, WRIA or drainage plans for watershed maps. Or, you can determine watershed boundaries by using topographic maps. Instructions on how to do this are available at www.ecy.wa.gov/programs/wq/plans/management/manual/appendixc.html.

For Puget Sound jurisdictions, Ecology will prepare broad-scale characterizations and will identify contributing watersheds called "hydrologic units." This information should be available in December 2009.

Reaches are specific segments of the shoreline and will be the basis for in-depth discussion of shoreline functions. Sometimes called "management areas," reaches are typically distinguished by the relative intensity of land use development patterns, the physical landscape or critical biological processes. To determine the reaches:

- Review maps and aerial photos. Photos may show obvious changes in shoreline use. For example, the following photo illustrates this point.

Figure 7-4: This Washington Coastal Atlas photo shows Priest Point Park in Olympia on the left, adjacent to residential development.

- Consider physical and biological changes along the shoreline. These may include slope, tributaries, confluences of streams, riparian vegetation, land use, wetlands, drift cells boundaries, geomorphic and ecological character of the shoreline, and tidal influence.
- Review existing marine inventories and documents such as the Washington Department of Natural Resources ShoreZone boundaries.
- Classify shorelines into various types. For example, marine shorelines may be dunes, river deltas or estuaries, sand-gravel beaches, etc. Classifications of marine, river and lake shorelines are useful indicators of ecosystem processes and shoreline ecological functions, changes the shoreline is most sensitive to, modifications that impact shoreline functions, and restoration actions that might improve impairments. (For jurisdictions working on Puget Sound marine shorelines, it may be helpful to look at *A Geomorphic Classification of Puget Sound Nearshore Landforms* for ideas on how to characterize shorelines: http://www.pugetsoundnearshore.org/technical_papers/geomorphic_classification.pdf.)
- Establish reaches based on these local physical and biological characteristics. In some cases, a shoreline classification, such as a river delta, may be a reach. Most of the time, classifications may need to be further divided into several reaches.
- Document the rationale used to identify shoreline reaches.

Once you determine where the reach breaks are, prepare a map or maps of the shoreline reaches. This map will be helpful to you as you develop the analysis template and consider environment designations.

Following is an explanation of reach delineation for streams and lakes from the Whatcom County Shoreline Inventory and Characterization. (June 2006, pages 2-26 and 2-27.)

Reach Delineation

As with the marine shoreline, streams and lakes were divided into reaches to facilitate the inventory of shoreline conditions. Stream reaches were identified based on biophysical criteria, including but not limited to the extent of tidal influence, tributary confluence, geomorphology, land cover, wildlife association, and riparian condition. Features such as fish habitat type, gradient, and stream confinement from the Salmon and Steelhead Habitat Inventory and Assessment Procedure (SSHIAP) and Ecosystem Diagnosis and Treatment (EDT) databases also influenced reach breaks. The preliminary reach breaks were refined as the inventory and characterization progressed, so that the defined reaches fit within the overall shoreline planning process.

The procedure for determining the initial stream reach breaks was completed by identifying the various biophysical data over the shoreline streams using GIS. Each biophysical feature along each stream was marked, overlaid onto an aerial photo, and analyzed to identify features that were significant enough to justify a reach break. Not all biophysical features identified through this process resulted in a reach break.

The surface water drainage area for the Nooksack River was defined based on a high resolution (30 meters) Digital Elevation Model (DEM) paired with hydrography and culvert mapping that included flow direction through the culvert. Levees and berms were considered a barrier to surface drainage. Where a reach break coincided with the confluence of a tributary, the area draining to that tributary was considered part of the downstream reach. Mapped wetlands that ran parallel to streams/lakes were split near reach breaks. Lake reaches were generally defined based on obvious changes in existing land use or land cover. Most small lakes only have one inventory reach.

2) Conduct the analysis in order to characterize shoreline processes and functions.

The Guidelines outline three approaches to characterize shoreline processes and functions:

- Conduct the characterization within the framework of an existing regional plan or use the data provided in the plan.
- Use available scientific and technical information.
- Pursue a characterization of greater scope and complexity.

When deciding what approach to use, consider the geographic size of your jurisdiction, number of drainages, variety of shorelines and number of ecosystem-wide processes that are present. The analysis for a county with many miles of marine, river and lake shorelines will be more complex than that for a city with one-half mile of river shoreline.

To assist you in conducting the characterization, an analysis template at the reach scale is presented in Table 7-4, below. Ecology recommends that jurisdictions use this or a similar framework for analysis. This framework consists of a series of questions that address the shoreline issues and problems in a jurisdiction, within a table format. When answering the questions, you can identify a source of information and include it on the table. A format like this can help you think through the issues.

