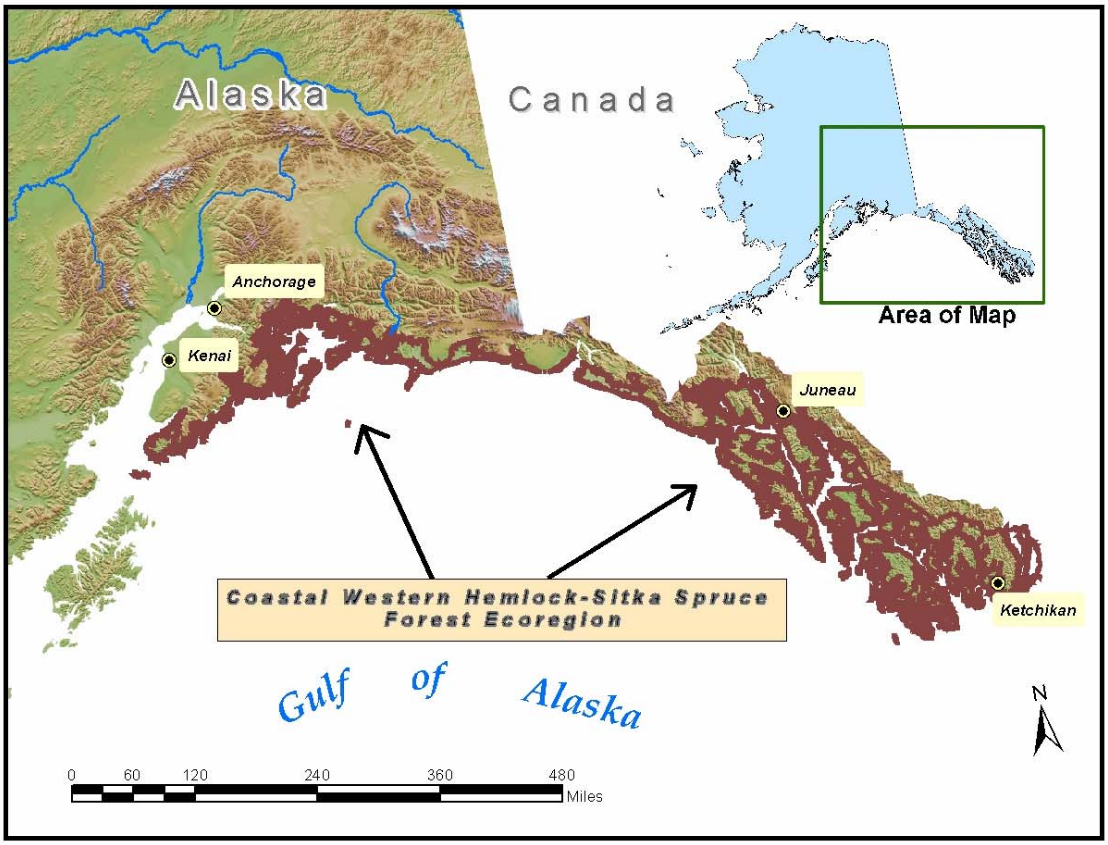
Wetland Functional Assessment Guidebook

Operational Draft Guidebook
for Assessing the Functions of Riverine and Slope River Proximal
Wetlands in Coastal Southeast & Southcentral Alaska
Using the HGM Approach



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U.S. Environmental Protection Agency (EPA)

U.S. Army Corps of Engineers (COE)

USDA Forest Service, Alaska Region (USFS)

USDA Forest Service, Forestry Sciences Laboratory, Pacific Northwest Research Station (FSL)

Alaska Department of Environmental Conservation (ADEC)

Alaska Department of Fish and Game (ADF&G)

Alaska Department of Natural Resources (ADNR)

USDA Natural Resources Conservation Service (NRCS)

US Geological Survey, Water Resources Division (USGS)

NOAA National Marine Fisheries Services (NMFS)

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This “Operational Draft Guidebook” (guidebook) draws from the "Regional Guidebook for Assessing the Functions of Low Gradient, Riverine Wetlands in Western Kentucky" for format and we thank Mr. Bill Ainslie (EPA), one of its principal authors, for his generous advice and assistance.

This guidebook also uses parts of "The Operational Draft HGM Guidebook for Wetlands on Precipitation Driven on Discontinuous Permafrost in Interior Alaska" and "The Slope/Flat Wetland Complexes in the Lower Kenai River Drainage Basin Using the HGM Approach Guidebook" for format. We thank the authors of these guidebooks for their work and assistance.

Disclaimer

This document is a Operational Draft Guidebook developed specifically to assist in the application of an HGM functional assessment model of riverine wetlands and slope river proximal wetlands in Coastal Southeast and Southcentral Alaska. It is intended to be used in its present form consistent with the *National Action Plan to Develop the Hydrogeomorphic Approach for Assessing Wetland Functions (Federal Register,* August 16, 1996 (Vol. 61, No. 160) at page 42603). The Operational Draft Guidebook will be used and reviewed for a two-year period by regulatory and resource agencies. Other organizations and other parties will have an opportunity to use the Operational Draft Guidebook during this two-year period and provide recommendations for improvement. After the Operational Draft Guidebook has been used in the field for two years it may be revised incorporating comments and corrections identified by the Guidebook Development Team. The revised Operational Draft Guidebook will be reviewed and approved by the COE/WES as a Final Guidebook.

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1. Introduction

Purpose of this guidebook

This guidebook is for government representatives and experts who manage wetlands. It provides information about applying the HGM approach to the functional assessment of riverine wetlands and slope river proximal wetlands, on low permeability deposits and bedrock in Coastal Southeastern and Southcentral Alaska. The guidebook is intended to provide a tool for a broad array of tasks related to project planning, design, implementation, and monitoring including:

- functional assessment models to determine impact assessment for both riverine wetlands and slope river proximal wetlands in Southeast and Southcentral Alaska,
- a wetland assessment tool for natural resource agencies for permitting, determining mitigation requirements, restoration design, development of monitoring protocols and contingency measures, wetland planning and classification, and teaching to better understand riverine and slope river proximal wetlands,
- a template from which additional riverine and slope subclass assessment models can be developed, and
- a platform for assimilating existing and future technical information and for the application of this information in rapid wetland functional assessments.

Chapters 1- 3 offer information about the HGM Approach and descriptive information concerning the hydrology, soil, vegetation, and habitat/faunal characteristics of riverine and slope river proximal wetlands in Coastal Southeast and Southcentral Alaska. With respect to the assessment of changes in functions in these wetlands, application of the HGM approach offered in this guidebook should be used in a manner that is consistent with HGM model logic and terminology and administrative procedures. Chapter 4 presents the HGM Models including functions and variables for the riverine and slope river proximal wetlands.

Appendix 1 is a copy of the Field Guide and Data Collection Procedures field book. The field book includes guidance on how to run HGM models and on how to develop a rapid HGM functional assessment report. The field book has been printed separately for use in the field without the larger guidebook. As part of the HGM rapid functional assessment report a numeric value for each of the wetland functions is necessary. These numeric values are referred to as Functional Capacity Indexes (FCIs). Appendix 2 provides a copy of the electronic spreadsheet that can be found at the ADEC website for calculating the FCI (www.state.ak.us/dec/dawq/nps/wetlands.htm#wet5). Appendix 3 provides an analysis and information about reference site data. Appendix 4 provides a copy of the State and Federal Interagency Memorandum of Understanding for developing and using HGM. Appendix 5 is a description of the process the development team followed to develop the guidebook, Appendix 6 is the Literature cited, and Appendix 7 is a Glossary.

The authors hope you find this guidebook to be a valuable tool in your effort to understand and manage wetlands and welcome any comments.

Alaskan Context

The State of Alaska includes 63% of the nation's wetland ecosystems (Hall et al. 1994). Activities in these wetlands and their associated waters (hereafter "wetlands") are regulated under federal, state, and local ordinances because these ecosystems have been shown to perform vital and valuable physical, chemical, and biological functions. As a consequence of these functions, Alaska's wetlands help to support the state's fish and wildlife populations, water resource quantity and quality, diverse human communities, and economy.

In addition to being valuable, Alaska's wetlands are highly variable. They include saltwater and freshwater areas influenced by tides, temperate rain forests, bogs, moist and wet tundra, slopes along the Southeastern and Southcentral coastlines, extensive rivers and streams, large river deltas, large and small complexes of lakes and ponds, and vast areas of black spruce forested wetland.

To ensure that Alaska's wetlands continue to be managed wisely, wetland professionals and policy makers need regionally based, scientifically valid, consistent, and efficient functional assessment tools. These assessment tools need to be developed in a manner that helps managers and users recognize and distinguish between naturally variable conditions and those changes in the functioning of Alaska's wetlands that result from human activities. In addition to detecting changes in wetland function, effective and properly structured assessment methods also include steps that ensure consistent technical and administrative approaches for completing assessments and documenting results. Such consistency provides the basis for scientific assessments that provide the technical input to ecosystem and watershed protection programs and restoration projects.

There are no widely accepted evaluation methods developed for Alaska's wetlands that accurately and consistently provide the means to evaluate changes in gains and losses of ecosystem functions. In response to this need, the Alaska Department of Environmental Conservation (ADEC) (with other cooperating state and federal agencies and organizations) initiated a broad-based, statewide effort to develop a Hydrogeomorphic (HGM) functional assessment for Alaska's wetlands. HGM was selected by ADEC and several other cooperating agencies and organizations because it offers a relatively rapid, efficient, and reference-based method of assessment that allows users to recognize human-induced changes in the functions of wetlands ecosystems (Brinson 1993, Brinson et al. 1995). The HGM method departs from other functional assessment approaches because it is based on: (1) recognition of differences among wetlands (i.e. classification), (2) identification of functions performed by classes and subclasses of wetlands, and (3) regionally developed reference systems (Brinson 1996, Brinson 1995).

Three groups of wetland experts and other assisting personnel collected information and field data and developed the assessment models and framework upon which this document was built (See Appendix 3). There were three previous drafts produced during 1997 – 2001. The first draft was developed in 1997 by the National Wetlands Training Cooperative (NWTC). During 1997 to 2001 the authors revised the first draft, incorporating a significant amount of additional fieldwork and data from testing the assessment models. Additional reference sites and field data were added to the database. A second draft was developed in 2001 incorporating the results of several additional sites and field tests. A field peer review was also conducted in 2001. Peer review comments and field-testing were incorporated into this document. A field training course on how to use the field guide (Appendix 1) was conducted in Juneau on June 25, 2003, and included nineteen local wetland managers and scientists. The field guide and models were run on one site and generated several small adjustments and editorial improvements that have been incorporated into this document.

HGM has proved to be a valuable tool in Alaska, even in this beginning stage of development. The teams that have worked on the guidebooks have all used the HGM concepts in other contexts and recently HGM has been considered for use in the first effort at wetlands mitigation banking in Southeast Alaska. With the aforementioned 63% of our nation's wetlands, Alaska should lead in wetland management. This guidebook takes a step toward that goal.

2. Overview of the Hydrogeomorphic Approach

There are three essential elements in the HGM approach to assessment of functions of wetlands. The first is classification of wetlands based on hydrogeomorphic factors. The second is identification, definition, and description of the functions for the subclass of wetlands under consideration. The third is development of a reference system that includes descriptive information about the subclass and the range of variation in structure and function observed within the subclass (Brinson 1993, Brinson 1995, Brinson 1996). Assessment protocol was added as a fourth element in this guidebook. Procedures for development of guidebooks that incorporate the essential elements of HGM and synthesize them into a standardized assessment approach for a particular subclass of wetlands have been outlined by the EPA and Corps (e.g., Brinson 1993, Smith et al.,1995, U. S. Army Corps of Engineers 1997). Each element of the HGM Approach is discussed below.

Hydrogeomorphic Classification

The first essential element of the HGM Approach is classification of a wetland. Classification is based upon a wetland's (1) position in the landscape or geomorphic setting, (2) dominant source of water, and (3) hydrodynamics (of the water in the wetland) (Brinson 1993). Seven hydrogeomorphic classes have been identified: riverine, depression, slope, mineral soil flats, organic soil flats, estuarine fringe, and lacustrine fringe. Each of these classes is defined in Table 2. These classes can be further divided into subclasses. For example, the depression class can be subdivided into perched, shallow surface, and subsurface flow-through depressions. The purpose of the HGM classification is to provide a mechanism to account for the natural variation inherent in wetlands. This variation is often attributable to the factors mentioned above, i.e. geomorphic setting, dominant water source, and hydrodynamics (Brinson 1993).

Table 1. Seven HGM Classes of Wetlands

Seven HGM Classes of Wetlands	
CLASSIFICATION	**DEFINITION**
Riverine	Riverine wetlands occur in floodplains and riparian corridors in association with stream channels. Dominant water sources are overbank flow from the channel or subsurface hydraulic connections between the stream channel and wetlands. Additional water sources may include groundwater discharge from surficial aquifers, overland flow from adjacent uplands and tributaries and precipitation. Riverine wetlands lose surface water by flow returning to the channel after flooding and saturation flow to the channel during precipitation events. They lose subsurface water by discharge to the channel, movement to deeper groundwater, and evapotranspiration. Examples: Bottomland Hardwood Floodplain wetlands in the Southeastern U.S.; Riparian wetlands in annually flood prone areas such as Riverine wetlands in Coastal Southeast and Southcentral Alaska.

Seven HGM Classes of Wetlands	
CLASSIFICATION	**DEFINITION**
Depressional	Depressional wetlands occur in topographic depressions on a variety of geomorphic surfaces. Dominant water sources are precipitation, groundwater discharge, and surface flow and interflow from adjacent uplands. The direction of flow is normally from surrounding non-wetland areas toward the center of the depression. Elevation contours are closed, allowing for the accumulation of surface water. Depressional wetlands may have any combination of inlets and outlets or lack them completely. Dominant hydrodynamics are vertical fluctuations, primarily seasonal. Depressional wetlands lose water through intermittent or perennial drainage from an outlet, evapotranspiration, or contribution to groundwater. Examples: Prairie Potholes; Vernal Pools in the California Central Valley; Depressions on valley alluvium in the Pacific Northwest.
Slope	Slope wetlands normally occur where there is a discharge of groundwater to the land surface. They usually exist on sloping land surfaces - from steep hillslopes to nearly level terrain. Slope wetlands are usually incapable of depressional storage. Principal water sources are groundwater return flow and interflow from surrounding non-wetlands as well as precipitation. Hydrodynamics are dominated by downslope unidirectional flow. Slope wetlands can occur in nearly level landscapes if groundwater discharge is a dominant source to the waters/wetland surface. Slope wetlands lose water by saturation subsurface and surface flows and by evapotranspiration. Channels may develop but serve only to convey water away from the waters/wetland. Examples: Swales in the California Central Valley; Forested wetlands on toe slopes adjacent to, but above floodprone areas of western streams.
Mineral Soil Flats	Mineral soil flats are most common on interfluves, extensive relic lake bottoms, or large floodplain terraces where the main source of water is precipitation. They receive virtually no groundwater discharge, which distinguishes them from depressions and slopes. Dominant hydrodynamics are vertical fluctuations. They lose water by evapotranspiration, saturation overland flow, and seepage to underlying groundwater. They are distinguished from flat upland areas by their poor vertical drainage and low lateral drainage. Example: Pine flatwoods of the Southeastern U.S.
Organic Soil Flats	Organic soil flats, or extensive peatlands, differ from mineral soil flats, in part, because their elevation and topography are controlled by vertical accretion of organic matter. They occur commonly on flat interfluves, but may also be located where depressions have become filled with peat to form a relatively large flat surface. Organic flats often expand beyond the areas where they started to form (usually depressions) to adjacent areas that were non-wetland or mineral soil flats. Water source is dominated by precipitation, while water loss is by saturation overland flow and seepage to underlying ground water. Raised bogs share many of these characteristics, but may be considered a separate class because of their convex upward form and distinct edaphic conditions for plants. Example: Precipitation driven wetlands on discontinuous permafrost in Interior Alaska, Pocosin wetlands in eastern North Carolina; portions of the Everglades.

Seven HGM Classes of Wetlands	
CLASSIFICATION	**DEFINITION**
Tidal Fringe	Tidal fringe wetlands occur along coasts and estuaries and are under the influence of sea level. They usually intergrade landward with riverine or slope wetlands where tidal currents diminish and other sources of water (e.g., river flow, groundwater discharge) dominate. Tidal fringe wetlands seldom dry for significant periods. They lose water by tidal exchange, by saturation overland flow to tidal creek channels, and by evapotranspiration. Organic matter normally accumulates in higher elevation marsh areas where flooding is less frequent and they are isolated from shoreline wave erosion by intervening areas of low marsh. Examples: *Spartina alterniflora* (Salt Marshes).
Lacustrine Fringe	Lacustrine fringe wetlands occur adjacent to lakes where the water elevation of a lake maintains the water table in the water/wetland. In some cases, they consist of a floating mat attached to land. Additional sources of water are precipitation and groundwater discharge. Surface flows bi-directionally, usually controlled by water level fluctuations such as seiches in a adjoining lake. Lacustrine fringe wetlands are indistinguishable from depressional wetlands where the size of a lake becomes so small relative to fringe wetlands that the lake is incapable of stabilizing water tables. Lacustrine wetlands lose water by flow returning to a lake after flooding, by saturation surface flow, and by evapotranspiration. Organic matter normally accumulates in areas sufficiently protected from shoreline wave erosion. Example: Great Lakes Marshes.

Identification, Definition, and Description of Functions

The second element of the HGM approach is identification, definition, and description of the functions of the wetlands of concern. Wetland "functions" are defined as "processes that are necessary for the maintenance of an ecosystem." These processes include primary production, nutrient cycling, and decomposition (Brinson 1993). In the context of HGM, the term "functions" is used as a means to distinguish ecosystem functions from values. The term "values" is associated with society's perception of ecosystem functions. Ecosystems perform functions regardless of whether or not they have value. Generally, HGM Guidebooks group functions according to logical sets such as (1) hydrologic, (2) biogeochemical, (3) plant community, and (4) habitat.

Reference Systems

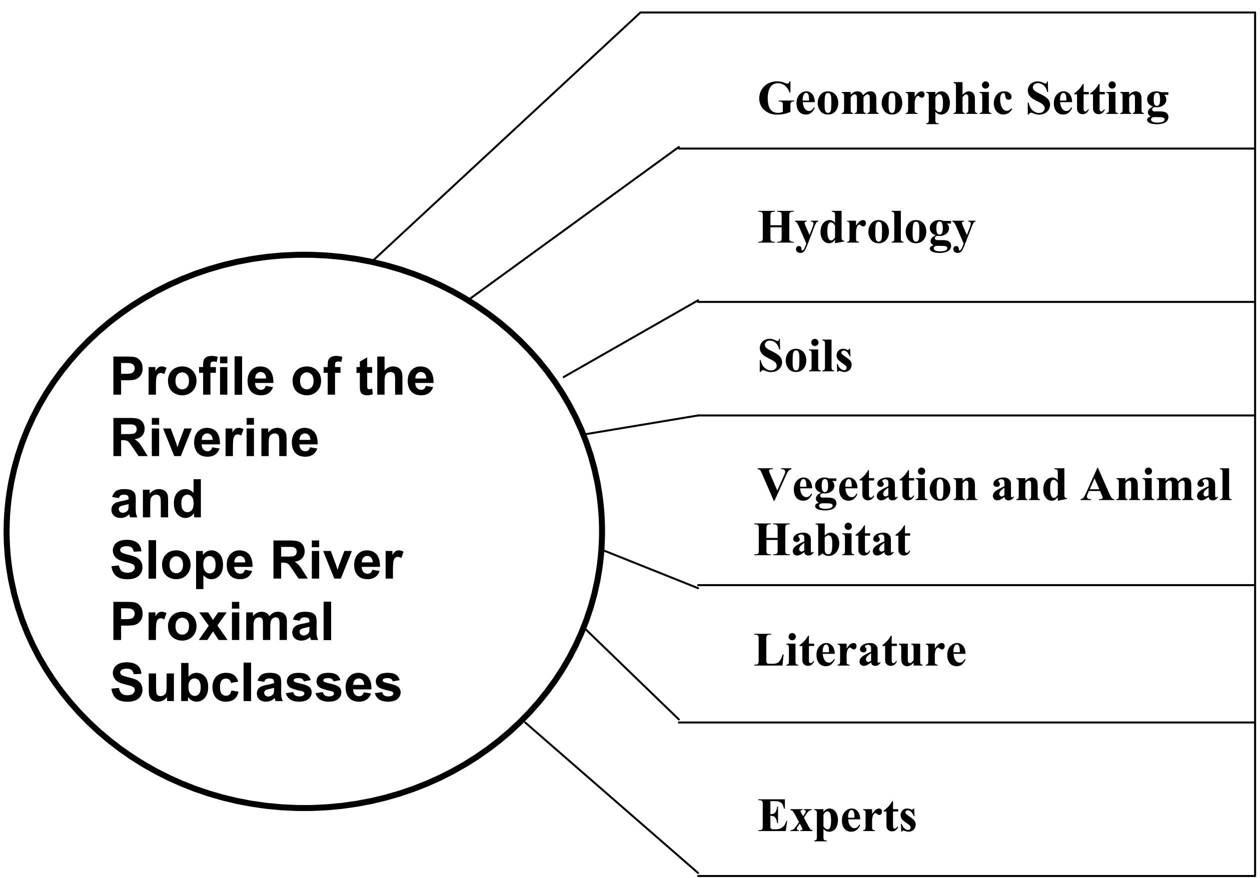
The third element of the HGM approach is the establishment and use of a reference system. The structure of an HGM reference system is shown in Figure 1. To apply the use of reference systems in the context of HGM, it is important to understand the standard definitions presented in Table 2.

Table 2. Reference Wetland Terms and Definitions

Reference Wetland Terms and Definitions	
TERM	**DEFINITION**
Reference Domain	All wetlands within a defined geographic region that belong to a single hydrogeomorphic subclass.

Reference Wetland Terms and Definitions	
TERM	**DEFINITION**
Non-Standard Reference Sites	Sites within the reference domain that encompass the known variation of the regional subclass. Reference sites are used to establish the ranges of functions within the regional subclass, including functional changes resulting from site alteration (human-induced perturbation).
Standard Reference Sites	The sites within a reference wetland data set from which reference standards are developed. Among all reference wetlands, reference standard sites are judged by an interdisciplinary team to have the highest level of functioning.
Reference Standards	Conditions exhibited by a group of reference sites that correspond to the highest level of functioning (highest sustainable capacity) across the suite of functions of the subclass.
Project Assessment Area	The area that encompasses all activities related to an ongoing or proposed project
HGM Assessment Area	The wetland area, or portion of the wetland, which will be assessed with HGM models. There has to be at least one assessment area per assessment.

Figure 1. HGM Reference System Structure



Reference System Development

The subclass profile is the highest organizational element of the HGM Reference System (Figure 1). Typically HGM users will use reference systems (1) to apply HGM models and thus detect changes in ecosystem functioning, (2) as design templates, and (3) to set monitoring targets and to specify contingency measures (Figure 2). The principle of reference in the context of HGM is useful because everyone uses the same standard of comparison, and relative rather than absolute measures allow efficiency in time and consistency in measurements.

Standards and details concerning development of HGM reference systems are given in the National Reference Guidebook (Whigham et al. in prep.) Basically, to develop an HGM reference system, an interdisciplinary team (or “Development Team") visits reference sites in a range of conditions (i.e., relatively pristine to highly degraded) in the same hydrogeomorphic subclass. At each site, the Development Team collects data on physical, hydrologic, biogeochemical, plant community, and faunal support/habitat community attributes. When synthesized and interpreted, and combined with the best scientific judgment of the interdisciplinary team, these data help to indicate the range of ecosystem conditions, functions, and responses to human and natural disturbance (Whigham et al. in prep.).

In addition to developing a subclass profile, the Development Team uses best scientific judgment to determine whether each site is a “reference standard site.” Reference standard sites are those that are determined by the Development Team to be functioning at the highest level (i.e., highest sustainable capacity) across the suite of functions exhibited within the subclass. “Reference standards” are articulated from the data collected at the reference standard sites. Reference standards are the conditions exhibited by the reference standard sites that correspond to the highest level of functioning. In the HGM approach, reference standards are used to construct functional profiles of the wetlands subclass, and to set the standards that allow development of HGM models.

Ideally, all of the wetlands within a defined geographic region that belong to a single hydrogeomorphic subclass constitute the “reference domain.” Again, reference sites are selected to encompass the known range of variation within the potential reference domain. It is important to note that practical limitations of funding, personnel, and access do not usually allow sampling of all wetlands within a region. Therefore, the reference domain is often envisioned as both the actual wetlands sampled to build the reference system, and the geographic area within which reference sites for a regional wetlands subclass have been sampled. Where sampling of additional reference sites could reasonably be used to expand the (sampled) reference domain (e.g., within an ecoregion), one can infer a “potential reference domain.” The potential reference domain thus constitutes the sampled reference domain plus the pool from which additional reference sites might be selected to expand the sampled reference domain.

In summary, these reference standards and domains are the framework for HGM.

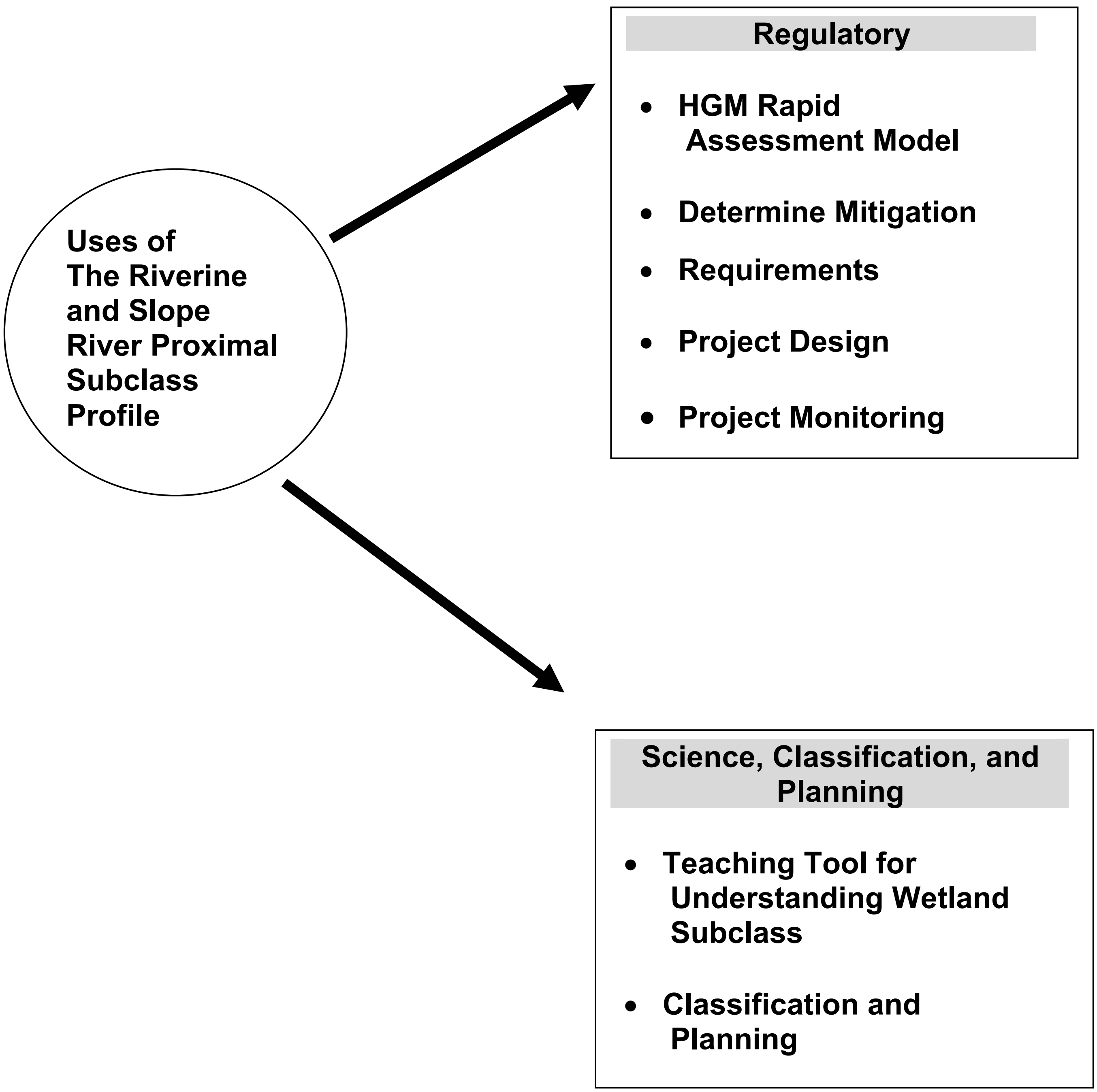


Figure 2. Use of the HGM Subclass Profile (Modified from the National Wetlands Science Training Cooperative 1996)

Assessment Models and Functional Indexes

Identification of functions within a wetland subclass is followed by development of assessment models and estimates of the capacities of the wetlands within a subclass to perform those functions. These are functional capacity indexes (Smith et al. 1995, see Chapter 4). An HGM model for a particular function is usually expressed as a simple formula that combines variables in certain ways to yield an estimate of a "functional capacity index," or FCI. The relationships among variables that are combined to develop an FCI have been established based on analyses of reference system data developed for the subclass (Figure 3). By definition, reference standard sites yield FCIs of 1.0, and FCI values range from 1.0 to 0.0. Therefore, highly degraded wetlands may yield FCIs of 0.0 (i.e., unrecoverable loss of function). Thus, an FCI is an estimate of the function performed by a water/wetland with respect to reference standard conditions.

It has long been recognized that some wetlands perform certain functions better than others, not because they are impacted in some way, but because wetlands are inherently different (Brinson 1993). For example, bottomland hardwood forests of the Southeastern United States support breeding habitat for neotropical migrant birds more intensively than forested wetlands on steep slopes throughout Southeast Alaska. These two extremes in breeding habitat differ greatly so most comparisons between them become meaningless. The same logic applies to comparison of functions across classes, (e.g., between riverine and depressional wetlands). To avoid assessment of functions that are inappropriate for a particular class of wetland, functions are described differently for each of the seven classes of wetlands defined in Table 1. Even with the significant overlap in functions between wetland classes, these functions are likely to be performed at different levels or intensities. Furthermore, the field indicators and variables used to assess each function differ sufficiently to require separate treatment.

To develop assessment models for functions associated with a regional wetland subclass, “variables” must be identified, defined, and scaled using data from the reference system. Variables are the attributes or characteristics of the wetland ecosystem or the surrounding landscape that influence the capacity of a wetland to perform a function or a set of functions. For example, in the Coastal Southeast and Southcentral regions of Alaska, the amount of shade and stream channel roughness affect the habitat function termed "Maintenance of In-Channel Aquatic Biota." At each Project Assessment Area, a variable may be operating or expressed to a greater or lesser degree, depending on land uses, degree of disturbance, etc. Hence, variables relate directly to the degree of human disturbance on a particular site. In the field, variables are either measured directly (e.g., tree stem density) or indirectly through the use of field indicators. Field indicators are observable characteristics of the wetland that correspond to identifiable variable conditions in the water/wetland or in the surrounding landscape (e.g., microtopographic roughness = number of pits >50 cm diameter capable of storing ponded water).