Table 7-4: Shoreline analysis template (reach scale application)

East Fork Issaquah Creek and Mainstem, Reaches X & D:		
Unimpaired Conditions Assessment of watershed processes & functions	**Level of impairment to processes & functions and associated issues**	**Solutions and Actions: Recommended protection & restoration measures and environment designations**
Ecosystem processes: *What areas are important in the watershed for maintaining processes at this reach?* Forested areas of watershed in areas of higher precipitation, including rain-on-snow and snow dominated areas. Areas of higher permeability. Source: Issaquah Creek Final Basin Plan 1996 ***Shoreline functions:*** *What functions are present at the site (un-impaired conditions)?* Floodplain storage, removal of sediment, nutrients and toxins, aquatic and riparian habitat. Source: Appendix B, Protecting Aquatic Ecosystems, Ecology Publication 05-06-027	**Ecosystem processes:** *How have the processes been impaired?* Watershed Processes. Forested areas in upper watershed have low degree of clearing and development. Water flow processes are therefore functioning properly for the broad scale. Source: Dept of Ecology watershed characterization 2008 Reach Scale Processes. Overbank flooding is impaired by streambank armoring. This increases overall flooding potential for the City of Issaquah, which is a significant issue. Sediment processes highly impacted: High percentage of substrate impacted by fine sediment. Large woody debris (LWD) is limited and existing material is either unstable or ineffective. Source: Stream Inventory and Habitat Evaluation Report 2003 **Shoreline functions**: *How have the functions been impaired?* Floodplain storage function has been significantly impaired by armoring and dikes. Water quality functions are not significantly impaired in the East Fork. Fecal coliform, low DO and suspended sediment problems in mainstem for Reach D. Riparian functions: 68% of riparian habitat dominated by urban uses in Reach X. Sizable portion of riparian corridor intact for Reach D. Fish Habitat: Only 5% of riffles are available for spawning in Reach X. Lack of side channel habitat in Reach D. 7 to 8% of time spawning temperatures exceeded for Reach D. Pool frequency low and spawning gravels embedded for Reach D. Source: Stream Inventory and Habitat Evaluation Report 2003	**Ecosystem processes and functions:** *What are the solutions and actions based on analysis of processes and functions (columns 1 and 2)?* Analysis: Water flow processes are intact and protected for broader watershed. This will help support natural flow regimes and restoration of structure and function in downstream habitats. Sediment and LWD processes appear to be impaired at the reach scale. Solution and Actions: Restore overbank flooding in reach X and D by removing armoring and dikes. Restore riparian forest - replant buffer with species contributing to LWD recruitment. Provide for better control of sediment sources from roads and construction. Start stormwater retrofit program to reduce direct discharge to creek and capture sediment through bioswales and restoration of natural features. **Recommended Designation, Development Standards and Regulations:** A Public Recreation and Riparian Restoration Management zone or designation is recommended for these reaches. Several of the properties are in city ownership and slated for park development (Emily Darst and Cybil Madeline Parks). Restoration actions should be linked by regulations to projects 17,18,19,20 and 48 in Stream and Riparian Restoration Plan (2006). Setbacks for park development should be adequate to allow establish of riparian buffer (minimum 150 feet).

Although this table uses shoreline reaches as a basis for analysis, you can use a shoreline area that is appropriate for your jurisdiction. You may be able to combine several reaches with similar shoreline functions. Small jurisdictions with short lengths of shoreline may only have one reach and could provide the information in one table.

Use existing information and data gathered during the inventory. Use inventory information to help you answer questions about the level of impairment to shoreline processes and functions (Column 2). Inventory data such as amount of armoring or impervious surface are examples of impairments.

Think about the cause and effect relationships between the stressors of the natural environment and existing shoreline conditions. Levies, dikes, channelization, or channel incision (often caused by increased surface water runoff) can cause floodplains to be disconnected from streams and estuaries. With a disconnected floodplain, the shoreline suffers a loss of wetlands, loss of floodplain storage, loss of opportunity for nutrient cycling, and loss of sediment storage.

Use this information to develop preliminary solutions for shoreline management, including environment designations, policies, development standards and recommendations for protection and restoration. Solutions may include:

- Selecting appropriate types and intensity of development for different shoreline environment designations.
- Identifying the best locations for mitigation.
- Identifying the types of mitigation needed in different areas.
- Identifying the best areas for cost-effective restoration.
- Identifying the best areas for protection and development.

The solutions will lead to environment designations, policies and regulations. For example, areas that are identified as appropriate for higher density development could be designated Shoreline Residential in your SMP, while undeveloped areas with highly functioning shorelines may be designated Conservancy. Areas identified for protection and restoration should be included in the Restoration Plan.

Preparing Inventory and Characterization Report

The shoreline inventory and characterization report should provide an analysis of the inventory data, ecosystem characterization and shoreline functions, shoreline use, and public access opportunities. This report should present findings so that it is useful for making SMP decisions regarding environment designations, policies and regulations. There are a variety of ways to organize this information, but readers should be able to clearly understand relationships. Ecology recommends that you use a table to display this information.

Tasks involved in preparing the report include:

1) **Compile maps.** You might prepare many maps as part of the inventory and characterization. Some of them will be used for the analysis; not all of them must be submitted to Ecology as part of the Characterization Report.

As part of the report, include a vicinity map and map or maps showing shoreline jurisdiction, corporate boundaries, and WRIA or watershed boundaries. Required maps at the reach scale should show biological features, critical areas, listed species, critical riparian or aquatic vegetation, channel migration zones and existing land uses. Maps also should show opportunities for shoreline protection and restoration and public access.