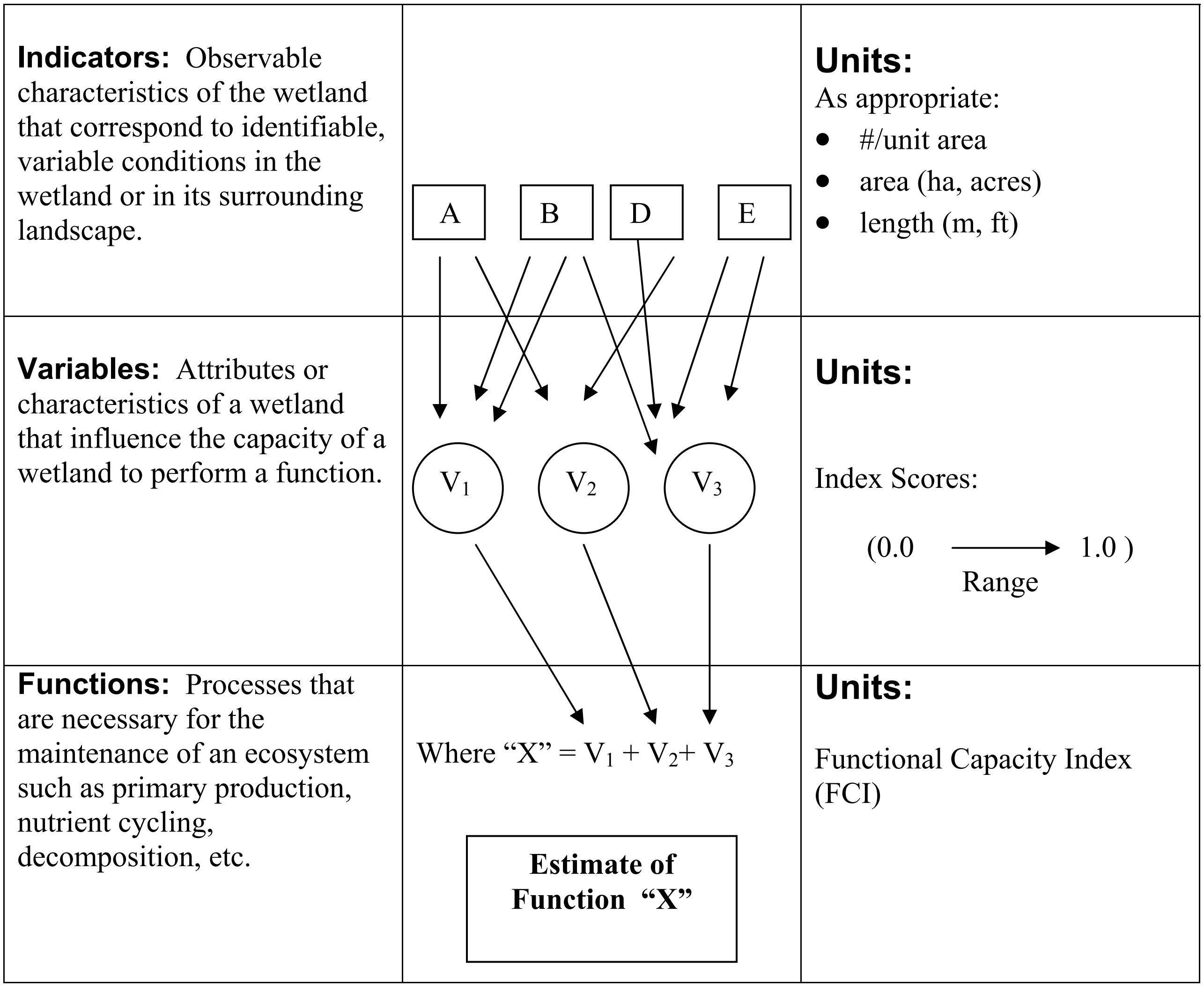


Figure 3. Structure of an HGM Model (Modified from the NWSTC 1996)

Assessment Model Protocol. According to the U.S. Army Corps of Engineers (COE) guidelines for developing HGM models, an assessment protocol for users of the HGM models must be included in a guidebook. In fact, an assessment protocol is the fourth essential element of the HGM approach. The assessment protocol establishes criteria for the background information necessary to perform a rapid functional assessment, and provides instructions for measurement of variables in the field and subsequent calculations of Functional Capacity Indexes (FCIs). Use of an assessment protocol sets minimum requirements for valid use of wetland models and thus helps ensure their unbiased, consistent application. More details on the assessment protocol developed in this guidebook are presented in the "Assessment Protocol" in the field book (Appendix 1). Critical to the development of an assessment protocol is local support and policy concurrence. Memorandums of Understanding are very useful (Appendix 5). Also, any protocol must be consistent with national guidance (Appendix 4).

Local Support and Policy Concurrence. Before ADEC agreed to oversee the development of this guidebook, the support of managers at the local, state, and federal level were obtained. A series of meetings were held with policy makers, including several meetings with key federal, state, and local agency officials. We also met with private sector representatives and Native organizations.

Interagency Memorandum of Understanding. Cooperation among state and federal agencies with jurisdiction over wetlands is necessary for developing the HGM Approach and HGM Guidebooks. Recognizing the need for cooperation, ADEC developed an interagency Memorandum of Understanding (MOU), with support from eleven state and federal agencies (ADEC, ADNR, ADF&G, FWS, NRCS, ADT&PF, COE, FHWA, EPA, USGS, and USFS) and a letter of support from the National Marine Fisheries Services (NMFS) within the National Oceanic and Atmospheric Administration (NOAA). The MOU supports and guides the development of HGM in Alaska (Appendix 5). The HGM interagency MOU sets forth three classes of interagency/stakeholder teams to establish and develop the HGM approach and guidebooks in Alaska, which are the

- HGM Management Team,
- HGM Statewide Technical Oversight Team, and
- HGM Guidebook Development Teams.

The MOU also outlines data and information management, and how the guidebooks will be used.

Consistency with National Guidance. The authors of this guidebook developed the document over a period of time when national guidance on HGM was being articulated and refined by the "National Hydrogeomorphic Implementation Team" (NHIT). The NHIT group consists of representatives from the COE, EPA, FWS, NRCS, FHA, and NMFS (Federal Register: August 16, 1996 (Vol. 61, No. 160, pp. 42593-42603), Federal Register: June 20, 1997 (Vol. 62, No. 119, pp. 33607-33620)). At the time this was written, NHIT guidance on the development and implementation of HGM continued to be in flux. Thus, the sequence and timing of some tasks completed while developing this guidebook differ from those outlined in current versions of national guidance that can be found in Appendix 4.

3. Characterization of the Riverine and Slope River Proximal Wetlands in Coastal Southeast and Southcentral Alaska

This chapter describes the area where this guide book can be used and the major characteristics of the Riverine and Slope River Proximal Wetland Subclasses. Outlined below are the topics contained in this chapter:

1. **Area of Applicability – Coastal Western Hemlock-Sitka Spruce Forest Ecosystem**
2. **Reference Domain for the Riverine and Slope River Proximal Subclasses**
3. **Summary of Dominant Features of Riverine and Slope River Proximal Wetlands**
4. **Description of Riverine and Slope River Proximal Subclasses**

a. Landscape Position

Riverine Wetland Subclass

Major Stream Classifications
Stream Structure and Function

Slope River Proximal Wetland Subclass

b. Characterization of Riverine and Slope River Proximal Wetlands

Hydrology

Soils

Vegetation

Fish and Wildlife

Area of Applicability – Coastal Western Hemlock-Sitka Spruce Forest Ecosystem

The ecological functions and characteristics of the Riverine and Slope River Proximal wetlands subclasses contained in this guidebook are based on information and data collected from five study areas within the Coastal Western Hemlock-Sitka Spruce Forest Ecosystem (Gallant, et al, 1995). The study areas (Juneau, Ketchikan, Sitka, Hoonah, and Port Graham and Nanwalik) are located throughout Southeast Alaska and at the northern end of the reference domain (Figure 5).

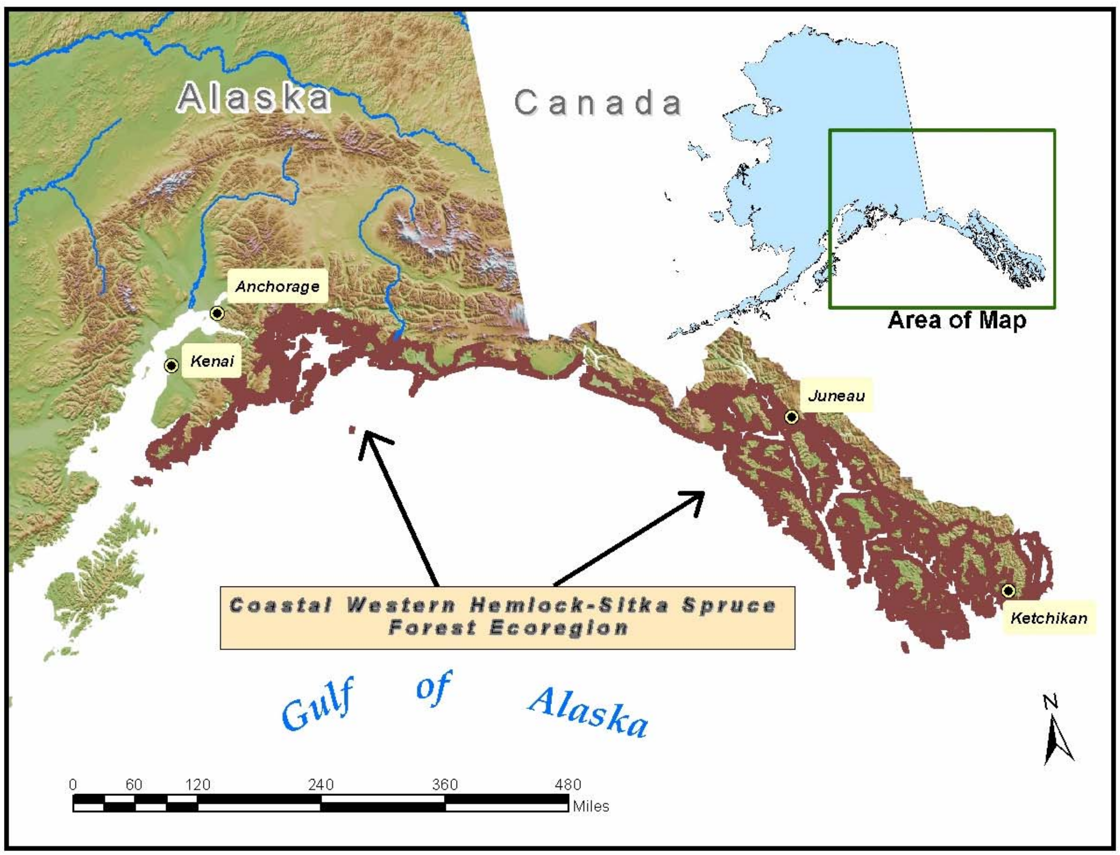


Figure 4. Area of Applicability - Coastal Western Hemlock-Sitka Spruce Forest Ecosystem

Reference Domain for the Riverine and Slope River Proximal Subclasses

The HGM functional assessment methodology separates wetlands into different geomorphic classes based upon (1) their geomorphic setting, (2) water sources, and (3) hydrodynamics (Brinson 1993). In past HGM efforts, guidebooks have covered only a single geomorphic class. In contrast, this guidebook contains functional assessment models for both riverine wetlands and slope river proximal wetlands in Coastal Southeast and Southcentral Alaska. The rationale for inclusion of two geomorphic classes within one guidebook is as follows:

- riverine wetlands and slope river proximal wetlands in Coastal Southeast and Southcentral Alaska are highly integrated components of the landscape,
- riverine wetlands represent a small percentage of the Coastal Southeast and Southcentral Alaskan landscape (preliminary calculations indicate <1%) compared to the extent of slope wetlands. Thus, a model solely for riverine wetlands has limited applicability, and
- due to recent trends in development/project proposals in Coastal Southeast and Southcentral Alaska, the end-users of the functional assessment models (i.e., the regulatory community, consultants, etc.) require a methodology that can assess wetland functions in both geomorphic classes on a project site.

Despite the inclusion of assessment models for two different geomorphic classes in a single guidebook, the models are linked together (although represented as mutually exclusive). Each model is written for a particular geomorphic class that is found in a specific portion of the Coastal Southeast and Southcentral Alaska landscape. The functional assessment methodology provided in this guidebook will not work if the models are used in the incorrect landscape position (e.g., utilization of the riverine wetlands model for functional assessment in slope wetlands). As a result, proper field identification of geomorphic classes and bounding of those geomorphic classes in relation to the Project Assessment Area are essential.

Established Reference Domain

According to HGM assessment methodology, the reference domain by definition is “all wetlands within a defined geographic region that belong to a single hydrogeomorphic subclass” (Brinson 1993). Reference wetlands encompass the known variation of the subclass and are used to establish the ranges of functions for that subclass. The reference domain as established in this guidebook includes the area between Dixon Entrance, Alaska, north to the southern coastal areas of the Kenai Peninsula. The eastern extent is delineated by the coastal mountain range divide and the western extent is delineated by the down-gradient extent of riverine wetlands and/or slope wetlands where they intergrade with estuarine fringe wetlands (Figure 1). The reference domain uses the area described as the Coastal Western Hemlock-Sitka Spruce Forest Ecosystem (Gallant, et al. 1996). The riverine and slope models in this guidebook provide a template and should not require major modifications if utilized within the reference domain as described above.

Potential Reference Domain

Based upon the best professional judgment of the Development Team, the potential reference domain for the wetlands subclasses could extend from the vicinity of Kodiak Island in the north for both riverine and slope classes to southern Oregon (South) for the riverine class and to southern Puget Sound (Olympia, Washington) for the slope subclass. The eastern and western boundaries will likely remain the same as they are for the established reference domain described above. Collection of additional reference data outside of the reference domain established in this guidebook is necessary in order to verify the ultimate extent of the reference domain.

Table 3. Reference Domain and Geomorphic Class Terms

Geomorphic Class	Riverine Wetlands and Slope Wetlands.
Geomorphic Subclass	Riverine Wetlands and River Proximal Slope Wetlands on Low Permeability Deposits and Bedrock.
Established Reference Domain	Southeast Alaska from Ketchikan (South) to the Southern Coastal areas of the Kenai Peninsula, to the coastal mountain range divide (East) to the down-gradient integrate with estuarine fringe wetlands (West).
Potential Reference Domain	Riverine Subclass: Coastal Southeast and Southcentral Alaska from the vicinity of Kodiak Island (North) to the vicinity of Roseburg, Oregon (South), to the Coastal Mountain Range divide (East) to the down-gradient integrate with estuarine fringe wetlands (West). Slope River Proximal Subclass: Same as riverine class except that the southern extent of the reference domain is somewhat more limited - the vicinity of Southern Puget Sound/Olympia, Washington.

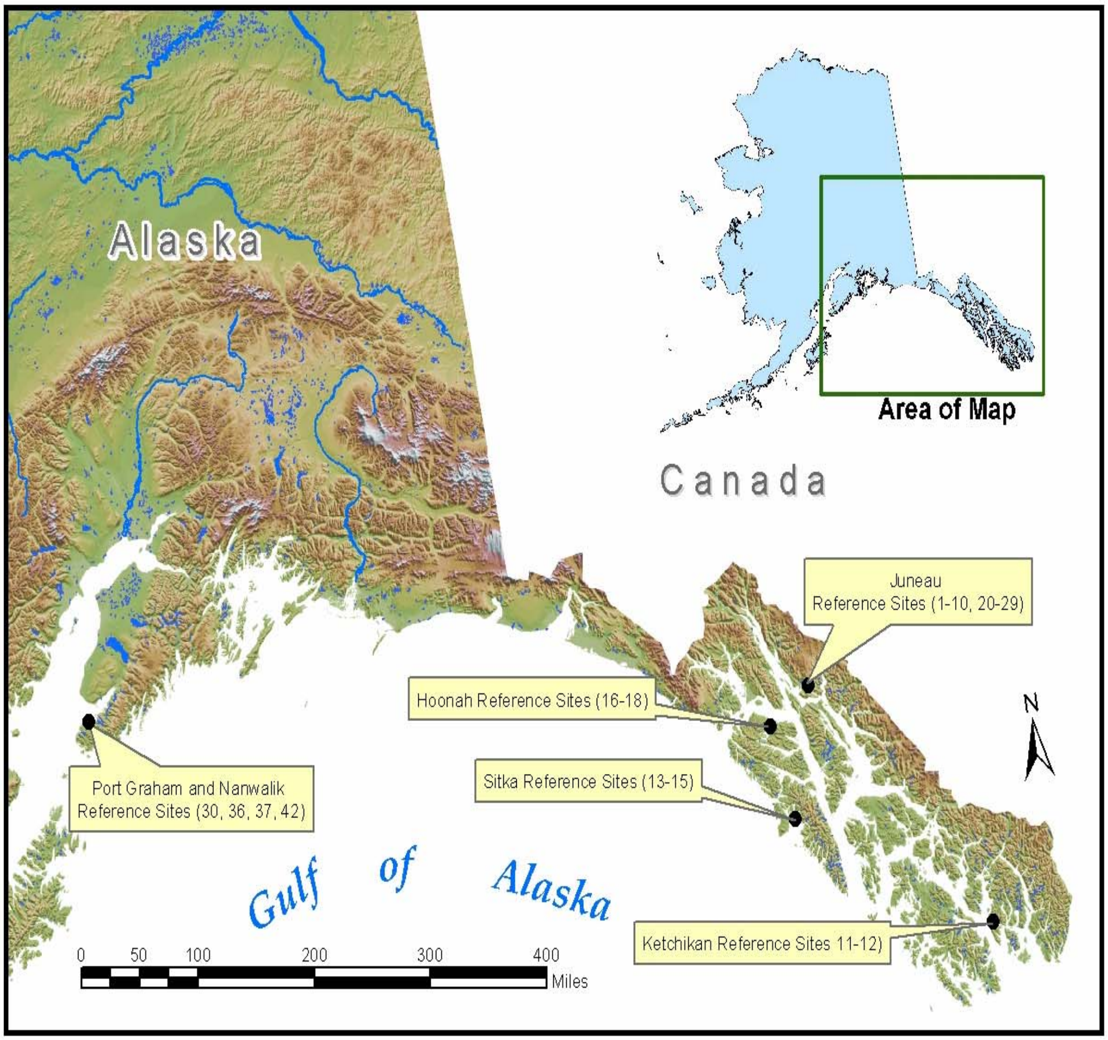


Figure 5. Reference Domain Study Areas

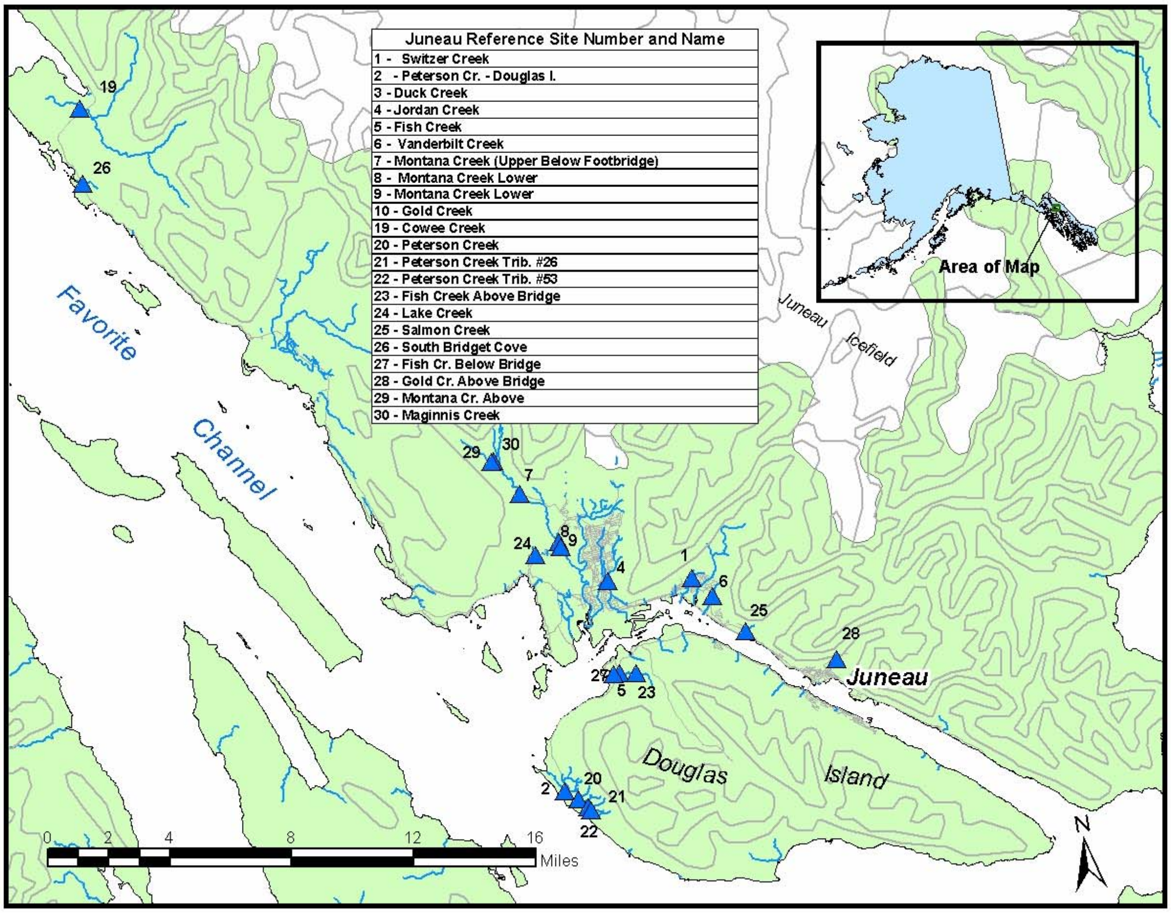


Figure 6. Juneau Area Reference Sample Sites

Summary of Dominant Features of Riverine and Slope River Proximal Wetlands

This guidebook covers Riverine and Slope HGM wetland classes. Slope wetlands adjacent to riverine wetlands are highly integrated components of the landscape in Southeast and Southcentral Alaska. Therefore, both riverine and slope river proximal wetlands are included in this guidebook. Riverine wetlands normally occur in floodplains and riparian corridors in association with stream channels. Overbank flow from the channel or subsurface hydraulic connections between the stream channel and the wetland are the dominant water sources. Precipitation, overland flow from adjacent uplands, and tributaries are significant contributors to the hydrology of slope wetlands in coastal Southeast and Southcentral Alaska. Slope wetlands are normally found where abrupt decreases in slope angles cause these water sources to discharge groundwater toward the land surface.

Table 4. Dominant Features of Riverine and Slope River Proximal wetlands in Coastal Southeast and Southcentral Alaska.

CHARACTERISTIC	RIVERINE	SLOPE RIVER PROXIMAL
Location	Active River Channel	Located within 200 feet of the bankfull of a river channel.
Hydrologic Source	Unidirectional flow, higher order streams, derived from non-glacial water sources.	Ground or surface water flow.
Vegetation	Any vegetation life form (e.g., trees, shrubs, herbaceous, etc.) that are not in a marine, or estuarine system or directly influenced (i.e., actively flooded) by those systems.	Any vegetation life form (e.g., trees, shrubs, herbaceous, etc.) that are not in a marine, or estuarine system or directly influenced (i.e., actively flooded) by those systems.
Landforms	Occur in valley bottoms, flow predominantly on bedrock, glacial till or glacial marine deposits, Low elevation stream reaches may flow on Pleistocene or Holocene alluvial gravel deposits, or deltaic estuarine deposits raised in elevation by tectonic lift.	Occurs adjacent to streams and valley sides. Occurs in valley bottoms, flow predominantly on bedrock, glacial till or glacial marine deposits, low elevation stream reaches may flow on Pleistocene or Holocene alluvial gravel deposits, or deltaic estuarine deposits raised in elevation by tectonic lift. **Note**: wetlands in closed depressions are out of the subclass.
Slope	0.01 % to ≤ 2.50 % (Average Water Surface)	0.1 % to ≤ 25 % (Horizontal Land Surface)
Parent Materials	<u>Upper reaches</u>: exposed bedrock, glacial till, and colluvium over bedrock, alluvial sand, and gravel. <u>Lower reaches</u>: dense basal till, marine lucustrine, and glacial fluvial sediments, and alluvial sand and gravel.	<u>Upper reaches</u>: exposed bedrock, thin till and colluvium over bedrock. <u>Lower reaches</u>: dense basal till deposited by flowing glacial ice, outwash, and gravel.
Soils	Sand, silt, and gravel deposits with occasional surface organic matter accumulation.	Sand, silt, and gravel deposits with occasional surface organic matter accumulation.

The following table is a dichotomous key for determining if this guidebook can be used for assessing a particular wetland.

Table 5. Key to Riverine and Slope River Proximal Wetlands in Coastal SE & SC Alaska

1a.	The assessment area is not a jurisdictional wetland according to the Corps of Engineers Wetland Delineation Manual (U.S. Army Corps of Engineers 1987). For example, (1) the area is a deepwater aquatic habitat. Deepwater aquatic habitats are areas that are permanently inundated at mean annual water depths > 6.6 ft or permanently inundated areas ≤ 6.6 ft that do not support rooted-emergent or woody plant species: **Non-wetland: Guidebook not applicable.**
1b.	The assessment area is a jurisdictional wetland according to the Corps of Engineers Wetland Delineation Manual: **2**
2a.	The wetland is tidally influenced, glacially driven water source, in a closed depression (e.g., pothole on glacial moraine), or is adjacent to a lake where the water elevation of the lake maintains the water table in the wetland: **Guidebook not applicable.**
2b.	The wetland is a river or within 200 feet adjacent to a river : **go to 3**
3a.	The slope of the land or water surface exceeds 25%: **Guidebook not applicable.**
3b.	The slope of the land or water surface ≤ 25%: **go to 4**
4a.	The wetland is located in valley bottoms, within 200 feet of the bank-full of a river channel, and ground or surface waterflow driven. **YES. Use the Slope River Proximal Subclass in this guidebook.**
4b.	The wetland is in an active river channel, a higher order stream reach derived from non-glacial water sources, occurring on valley bottoms, and corresponds with Rosgen Stream types "B" or "C" and USFS Tongass National Forest Channel Types 1) Moderate Gradient Mixed Control, 2) Moderate Gradient Contained, or 3) Flood Plain process groups. **YES. Use the Riverine Subclass in this guidebook.**

Description of the Riverine and Slope River Proximal Subclasses

Landscape Position

Coastal Southeast and Southcentral Alaska riverine wetlands are set within a landscape of extensive forests on slopes and peatland. At the lower end of the slope wetlands are riverine wetlands associated with first, second, and third-order streams. These streams flow predominantly on bedrock, glacial till, or glacial marine deposits, such as the Gastineau Formation (Miller 1975), that have very low hydraulic conductivity. Low elevation stream reaches may flow on Pleistocene or Holocene alluvial gravel deposits, or deltaic estuarine deposits raised in elevation by tectonic lift. Peak streamflows are driven by rainfall and rain-on-snow events and not glacial meltwater. Baseflow is driven by discharge of shallow groundwater (interflow) from slope wetlands and from deep groundwater discharge from bedrock or surficial aquifers. The proportion of shallow and deep groundwater discharge is unknown, but observations indicate that shallow groundwater discharge from slope wetlands may be a significant proportion of stream base flow.

Riverine wetlands in Coastal Southeast and Southcentral Alaska often occur where channels flow through extensive forested slope wetlands, including peatlands (Photo 1). Surface water flow, shallow groundwater flow, and precipitation pass through the slope wetlands prior to discharge into riverine wetlands. Slope river proximal wetlands retain some interflow subsequently lost through evapotranspiration. Retained water is also modified by biogeochemical processes as it passes through the surface layer of the river proximal slope wetlands. This water, in turn, influences stream water chemistry of riverine wetlands and is critical to maintaining fisheries.

The downstream extent of riverine wetlands is the point at which they intergrade with riverine and tidal influenced rivers and estuarine wetlands (Cowardin 1992). According to the hydrogeomorphic classification, the riverine class is dominated by unidirectional flows, while estuarine fringe wetlands are dominated by bidirectional flows (Brinson 1993). The transition between unidirectional and bidirectional flow is often a gradual one requiring field operational definitions to consistently delineate where on the landscape wetland classes begin and end.

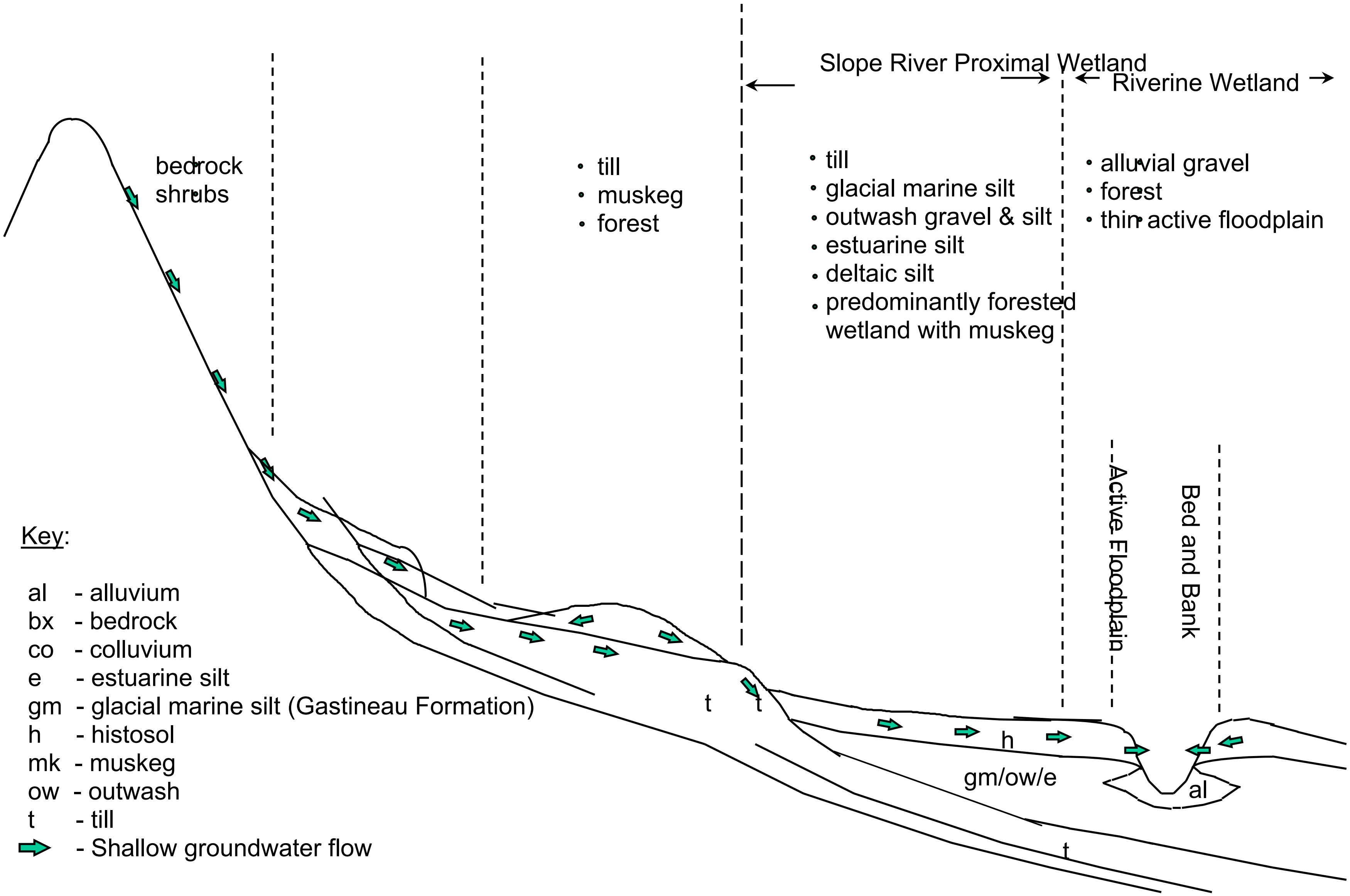


Figure 7. Idealized Cross-Section Showing the Typical Relationship Between Riverine and Slope River Proximal Wetlands.