2) **Prepare a summary describing ecosystem processes and shoreline functions.** The report should summarize information about the regional setting, topography, and extent of shorelines under SMA jurisdiction, including a general description, type and length of shorelines, and areas that influence SMA shorelines, such as drainage basins or littoral zone. The report also should:

- Identify the ecosystem-wide processes, their level of importance in the watershed and relationship to shoreline processes and functions relevant to your jurisdiction. Describe the relationship between upland activities and shoreline function.

- Identify the type and extent of alteration to ecosystem-wide processes and shoreline functions. To carry out this task, you can use existing watershed analyses (e.g. basin plans – http://www.ecy.wa.gov/watershed/index.html) or your own methods to assess the level of alteration. Guidance on another method for determining alterations to processes can be obtained by reviewing the appendices of *Protecting Aquatic Ecosystems: A Guide for Puget Sound Planners to Understanding Watershed Processes (Ecology publication 05-06-027).* These appendices contain a summary of the types of alterations that may affect processes for the movement of water, sediment, pathogens, nutrients and toxins. The appendices also provide supporting scientific literature for these relationships.

  Discussion about historical impacts such as the Ice Age floods and the melting of the glaciers, or the lowering of Lake Washington due to the opening of the Hiram Chittenden Locks, should be brief and relevant to current shoreline issues. If historical impacts are not relevant, you should not discuss them.

- List recommended measures to protect and restore ecosystem-wide processes and shoreline functions. These measures need to contain sufficient detail to allow development of shoreline environment designations, development policies, regulations and standards and a restoration plan. These measures might include restoring the floodplain, establishing buffers, removing intertidal fill or a dike, replacing a culvert with a bridge, acquiring conservation easements, or prohibiting certain types of development, for example.

  You should identify the measures based on the degree and type of alteration to ecosystem-wide processes and associated shoreline functions. Protection opportunities should be noted for shoreline areas with the least amount of alteration. Restoration

opportunities are indicated for those areas with a high degree of importance to shoreline processes and a high level of impairment. These measures are developed from the characterization information collected and analyzed in Tasks 2.1 and 2.2. These measures will help to identify appropriate environment designations and SMP policies and regulations.

- Identify public access needs and opportunities within the jurisdiction. (See Chapter X, under development).

- Discuss land uses, projected trends, and opportunities for water-oriented uses (from shoreline use analysis. see Chapter X, under development).

Developing the table (see Table 7-4, Shoreline analysis template, above) helps you to think through the relationships between ecosystem processes and functions, alterations and measures to protect and restore them.

If you use the table for your analysis, shoreline functions will be discussed there (we recommend using the table.) Another option is to summarize shoreline functions in narrative fashion outside of a table, as presented below. The Quilcene watershed example discusses floodplain and channel migration zone. The Skykomish River discussion also notes the impacts to the floodplain due to development.

Quilcene watershed

- Quilcene watershed: Beginning in the late 1800s, extensive diking has occurred in the Little Quilcene River estuary, eliminating good quality salt marsh habitat, isolating distributary sloughs, and compromising estuary function. An estimated 26% of the original Big Quilcene delta has been filled or obstructed by dikes (Ames et al. 2000). Both the Little and Big Quilcene deltas have prograded due to loss of floodplain connectivity and excessive sediment load from the upper watershed. Excessive channel aggradation has increased the streambed elevation and extended the Big Quilcene River mouth 1700 feet into the historic estuary. The aggradation and progration have also exacerbated the recurring flooding problems in the lowest portion of the Big Quilcene River. The floodplain has been modified by rip-rap armor, diking, and dredging as protection for residents living within the historic floodplain.

  Even though there are numerous hydromodifications, the channel avulsion hazard zone is a broad and extensive surface in reaches A, the mouth to Rogers Road, and B from Rogers Rd for approximately 3800 ft upstream (USDI, BOR 2004). In reaches A and B, the avulsion hazard zone is defined by extensive multiple channels which create an irregular surface morphology visible on aerial photography and LIDAR (USDI, BOR 2004, Figure 16).

Skykomish River reach

- The Skykomish River in this reach is a braided and dynamic lower gradient depositional floodplain (Holocene Floodplain type), where sediment and wood are actively deposited. Because the shoreline has been hardened within the city's shoreline jurisdiction, the river channel is now limited in its capacity to shift to the north.

Relating Inventory and Characterization to SMP Components

The characterization is a key product for developing the SMP and showing how the SMP will achieve no net loss of shoreline ecological functions. The characterization identifies the current shoreline conditions and is the baseline for measuring no net loss. You should use the inventory and characterization report in the following ways:

- Present the inventory and characterization report at public meetings and workshops, and use the findings when you develop a shoreline strategy (Task 3.1, SMP planning process chart).
- Use the recommendations to protect and restore ecological functions when drafting goals, policies, regulations and environment designations (Tasks 3.2 – 3.4).
- Consider the inventory and characterization as the baseline for conducting the cumulative impacts analysis (Task 3.6).
- Identify opportunities for shoreline protection and restoration and include them in the Restoration Plan (Task 3.7).