Riverine Wetlands

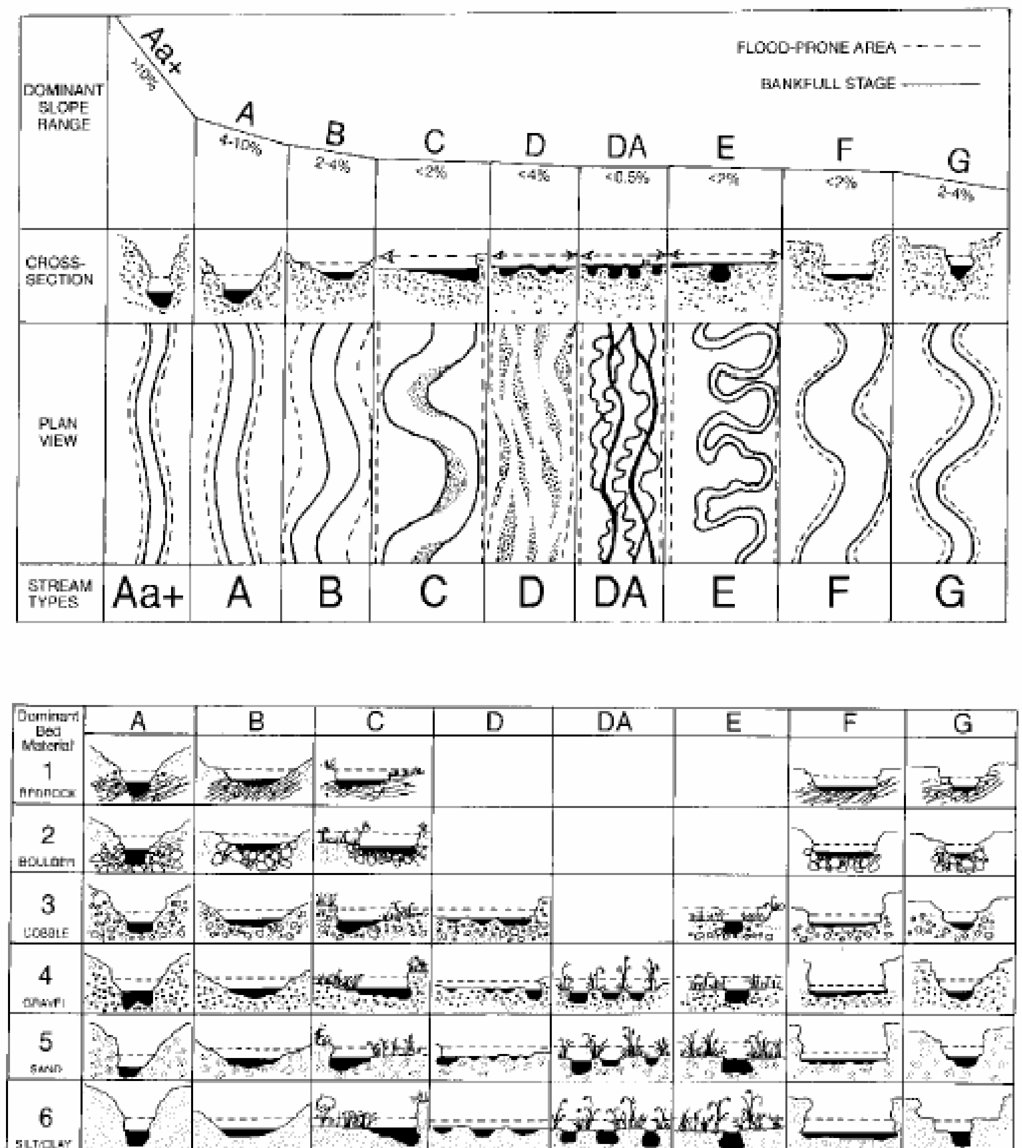
Riverine wetlands of Coastal Southeast and Southcentral Alaska occur in valleys with steep slopes. Valleys occur where regional faults created weaknesses in bedrock eroded by pre-glacial streams and glacial erosion. Glacial erosion has been extreme in the region, creating deep, steeply-sided, U-shaped valleys. The upper surfaces of these valleys consist of exposed bedrock, thin till, and colluvium over bedrock. The lower slopes are covered with a dense basal till deposited by flowing glacial ice. The till may be overlain by occasional deposits of outwash, sand and gravel of various ages, and deposits associated with glacio-marine environments (e.g., the Gastineau Formation, deltaic silts and gravels, and alluvium) (Miller 1975), uplifted by isostatic and eustatic processes. Slope wetlands and uplands occur on the valley sides and benches while riverine wetlands occur in valley bottoms. In Southeast Alaska the extent of riverine wetlands is small, <1% of the total landscape, due to the frequently incised streams and distinct lack of alluvial floodplains in the subclass.

Major Stream Classifications

The Riverine wetland subclass in this guide book can be cross-referenced to the Rosgen Stream Classification “B” and “C” Stream Types and the U.S. Forest Service, Tongass National Forest Southest Alaska Channel Types (Process Groups) 1) Moderate Gradient Mixed Control, 2) Moderate Gradient Contained, and 3) Flood Plain (Figures 8 and 9). The descriptive information associated with these stream classifications may be useful for those familiar with these stream classifications systems when using the rapid assessment report for the riverine wetlands subclass in this guidebook. On the next page is a chart showing the major features of the Rosgen’s Stream Classification.

Figure 8. Rogen's Stream Classification.

Longitudinal, cross-sectional and plan views of major stream types (top); Cross-sectional shape, bed-material size, and morphometric delineative criteria of the 41 major stream types (bottom). (redrawn from Rosgen (1994), by permission of Elsevier Science B.V)



	A	B	C	D	DA	E	F	G
ENTRH.	<1.4	1.4-2.2	>2.2	N/A	>2.2	>2.2	<1.4	<1.4
SIN.	<1.2	>1.2	>1.4	<1.1	1.1-1.6	>1.5	>1.4	>1.2
W/D	<12	>12	>12	>40	<40	<12	<12	<12
SLOPE	.04-.099	.02-.039	<.02	<.04	<.005	<.02	<.02	.02-.039

Figure 9. Stream Classification Cross Reference

Rosgen Classification (Stream Type & General Description)	
Aa+	Very Steep, deeply
A	Steep entrenched, cascading , step/pool streams. High energy/debris transport associated with depositional soils, Very stable if bedrock or bolder dominated channel.
B	Moderately entrenched, moderate gradient, riffle dominated channel, with infrequently spaced pools, Very stable plan and profile, Stable banks.
C	Low gradient, meandering, point-bar, riffle/pool, alluvial channels w/broad, well defined floodplains.
D	Breaded channel w/longitudinal & Transverse bars. Very wide channel w / eroding banks.
DA	Anastomosign (multiple channels) narrow & deep w / extensive, well vegetated floodplains & associated wetlands. Very gentle relief w / highly variable sinuosities & width/depth ratios. Very stable banks.
E	Low gradient, meandering riffle/pool stream w / low width ratio & little deposition. Very efficient and stable. High meander width ratio.
F	Entrenched meandering riffle / pool channel on low gradients w / high width / depth ratio.
G	Entrenched "gully" step/pool & low width / depth ratio on moderate gradients.

HGM Riverine Wetland Subclass for Coastal Southeast and Southcentral Alaska

- Higher order Stream,
- Non glacial water sources
- Occur in valley bottoms
- Flow predominantly on bedrock, glacial till or glacial moraine deposits
- Low elevation stream reaches may flow on alluvial gravel deposits, or deltaic estuarine deposits.

US Forest Service, Tongass National Forest Southeast Alaska Channel Types (Process Groups)
• High Gradient Contained
• **Moderate Gradient Mixed Control**
• **Moderate Gradient Contained**
• **Flood Plain**
• Large Contained
• Alluvial Fan
• Glacial outwash
• Palustrine

Stream Structure and Function

Riverine wetland structure and functions are the result of valley morphology and riverine or fluvial processes. “Riverine” refers to a class of wetlands that has a floodplain or riparian geomorphic setting. Riverine wetlands include the river channel and the floodplain/floodprone area from the river headwaters down to the confluence with the estuarine geomorphic class. The floodplain is the low gradient area adjacent to the river channel that is currently flooded during times of high discharge (Dunne and Leopold 1978). The floodprone area is defined by the projection of a plane at a level twice the bankfull thalweg depth. The bankful depth is where the water surface is level with the floodplain surface (see Figure 9).

In some instances, projection of twice the bankfull-thalweg depth will result in a floodprone area that is too great in lateral extent and hence incorporates a portion of the landscape that is, in fact, a slope wetland or upland/slope complex outside of riverine/fluvial influence. In these instances, other indicators such as undeveloped soil horizons (Entisols), debris wrack, drift lines, vegetation bent due to stream flow, topographic breaks, and best professional judgment need to be employed to determine the lateral extent of the floodprone area, and thus the extent of the riverine class (see Figure 9).

Table 6. Riverine Subclass Model Boundaries

Geomorphic Class	Riverine Wetlands.
Longitudinal Boundary	Rivers above the influence of tidal waters or bidirectional flow (estuaries) to the Coastal/Cascade Mountain Range Divide.
Lateral Boundary	The lateral extent of the riverine subclass includes the active channel and active floodplain out to the extent of the floodprone area. The floodprone area is defined by the projection of a plane at twice the bankfull thalweg depth (see Figure 4). In some instances, the floodprone area, as defined above, includes a portion of the landscape that is, in fact, a slope wetland. Indicators such as undeveloped soil profiles in the upper portion of the soil profile, debris wrack, drift lines, stream flow bent vegetation, topographic breaks, and best professional judgment need to be employed to determine the lateral extent of fluvial influence, and thus the extent of the riverine class.

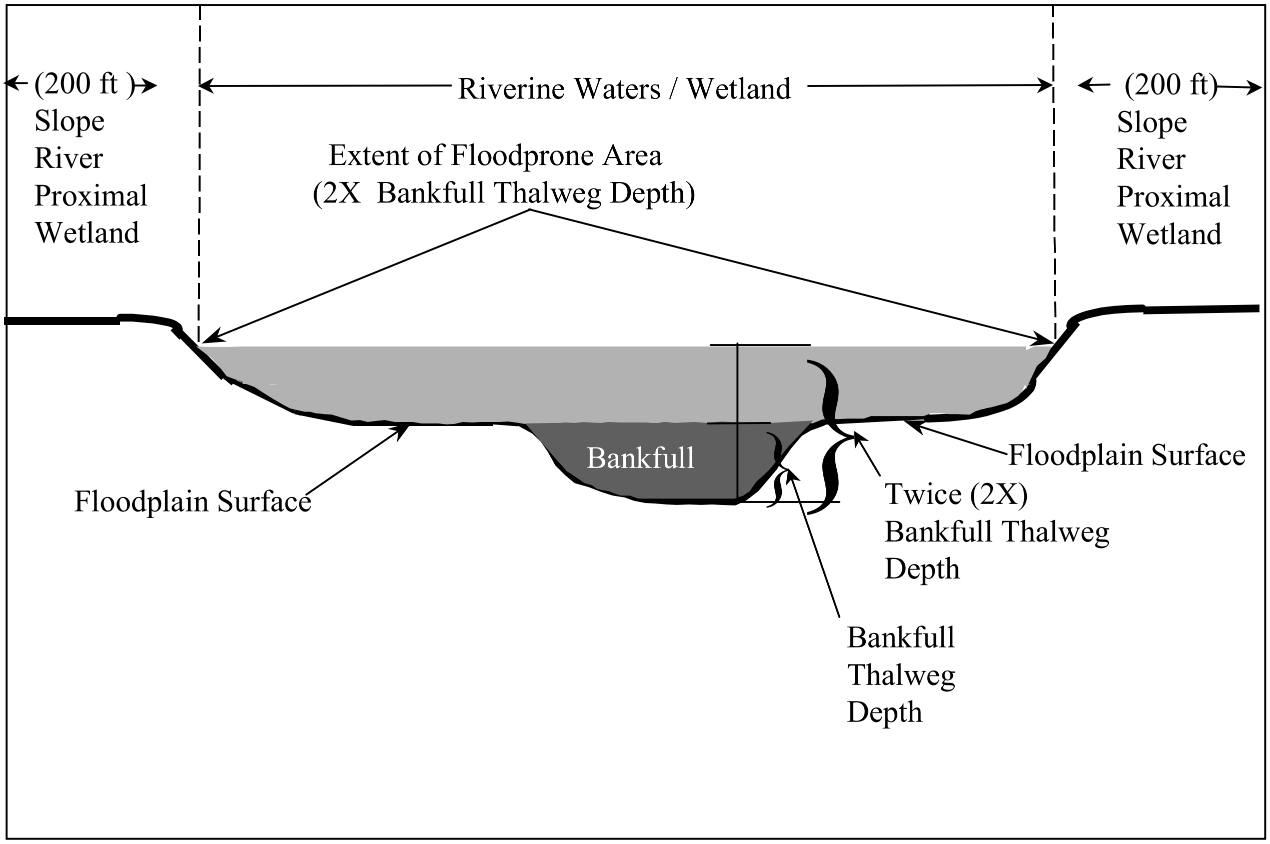


Figure 10. Stream Channel cross-section and measurements

Note:

1) The floodprone area is the area defined by the projection of a plain at twice the
    a. bankfull thalweg depth.
2) In some instances, the floodprone, as defined by the projection of a plain at 2X bankful thalweg depth, will extend into areas that are slope wetlands. Riverine waters/wetlands include those areas that are predominated by fluvial processes (i.e., uni-directional flow, overbank flooding). Slope river proximal wetlands are those areas that are dominated by ground water flow.

The dominant water sources for riverine wetlands are: (1) overbank flow during bankfull or greater discharges, (2) hyporheic or subsurface discharge from unconfined fluvial aquifers, and (3) lateral subsurface flow from adjacent slope wetlands. Additional water sources are precipitation and tributary inflow.

The extent of riverine wetlands within the landscape is a function of valley morphology (*i.e.*, steep confined channels do not have floodplains or floodprone areas, while low gradient unconfined channels in broad valleys have extensive floodplain/floodprone areas. Channel confinement/entrenchment can be described as the ratio of the floodprone area width to the bankfull width (Rosgen 1996). Throughout the Coastal Southeast and Southcentral Alaska landscape riverine wetlands grade laterally into slope wetlands at the point where fluvial influence ends and groundwater occurs close to the adjacent slope surface.

A typical reference standard river in Coastal SE/SC Alaska.

Photograph 1. A typical reference standard riverine wetland in SE/SC Alaska. Reference Site #5 (Fish Creek)

Photograph 2. A typical reference standard riverine wetland in SE/SC Alaska. - Reference Site #5 (Fish Creek)

Figure 11. An Example of a Course Wood Jam in a Reference Standard Site in SE Alaska.

Course wood and logjams can alter the course of a river (i.e., avulsions around jams), alter channel hydrodynamics, control channel bed elevations and floodplain development through sediment retention, and create scour and step pools.

Slope River Proximal Wetlands

The slope river proximal wetlands subclass is defined as wetlands that extend upslope 200 ft beyond the boundary of riverine wetlands. Therefore, this subclass of slope wetlands adjacent to riverine wetlands is referred to as "slope river proximal" wetlands. The slope river proximal wetland subclass includes the following types of wetland: Palustrine Forest (PF), Palustrine Emergent (PE), and Palustrine Scrub Shrub (PSS) (Cowardin 1992). The lower extent of slope wetlands includes the portion of the landscape immediately above the floodprone area of the active river channel and/or the intergrade to the estuarine geomorphic subclass (Table 7). Slope wetlands that are not functionally connected to the riverine wetlands, and are beyond 200 ft upslope of the riverine wetlands are not included in this guidebook.

Slope wetlands occur where groundwater discharges toward the land surface (Chapter 2). Slope wetlands occur on steep hillsides as well as low gradient to nearly flat foot slopes, but they are usually incapable of depressional storage because they lack closed elevation contours. Principal water sources for slope wetlands are precipitation, groundwater return flow and through-flow from surrounding uplands. Slope wetlands lose water by subsurface and surface flow, and evapotranspiration.

Coastal regions in Southeast and Southcentral Alaska average 60 to 100 inches of rain per year and island areas in the same region average from 150 to 200 inches (USDA Forest Service 1995). Precipitation exceeds evapotranspiration due to high humidity, cool temperatures, and continual cloud cover throughout the year. These climatic conditions result in high volumes of subsurface flow through the slope river proximal wetlands of the mountainous landscapes of Coastal Southeast and Southcentral Alaska.

Table 7. Slope River Proximal Subclass Boundaries

Geomorphic Class	Slope Wetlands.
Longitudinal Boundary	Above the influence of tidal waters or bidirectional flow (estuaries) to the Coastal and Cascade Mountain Range Divide.
Lateral Boundary	Slope Wetlands begin immediately upslope of the riverine floodprone area and extend upslope for 200 (horizontal) feet.

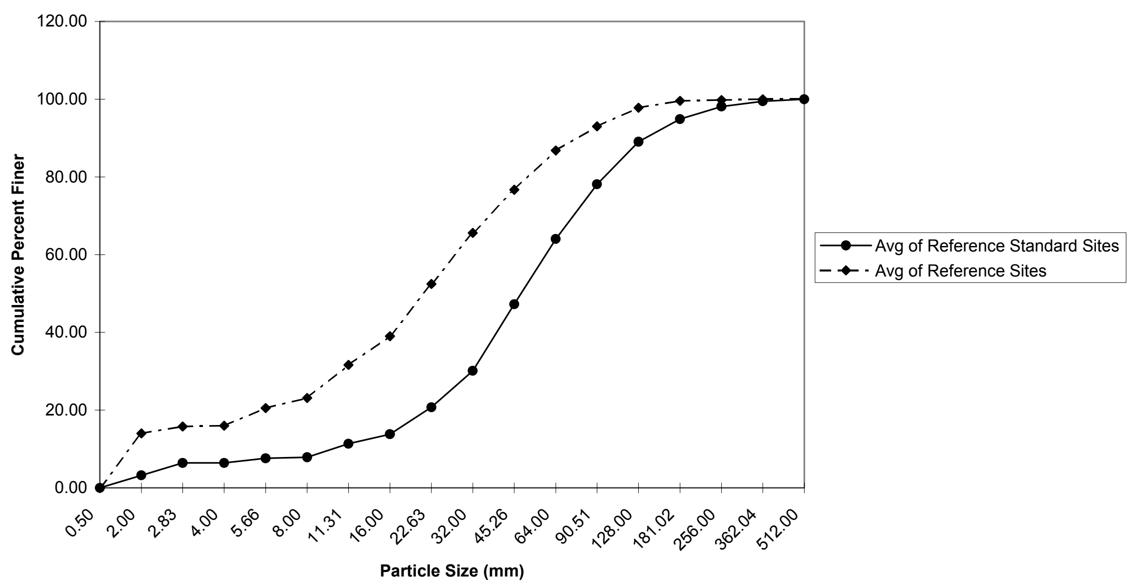
Photograph 3. Typical Slope River Proximal Wetland in Coastal SE & SC Alaska

Hydrology

Twenty sites were sampled in the riverine subclass in Coastal Southeast and Southcentral Alaska. Typical river channels have common meander bends, coarse woody debris, and coarse bedload (Photos 3). The reference standard sites have a greater average width, depth, thalweg depth, and cross-sectional area, yet the average width-to-depth ratios and the range in floodplain widths are less than the other reference sites (See Appendix 2). The reference standard sites exhibited fewer disturbances that resulted in alterations to the characteristic channel dynamics and morphology (i.e., width-to-depth ratios, entrenchment, etc.). Within the 20 reference sites sampled disturbances included: (1) increased inputs of fine particulate sediment from urbanization, forest practices, etc; (2) altered hydroregimes in the assessment area (e.g., stormwater inputs/diversions, water harvesting, development/clearcutting of adjacent slope wetland areas); (3) channelization and/or rip-rap stabilization; and (4) removal of coarse woody debris and/or coarse woody debris sources.

The graph plots average particle size against cumulative percent of "finer" particles for the reference sites versus the reference standard sites. As indicated in the graph, the cumulative frequency curve for the reference sites represents a distribution of finer bedload particle sizes than in the reference standard sites (i.e., the reference sites' curve is to the left of the reference standard sites' curve in the graph). By definition the reference standard sites represent the least impacted/disturbed sites within the reference data set while "reference sites" represent a range of disturbance. The finer bedload particle size distribution in the reference sites is likely the result of the types of disturbance listed above.

Figure 12. Average Particle Size of Reference Sites and Reference Standard Sites v. Cumulative Percent Finer



Characteristic of the reference standard sites is the presence of coarse wood and log jams within the channel (see Photo 3). Coarse woody debris and debris jams play a significant role in maintaining the characteristic channel dynamics of Southeast Alaskan rivers. Coarse woody debris and debris jams alter the hydrodynamics of the river and (1) drive the course of the river (e.g., avulsions around debris jams), (2) affect the development of floodplains, (3) control the channel bed elevation, (4) retain sediments, and (5) create scour and step pools.

Photograph 4. Representative size distribution of particles of Reference Standard Sites

Finally, reference standard sites in Southeast Alaska are characterized by undisturbed native vegetation communities along the channel banks and immediately proximate to the channel (i.e., off-channel slope areas) (Photos 1 and 2). Riparian forests represent a source of coarse woody debris and nutrient input and provide regulation of the micro-climatic conditions within the channel (e.g., water temperature and light interception). Disturbance to riverine wetlands in Southeast Alaska typically results in an increase of emergent vegetation within the channel.

Soils

Coastal Southeast and Southcentral Alaska are characterized by mountainous terrain rising immediately from marine waters and extending over a relatively short distance to mountain ridges. The land area associated with fluvial processes within the context of this model tends to be narrow confined channels and valleys. Parent material for soils of the alluvial valleys consists of silts, sands, and gravel that have been deposited by Holocene fluvial processes. The typical geomorphic stratigraphy of the subclass (riverine wetlands on low permeability deposits and bedrock) has glaciofluvial and marine derived silts underlying recent fluvial silt, sand, and gravel. Tectonic activity and isostatic rebound have resulted in the formation of raised areas of marine deposited silt. The marine silts create a deep impermeable layer that causes lateral drainage through the upper deposits into valley bottoms and streams. Marine silt has low permeability, while recent overlying deposits are highly permeable. Therefore, the water often discharges toward the surface in areas of groundwater concentration. Stream meandering is limited due to channel confinement, although stream channels have cut through some of the recent glaciofluvial deposits to form present-day channels.

Holocene silts, sands, and gravel form stream banks, levees, and small floodplain areas adjacent to the active channel. Soils formed in these deposits are Histosols, Entisols, and Inceptisols. The typical pedon has a thin organic horizon over a series of sand, silt, or gravel deposits. In many locations, the gravel lies over the glaciofluvial deposits and marine silt. Soils on the levees are fairly stable, and not prone to erosion because of plant roots. Soil formation and horizonation is limited in the riverine zone due to the short period since deposition Transformations within the soil profile consist of parent material weathering and organic accumulations in the upper horizons. Organic matter accumulation in the upper horizons has also led to subtle color changes. Due to higher water retention, the color changes in the upper horizons are particularly obvious in the unweathered silt deposits. Riverine soils are highly permeable and do not store significant amounts of water. Water flowing off slopes adjacent to the stream infiltrates vertically through porous sand and silt deposits into the gravel where it then moves laterally to the stream. The soils do not exhibit redoximorphic features, nor are they saturated continuously for any period of time. Water flowing off the surrounding landscape moves rapidly through the riverine soils.

Vegetation

The riverine forest in Coastal Southeast and Southcentral Alaska is typically organized into distinguishable plant communities running parallel to the stream channel (see Photos 1 and 2). The plant community closest to the stream (in the vicinity of bankfull) is often an herb/bryophyte strip and if disturbed, deciduous trees occur. The next plant community is commonly a shrub-dominated area that ends at the topographic break in slope indicating the top of the bank. The plant community above this topographic break is typically where large conifers are rooted. This zone, "off-channel forest," is an important source of large wood to the channel and is critical to the maintenance of stream morphology. In addition, vegetation in this area adds nutrients to the channel and contributes to the biodiversity of the riparian corridor by providing a source of nutrients and habitat.

In-Channel Bank Vegetation

In-Channel bank vegetation is rooted and growing in the area around bankfull and between bankfull at the top of the bank. These communities are influenced by the channel (e.g., water availability, erosional, and depositional forces), soil morphology, and/or by the break in canopy above the channel. The plants growing within the channel bank zone are important in biogeochemical stream processes and bank stabilization as well as for habitat and food sources for streamside invertebrates and amphibians.

No trees were growing in the channel bank of reference standard sites sampled during this study. The overstory of channel bank sites was composed of overhanging tree cover from off-channel zones (86% average cover). This may be due to the narrowness of the channel bank zones in reference standard sites or to the small sample size for this draft model. There were also few saplings within the channel bank; Sitka Spruce *(Picea sitchensis)* and Western Hemlock *(Tsuga* *heterophylla)* saplings each had an average percent cover of 3%. The shrub species with the highest average percent cover values included: Devil's Club *(Echinopanax horridum*, 16% average cover), Sitka Alder *(Alnus crispa*, 3% cover), and Huckleberries/Blueberries *(Vaccinium spp*., 2% cover). The average percent cover of the herb strata was 26%. Herbs found in the channel bank zone included sedges *(Carex spp.)*, Goatsbeard *(Aruncus sylvester)*, Horsetails *(Equisetum spp.)*, Lace Flower *(Tiarella trifoliata)*, and Oak Fern *(Gymnocarpium dryopteris)*. The average number of taxa found within 1/10 acre plots in these areas was 18. The ground layer consisted of depositional cobbles, gravels, sands, and silts ("bare ground"), 11% average cover); bryophytes (86% average cover), and litter (7% average cover).

The average overhanging tree cover in these impacted channel bank sites (26% average cover) was less than that of the reference standard channel bank sites (86% average cover). The average percent cover of saplings was similar to that of the reference standard sites; however, the composition of this strata was very different. There were no Western Hemlock (*Tsuga heterophylla)* saplings growing at "other reference sites," and there was only a trace amount of Sitka Spruce *(Picea sitchensis)* sapling cover. The majority of the sapling cover was composed of Red Alder *(Alnus oregona,* 8% average cover) and Black Cottonwood *(Populus balsamifera,* 1% average cover).

The average percent cover of the shrub strata at these disturbed sites was one-third that of the reference standard sites. There was no Devil's Club *(Echinopanax horridum)* or Mountain Alder *(Alnus crispa)* on these sites. Sitka Willow *(Salix sitchensis)* and other willows (*Salix* spp.) made up the majority of the shrub percent cover (5% cover). Impacted sites had an average of 44% herb cover, which is almost twice that of reference standard sites. In this preliminary data set it was observed that the average impacted channel bank was wider and subject to more frequent inundation than was the average reference standard channel bank zone. This observation is consistent with the data; there were increases in percent cover for species which commonly grow in standing water, such as Skunk Cabbage *(Lysichiton americanum)*, Western Marigold *(Caltha palustris)*, and sedges *(Carex spp.*). Other herb species that were more numerous at impacted sites include Lady Fern *(Athyrium filix-femina)*, Bluejoint Reedrush *(Calamagrostis canadensis)*, Western Buttercup *(Ranunculus occidentalis)*, and Large Leafed Avens *(Geum macrophyllum)*. Certain herb species such as Goatsbeard *(Aruncus sylvester)*, Horsetails *(Equisetum* spp.), Oak Fern *(Gymnocarpium dryopteris)*, and Lace Flower *(Tiarella trifoliata),* had lower average percent cover values at impacted sites than they did at reference standard sites. There was an average of 9 taxa per 1/10 acre plots in these areas. There was a marked difference in percent cover values for the ground layers between reference standard and "other reference sites." Litter and bare ground covers increased to average cover values of 45% and 53% respectively. Bryophyte percent cover decreased from 86% at reference standard sites to 11% at impacted sites.

Off-Channel Forests at Reference Standard Sites -Structure and Species Composition

At off-channel reference standard sites, the overstory is typically composed of Western Hemlock *(Tsuga heterophylla,* 32% average cover) and Sitka Spruce *(Picea sitchensis,* 22% average cover) with a combined basal area of 280 ft^2/acre. Average tree density in these forests is 98 trees/acre. There was an average of 30 saplings/small trees per acre. Sitka Alder *(Alnus crispa)* had the highest percent cover (8%) of this strata; it was particularly abundant in gap areas. Windthrow, avalanches, landslides, and disease are important sources of gaps in the Southeast Alaska forests. Coniferous regeneration was represented by Western Hemlock *(Tsuga* *heterophylla,* 8% average cover) and Sitka Spruce *(Picea sitchensis,* 1% cover) saplings. The shrub stratum (46% average cover) was dominated by Devil's Club *(Echinopanax horridum,* 39% cover), Five-leaved Bramble *(Rubus pedatum,* 20.4% cover), Huckleberries/Blueberries (*Vaccinium* spp., 8% cover), and Rusty Menzesia *(Menziesia ferruginea,* 3% cover). Huckleberry/ Blueberry plants *(Vaccinium* spp.) were commonly rooted on elevated microsites, whereas Devil's Club *(Echinopanax horridum*) was common in wet depressions. Prevalent herbs (total average stratum cover 42%) include: Skunk Cabbage (*Lysichiton americanum*, 28%), Oak Fern (*Gymnocarpium dryopteris*, 26%), Spleenwort-leafed Goldthread *(Coptis asplenifolia*, 7%), Twisted Stalk (*Streptopus amplexifolius*, 5%), Lady Fern *(Athyrium filix-femina,* 5%), Lace Flower (*Tiarella trifoliata*, 4%), Dwarf Dogwood (*Cornus canadensis*, 4%), and Enchanter's Nightshade (*Circaea alpina*, 3%). An average of 14 taxa were found within each 1/10 acre reference standard off- channel forest plots. Bryophytes were the dominant ground cover (53% average cover), followed by litter (17% cover), and bare ground (0.5%).

Off-Channel Forests at "Other Reference Sites" - Structure and Species Composition.

Trees found in these impacted off-channel forests include both deciduous and coniferous species. Sitka Spruce (*Picea sitchensis*) represented the highest average percent cover (17%), followed by Black Cottonwood (*Populus balsamifera*, 8%), Western Hemlock (*Tsuga heterophylla*, 5%), Red Alder (*Alnus oregona*, 4%), and Sitka Alder (*Alnus crispa*, 2%). The average basal area for these forests was 191 ft^2/acre and the average density was 197 trees/acre. Sapling/small tree cover is more than twice that of the reference standard condition (30% versus 12%). There was no evidence of Western Hemlock (*Tsuga heterophylla*) regeneration within these plots; however, Sitka Spruce (*Picea sitchensis*) saplings had an average percent cover of 18%. The majority of the sapling cover was provided by deciduous species; Red Alder (*Alnus oregona*) saplings had an average cover of 19% and Sitka Alder (*Alnus crispa*) sapling cover was 4%.

The composition of the shrub and herb communities in these sites was very different from that found at the reference standard sites. The Devil's Club *(Echinopanax horridum)* in these impacted off-channel forests had an average percent cover of 2%. There was also a decrease in average percent cover of Five-leafed Bramble *(Rubus pedatus)*; it was 0.2% cover. The average cover values of willows (*Salix spp*., 8%) and Salmonberry *(Rubus spectabilis,* 2%) increased in these sites. The largest drop in percent cover for herb species was Skunk Cabbage (*Lysichiton americanum,* 2% cover), followed by Oak Fern (*Gymnocarpium dryopteris*, 2% cover), and Spleenwort-leafed Goldthread (*Coptis asplenifolia*, 0% cover). Herb taxa that had higher percent covers in the impacted sites than they did at the reference standard sites include: Goatsbeard (*Aruncus sylvester*, 7% cover), Horsetails *(Equisetum spp*., 7% cover), graminoid species (6% cover), and Bluejoint Reedrush (*Calamagrostis canadensis*, 4% cover). An average of 9 taxa were found within each 1/10 acre plot in these impacted sites. Organic litter was the most common ground cover (79% cover), followed by bryophytes (19% cover), and bare ground (12%).

These data appear to indicate that upon impact, off-channel riverine forests exhibit an increase in deciduous tree species accompanied by a decrease in the percent cover supplied by coniferous species. The moisture level of the site likely decreases; Devil's Club *(Echinopanax horridum)*, Skunk Cabbage *(Lysichiton americanum)*, and bryophytes become more scarce.

Fish and Wildlife Resources

The abundant fish and wildlife resources in Coastal Southeast and Southcentral Alaska are internationally known. These abundant resources are used for subsistence, sport, and commercial purposes. Non-consumptive use of fish and wildlife is increasing dramatically as a result of the rise in the tourism industry. Most of the fish and wildlife species in the area are dependent on wetland habitats for some or nearly all of their life requirements.

The area streams contain important anadromous and resident fish habitats. The streams support five species of anadromous salmon (pink, chum, coho, sockeye, and chinook) as well as resident cutthroat trout, rainbow/steelhead trout, and dolly varden char. These species are important to the commercial, recreational, charter boat/lodge, and subsistence fisheries of the region. These fish also are a major food resource for bears, river otters, eagles, and other wildlife. Other nongame species, including sculpin, sticklebacks, and smelt, are also present or in adjacent waters (Taylor, 1979).

Anadromous fish spend part of their life in fresh water and part in salt water. Salmon lay their eggs in stream gravel, and juvenile fish hatch from the eggs and emerge from the gravel. The amount of time the juveniles spend in fresh water depends on the species of salmon. Pink salmon start their downstream migration immediately after emergence, while coho salmon juveniles generally spend two years in fresh water before migrating to the ocean. Pink and chum salmon depend heavily on estuaries during their early life stages. Salmon reach maturity in the ocean, returning to their natal streams to spawn and die and start the cycle again. Steelhead trout follow a cycle similar to coho salmon, except they often survive the spawning season, return to the ocean, and spawn again. Resident trout, and char spend all of their lives in fresh water spawning in stream gravel and growing to maturity in the streams and lakes of the region.

4. Functions and Assessment Models for Riverine and Slope River Proximal Wetlands

This chapter presents the ecological functions for the Riverine and Slope River Proximal wetlands. The major parts to this chapter are outlined below:

Comparison of Riverine and Slope River Proximal Wetland Functions including:

1. Variables for Riverine and Slope River Proximal
2. Definition of Variables for Riverine and Slope River Proximal

Riverine Wetland Model

1. List of Functions for Riverine Wetlands
2. Description of each function and corresponding Functional Capacity Indexes (FCI)
3. List of Model Variables
4. Description and Scaling of Model Variables

Slope River Proximal Wetland Model

1. List of Functions
2. Description of each function and corresponding Functional Capacity Indexes (FCI)
3. List of Model Variables
4. Description and Scaling of Model Variables

Comparison of Riverine and Slope River Proximal Functions

There is some overlap in the Riverine and Slope River Proximal functions. Below is a list of all the functions for Riverine and Slope River Proximal wetland functions to use as a guide for each model:

Riverine	Slope River Proximal
(1) Channel Meander Belt Integrity (2) Dynamic Flood Water Retention (3) Nutrient Spiraling and Organic Carbon Export (4) Removal of Imported Elements and Compounds (5) Particulate Retention (6) Maintenance of In-Channel Aquatic Biota (7) Presence of Coarse Wood structure (8) Maintenance of Riparian Vegetation (9) Maintenance of Connectivity and Interspersion	(1) Subsurface Water Retention (2) Dynamic Flood Water Retention (3) Nutrient Recycling (4) Organic Carbon Export (5) Integrity of Root Zones (6) Maintenance of Wildlife Habitat (7) Maintenance of Characteristic Plant Communities

Riverine and Slope River Proximal functions

Depending upon which subclass of wetlands you are assessing (Riverine or Slope River Proximal) there are potentially three scenarios for determining which functions to use when performing a wetland assessment:

Project Assessment Area	Functional Assessment Model
Riverine Wetlands	Riverine
Slope River Proximal Wetlands	Slope River Proximal
Riverine & Slope River Proximal Wetlands	Riverine and Slope Proximal Slope

Figure 1. Idealized Wetland Assessment Area Bounding

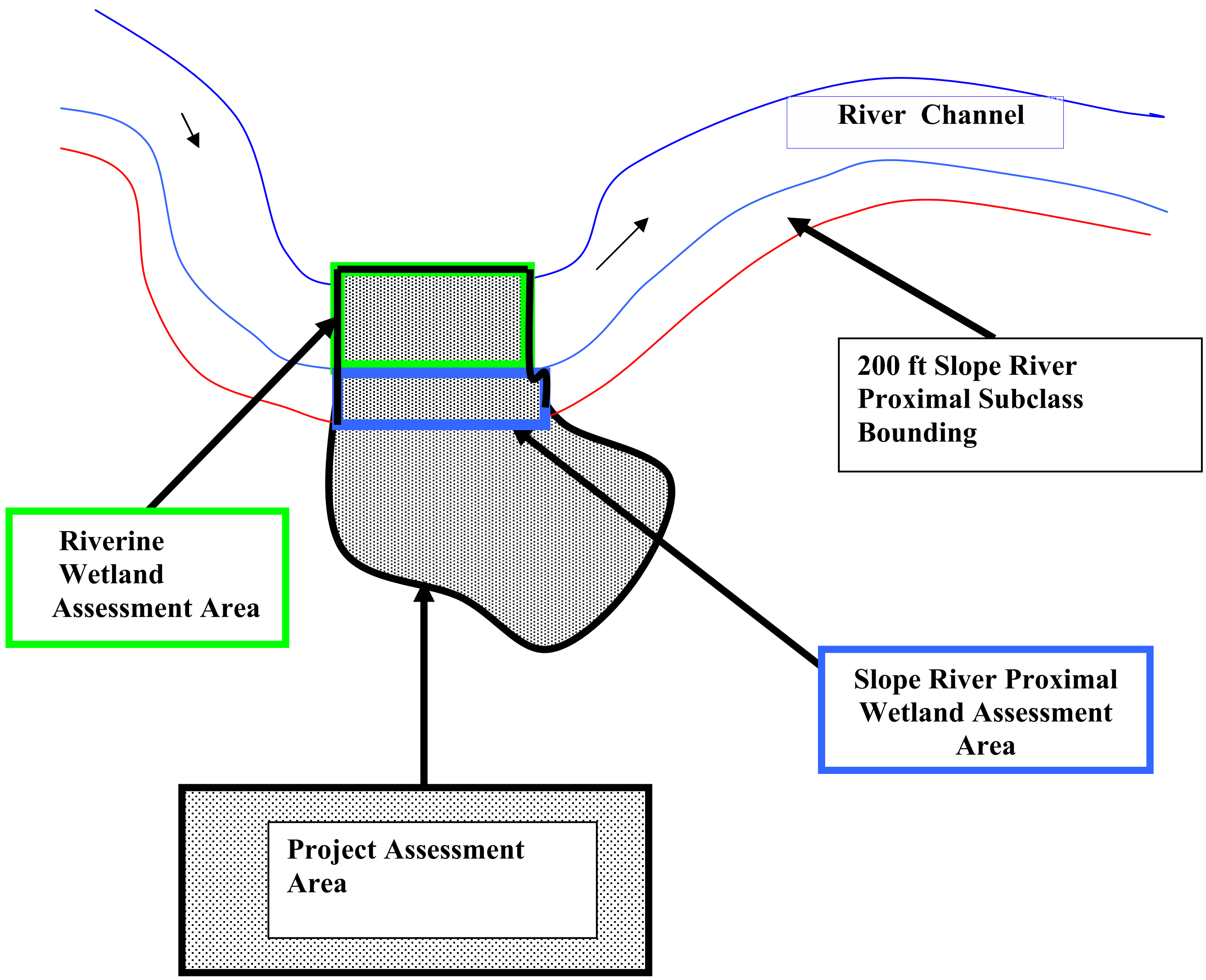


Table 8. List of Variables for Riverine and Slope River Proximal Wetlands

Hydrologic			
		Riverine	**Slope River Proximal**
Valthydro	Alterations of Hydroregime	X	
Vbarrier	Barriers to Fish Movement	X	
Vchanrough	Channel Bed Roughness	X	
Vcwin	In-Channel Coarse Wood	X	
Vcwpot	Potential Coarse Wood	X	
Vembedded	Embeddedness	X	
Vfreq	Overbank Flood Frequency	X	X
Vlogjams	Logjams	X	
Vmicro	Microtopography		X
Vpebble-D50	Median Particle Size-D 50	X	
Vsource	Water Source		X
Vsubin	Subsurface Flow into the Wetland	X	
Vsubout	Subsurface Flow from the Wetland		X
Vstore	Flood Prone Area Storage Volume		X
Vsurwat	Presence of Surface Water		X

Biogeochemical			
Vacro	Presence and Structure of the Acrotelm Horizon		X
Vcwslope	Coarse Wood in Slope		X
Vdecomp	Logs in Various Stages of Decomposition		X
Vredox	Redoximorphic Features		X
Vsoilperm	Soil Permeability	X	X
Vegetation and Land Use			
Vgaps	Canopy Gaps		X
Vshade	Riparian Shade	X	
Vstrata	Number of Vegetation Strata	X	X
Vtreeba	Tree Basal Area	X	X
Vvegcov	Total Vegetative Cover	X	X
Vadjuse	Adjacent Land Use		X
Vwatersheduse	Watershed Land Use	X	
Vwetuse	Assessment Area Land Use	X	X

Definition of Riverine and Slope River Proximal Variables

Hydrologic Variables	
Valthydro	**Alterations of Hydroregime.** Alterations of hydroregime that affect the assessment area (i.e., beavers, dams, dikes, levees, other human or other disturbances to the hydroregime).
Vbarriers	**Barriers to Fish Movement.** Number of barriers that affect the ability of fish to pass from down stream to the assessment area (i.e., dams, constricting culvers, other human or natural disturbances to in-stream flow).
Vchanrough	**Channel Roughness.** Particle size distribution of the channel bed such that 84% of the bedload is smaller then the D84 value (e.g., D84 is one standard deviation away from the mean value in the normal distribution).
Vcwin	**In-Channel Coarse Wood.** Coarse wood (> 4" diameter) below bankfull stage that is not a member of a logjam (i.e., single pieces/logs).
Vcwbank	**Coarse Wood.** The potential coarse wood to enter the project assessment area, from coarse wood upstream and from the stream bank.
Vembedded	**Embeddedness.** The percent of sediment surrounding gravel, cobble, and boulder particles.
Vfreq	**Overbank Flood Frequency.** Estimate of the frequency of overbank flooding in the wetland (how often peak seasonal discharge inundates a riverine wetland allowing temporary storage of surface water).
Vlogjams	**Logjams.** Logjams are stable accumulations of coarse wood below bankfull stage.
Vmicro	**Microtopographic Features.** The percent of microtopographic features.
Vpebble-D50	**Median Particle Size-D50.** The median particle size of the channel bed (i.e., D50).
Vsource	**Source of Water.** A measurement of the condition of the hydrologic source area.
Vsubin	**Subsurface Flow into the Water/wetland.** Subsurface flow into the water/wetland via interflow or return flow from adjacent areas.
Vsubout	**Subsurface Flow from the Wetland.** The number of subsurface flows into the stream channel.
Vstore	**Flood Prone Storage Volume.** Ratio of flood prone area width divided by channel width at bankfull.
Vsurwat	**Presence of Surface Water Storage.** Measurement of surface water ponding or potential ponding (i.e., static surface and shallow subsurface storage).

Biogeochemical Variables	
Vacro	**Presence and Structure of the Acrotelm Horizon.** Condition of the surface fibric zone commonly called the Oi soil horizon.
Vcwslope	**Coarse Wood in Slope wetlands.** Number of Coarse Wood pieces in the Project Assessment Area.
Vdecomp	**Logs in Various Stages of Decomposition.** The number of stages of decomposition of logs.
Vredox	**Redoximorphic Features.** Condition of the soil for allowing transport of gases, liquids, or plant roots to penetrate or pass through a bulk mass of soil or a layer of soil.
Vsoilperm	**Soil Permeability.** The permeability of the organic and/or mineral soil of the channel bank above the horizon of low permeability.
Vegetation Variables	
Vgaps	**Vegetative Gaps**. Abundance of canopy openings created by tree mortality or removal.
Vshade	**Riparian Shade.** Tree cover, shrub cover, and overhanging vegetation w/in & near bankfull channel.
Vstrata	**Number of Vegetation Strata.** The average number of vegetative strata present w/in the project assessment area.
Vtreeba	**Tree Basal Area.** Basal area of trees ($\geq$ 4" DBH) within the assessment area.
Vvegcov	**Total Vegetation Cover**. Sum of the percent cover of the six (mosses and lichen, forbs, graminoids and herbs, shrub, seedlings, small trees, trees and snags) vegetative covers in the assessment area.
Land Use Variables	
Vadjuse	**Adjacent Land Use.** Land uses and conditions in the area between the boundary of the project assessment area outward to 500 ft from the project assessment area, and also within the separate area that is 1000 feet upslope within the 90^0 arc.
Vwetuse	**Land use of Assessment Area Use**. Land uses and conditions in the project assessment area.
Vwatersheduse	**Watershed Land Use**. Land uses and conditions within 1000 feet and within a 90 degree watershed arc and the project assessment area.

List of Riverine Wetlands Functions

Hydrologic

1. Channel Meander Belt Integrity
2. Dynamic Flood Water Retention

Biogeochemical

3. Nutrient Spiraling and Organic Carbon Export
4. Particulate Retention
5. Removal of Imported Elements and Compounds

Habitat

6. Maintenance of In-Channel Aquatic Biota
7. Presence of Coarse Wood Structure
8. Maintenance of Riparian Vegetation.
9. Maintenance of Connectivity and Interspersion

Description of Riverine Functions and Corresponding Functional Capacity Indexes (FCI).

As explained in Chapter 2, models for each of the functions (ecological processes) that a wetland performs consist of variables (measurable field characteristics) combined in a logic driven mathematical equation to yield an estimate of a "Functional Capacity Index" or FCI. FCI values range from 1.0 to 0.0. Variables are combined into Primary and Secondary categories. Primary variables exert influence over secondary variables. The functions, FCIs, and primary (circles/ovals) and secondary (boxes) variables are described below. In some cases the circle/oval was used for all the variables when they were not clearly distinguished.

Primary Variables

Secondary Variables

Riverine Hydrologic Functions

1. Channel Meander Belt Integrity

This function includes the physical processes that influence lateral channel migration and sinuosity. Attributes of the function include normal flows, bedload size, bank roughness, coarse wood in the channel, coarse wood potentially released from the channel, land use disturbance, and number of in-channel logjams.

FCI: (Vwatersheduse + Vwetuse+ Valthydro + Vfreq + Vchanrough +Vcwpot +Vlogjam + Vcwin) / 8

Vcwin Valhydro Vchanrough Vfreq
Vlogjam Vwetuse Vcwpot Vwatersheduse

Effects On-Site: Maintenance of the Channel Meander Belt is essential to retaining the natural character of the channel and flood plain. The Channel Meander Belt has a direct influence on the development and maintenance of several riverine wetland functions (e.g., hydrologic, biogeochemical, and plant community/habitat functions).

Effects Off-Site: Downstream effects of this function include contributions to characteristic channel dynamics, water quality, and aquatic habitats (structure and function).

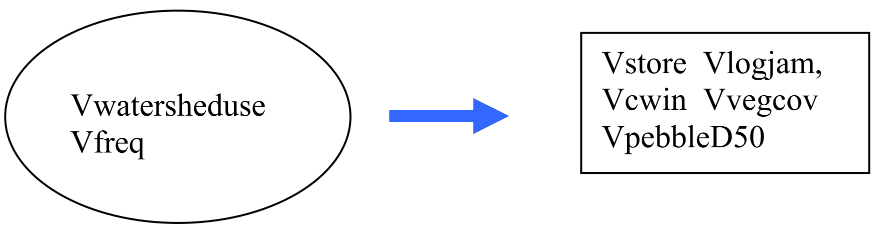
Rationale for Functional Capacity Index: This function is a reflection of channel stability and floodplain age. As the channel matures the entrenchment and sinuosity vary based on channel gradient, width, and bedload size. Older channels will have broad meander belts with width / depth ratios of >12 and sinuosity of > 1.2, whereas channels in younger landscapes will have lower ratios and sinuosity values <1.2.

Logic: Attributes include normal flows, bedload size, frequency of overbank flows, coarse wood in the channel and number of in-channel logjams.

2. Dynamic Flood Water Storage.

This function is defined as the capacity of the wetland flood plain to dissipate energy and floodwater storage. Attributes of the function include the width of flood prone area, storage volume, presence and number of coarse wood jams, density of armoring vegetation along secondary channels, and frequency of flooding.

FCI: (Vwatersheduse + Vfreq + (Vstore + VpebbleD50+ Vlogjam + Vcwin + Vvegcov) / 5) / 3



Effects On-Site: Dynamic flood water storage increases water residence time, promotes the deposition and retention of materials (i.e., sediment, nutrients, and contaminants), reduces in-stream flow velocities (thus maintaining characteristic channel geometry), creates low velocity pools in-channel for fish refuge, and creates hydraulic connections between the channel and associated flood plain wetlands.

Effects Off-Site: Dynamic flood water storage influences energy dissipation, reduces and delays downstream peak flows, reduces sediment delivery downstream, and improves water quality. Reduced peak flows and reduced sediment delivery maintain characteristic channel- dynamics downstream.

Rationale for Functional Capacity Index: A well functioning floodplain must be free of human encroachments like roads and levees and must be able to dissipate flood energy and store overbank flows. The flood prone area is defined as a level line projected across the flood plain at two times the thalweg depth.

Logic: Attributes include width of flood prone area ratio, storage volume, presence and number of coarse wood jams, density of armoring vegetation along secondary channels, and frequency of flooding.

Riverine Biogeochemical Functions

3. Nutrient Spiraling and Organic Carbon Export.

This function consists of abiotic and biotic processes that convert elements from one form to another (normally occurring between the channel waters and the stream bottom) and the capacity of a wetland to transport organic carbon in dissolved and particulate forms to downstream aquatic ecosystems.

FCI: (Vsubin + V cwin + V cwpot + Vchanrough + Vsoilperm + Vwatersheduse +Vshade) / 7

Vcwin	Vcwpot	Vsoilperm	Vwatersheduse
Vsubin	Vchanrough	Vshade	

Effects On-Site: Cycling of carbon, nitrogen, phosphorus, and other elements is a consequence of production and decomposition processes. The term spiraling is used instead of cycling because the nutrient transformations occur between flowing waters and sediments. Export of organic carbon (nitrogen, and phosphorus) from a site prevents excessive accumulation but also provides a locus for continued imports and utilization from upstream.

Effects Off-Site: Spiraling provides a consistent supply of nutrients for downstream portions of the riverine ecosystem. The process on-site also serves as a buffer for downstream aquatic ecosystems Downstream nutrient export from the riverine wetland provides support for aquatic food webs and biogeochemical processing.

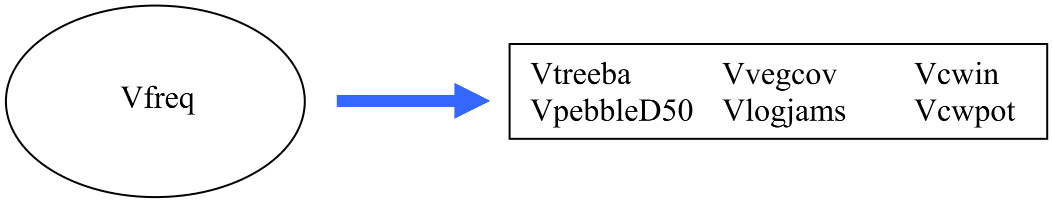
Rationale for Functional Capacity Index: The transport of organic carbon in dissolved and particulate forms to downstream aquatic ecosystems is controlled by the amount of water, coarse wood, channel bed roughness, permeability of the soil along the stream bank, amount of shade, and water uses in the channel.

Logic: (Vsubin + Vsoilperm) Subsurface flow into the stream channel is influenced by the integrity of the soil permeability. The other five variables influence structural aspects and approximate amount of biomass that contributes to the export of carbon.

4. Particulate Retention.

This function concerns deposition and retention of sediments, leaf litter, and fine woody debris transported from lateral and upstream sources, primarily through physical processes (e.g., overbank flooding, in-channel flow, and overland flow). A potential independent quantitative measure of this function would be cm/meter^2/year.

FCI: ((Vcwin + Vcwpot + Vlogjams + Vtreeba + VpebbleD50 + Vvegcov) /6 + Vfreq) /2



Effects On-site: Inorganic and organic particulates contribute to the overall nutrient budget available to an ecosystem. Organic matter may also be retained for decomposition, nutrient cycling, and detrital food web support. Particulate retention changes in-channel and off-channel topography and increases substrate diversity, which has hydrologic, biogeochemical, and habitat implications.

Effects Off-site: Retention of particulates reduces the potential for chronic or excessive transport of sediments and other particulates to downstream aquatic ecosystems, which helps maintain characteristic channel dynamics and water quality.

Rationale for Functional Capacity Index: Particulates transported from lateral and upstream sources, primarily through physical processes (e.g., overbank flooding, in-channel flow, and overland flow). A potential independent quantitative measure of this function would be cm/meter^2/year.

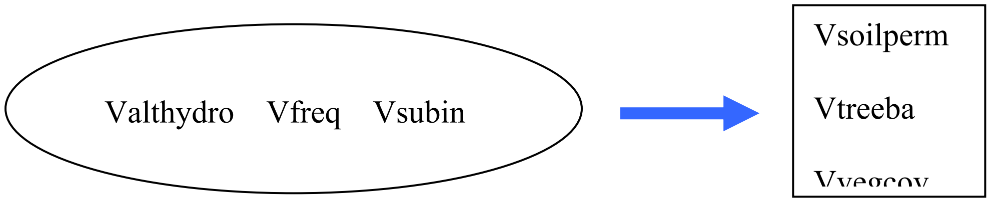
Logic: (Vfreq) (Frequency of overbank flooding) is the mechanism that transports sediment and fine debris particulates to the riverine wetland from upstream riparian and overland sources. The sediments and debris are used for nutrient cycling, decomposition, and food web support. As water spreads out over the flood plain, particulates drop out and change floodplain topography leading to increased substrate diversity. Without overbank flooding, the opportunity for sediment and particulate retention in wetlands adjacent to the channel cannot occur. Accordingly, if overbank flooding does not occur in the adjacent wetland, the function is not present.

(Vcwin + Vcwpot + Vlogjams + Vtreeba Vpebbled50 + Vvegcov)/6 - These variables consider in-channel and off-channel roughness factors contributing to this function. The relationship between roughness and velocity of surface water flow determines the ability of the water column to keep sediment particles entrained. Coarse wood, logjams and wetland vegetation adjacent to the channel slow the velocity of water during normal and flood flows allowing particulates to fall out and trap sediment. Turbulent flow is increased as roughness increases friction and shear forces. This leads to reduced water velocities, and subsequent sediment and particulate deposition. Each of these variables equally influences this function based on the similar effect they have on sediments and particulates being transported in the water column.

5. Removal of Imported Elements and Compounds.

Storage, removal and/or temporary immobilization of elements and compounds from overbank flooding or riparian sources (e.g., groundwater discharge or surface runoff from uplands). A potential independent quantitative measure of this function is the quantity of one or more imported elements and compounds removed or sequestered per unit area during a specified period of time (e.g., g/m^2/u^2).

FCI: (Valthydro + Vfreq + Vsubin + (Vvegcov + Vtreeba) /2 + Vsoilperm) /5



Effects On-site: Nutrients and contaminants (e.g., excessive levels of iron, phosphorous, nitrogen, heavy metals, hydrocarbons, pesticides, sewage, snow-disposal contaminants, etc.) are immobilized and broken down through biogeochemical processes (e.g., plant uptake, microbial action, absorption, denitrification, and decomposition) into innocuous or inactive forms.

Effects Off-site: The decrease in the concentration of exported nutrients, heavy metals, pesticides and other pollutants improves downstream water quality and aquatic habitat.

Rationale for Functional Capacity Index: The rationale for the FCI and selection of the model variables for this function use the National Guidebook Riverine Wetlands (Brinson, et. al. 1995). The variables are different than those used in this model, but the logic behind our surrogate variables is similar in most cases. However, there are some uncertainties:

Frequency of Overbank Flow - In order for riverine wetlands to remove imported elements and compounds, they must first be transported to the wetland. In riverine wetlands, one of the most common transport mechanisms is overbank flow. Without it, there would be little opportunity for water-borne materials in streams to be removed by biogeochemcial processes operating on flood plain wetlands (Brinson, et. al. 1995).

Surface Inflow - When precipitation rates exceed soil infiltration rates, overland flow in uplands adjacent to riverine wetlands may become a water source. Indicators include the presence of rills and rearranged litter in uplands leading to the quantitative measure of this function which would be cm/meter^2/year." (Brinson, et. al. 1995).

Logic:(Vfreq) - Absent overbank flows, the floodplain wetland's opportunity to carry out this function is limited to those elements and compounds introduced by way of ground water discharge at toe slopes or discharges from below into floodplain alluvium (e.g., artesian flows).

(Vsubin) - Another common transport mechanism for elements and compounds is subsurface flow, including seeps, upwellings, and groundwater discharge from upslope. Groundwater discharge typically occurs at toe slopes, but may also discharge from below into a floodplain alluvium itself. Groundwater discharge occurs in many Southeast Alaska wetlands as a result of steep watersheds, high rates of precipitation (rain and snow), and reduced evapotranspiration rates due to moderate temperatures and overcast conditions during much of the year.

(Vvegcov + Vtreeba)/2 - These variables represent flood plain roughness features and surfaces for microbial activity. A varied and complex topography exposes water simultaneously to a variety of conditions at any one time. The primary reason that many chemicals and compounds are removed by wetlands is due to microbial activity. Microbes tend to be associated with complex surfaces such as leaf litter, humus and soil particles, and plant surfaces. These surfaces provide a platform for growth and reproduction, and the material itself may be a source of organic matter for metabolism.

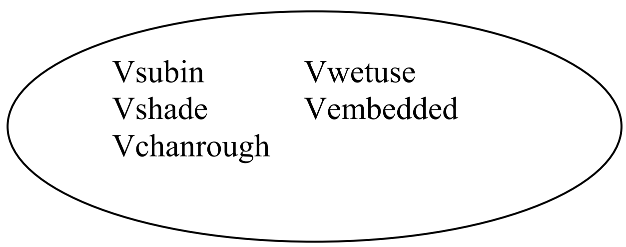
(Vsoilperm) - Many nutrient removal and sorption processes are dependent on the water table intercepting a specific soil condition that facilitates the removal of nutrients, such as anoxic or oxidized conditions. No soil condition is conducive for all processes. Physical and chemical removal of dissolved elements and compounds occurs through compellation, precipitation, and other mechanisms. Generally, soils that have fine texture (clays, silts) have greater sorption capacities than coarse textures. Soil organic matter also has sorptive properties, particularly in the chelation of heavy metals.

Riverine Habitat Functions

6. Maintenance of In-Channel Aquatic Biota.

This function relates to the ability of the wetlands to maintain characteristic aquatic biota, including structural components, in channel base flow, variety of stream velocities, and active flow prone area.

FCI: (Vsubin +Vshade + Vchanrough + Vwetuse + Vembedded) /5



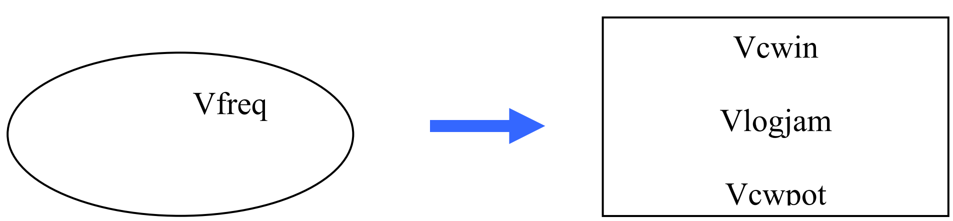
Effects On-site: Healthy aquatic biota in the form of micro and macro invertebrates (i.e., bugs on rocks, fish) directly relates to stream productivity. The more productivity the more biomass that can be produced and the richer the biota diversity.

Effects Off-site: A rich channel diversity will affect the adjacent lands by providing nitrogen to the riparian. Downstream aquatic taxa will benefit from the increased biomass and exported nutrients.

7. Presence of Coarse Wood Structure.

The ability of the wetlands to maintain coarse wood and potential coarse wood in the channel column to provide structure and nutrients to the wetlands.

FCI: ((Vcwin + Vlogjam + Vcwpot) / 3 + Vfreq) / 2



Effects On-site: Coarse wood within the channel and adjacent to the channel controls the amount of channel meander, scour, deposition, and sediment size. Wood also acts as a substrate for micro invertebrates as well as hiding cover for fish. Onsite productivity is maintained by the decomposition of the logs and their organic contribution to the production of biomass. Theoretically, too much large wood is detrimental because high loading levels create jams resulting in be a loss of a generation of wood for long-term recruitment.

Effects Off-site: Large and small wood migrate downstream during floods and other events. Log jams break and release flood type events which increase scour and deposition and change the bed forms in the channel. Nutrients, carbon, and aquatic biota all migrate downstream and benefit off-site stream productivity.

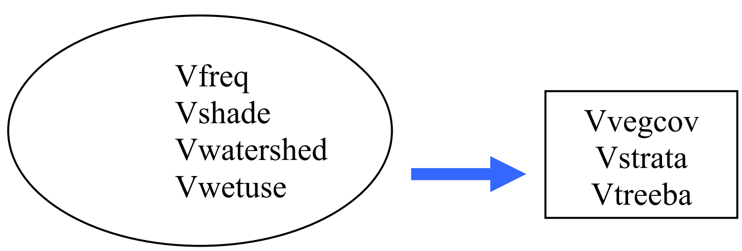
Rationale for Functional Index: This function is easily influenced by human activity. Logging can reduce the amount of large wood or increase it by leaving riparian buffers that are not wind firm. Each of these relate to an increase or decrease in large and small wood as well as regulate the behavior of the banks, beds, and profile of the stream. In systems that have no large wood, the productivity for aquatic biota is lower than one that is in balance with its stream energy.

Logic: To estimate the function, the amount of coarse wood in the channel and the amount in log jams and adjacent to the channel (Vcwin +Vlogjam + Vcwpot) are all considered to have equal weight. While we recognize that each may play an individual role, collectively they provide a good measure of how the stream will function. The other variable that is used is an estimation of the frequency of overbank flood flow (Vfreq) which creates the energy and power to transport the large and small wood into the channel or down stream.

8. Maintenance of Riparian Vegetation.

Ability of the stream and adjacent terrestrial and wetland habitats to maintain characteristic vegetation.

FCI: (Vfreq + Vwetuse +Vwatersheduse + Vshade + (Vvegcov+ Vstrata)/2 + Vtreeba)/6



Effects On-site: Vegetation provides organic matter and nutrients to support resident organisms. Vegetation provides habitat structure required by animals and influences micro-climatic conditions. Vegetation also provides roughness in the channel, influencing hydrologic processes, and it provides vegetation provides a source of coarse woody debris input to the channel resulting in the formation of logjams and floodplain development.

Effects Off-site: Vegetation provides habitat supporting regionally and locally wide ranging and migratory species. If harvesting of riparian forests is done in a sustainable manner, it can provide economic benefits far off site.

Rationale for Functional Index: In assessing this function, the current conditions as well as the physical factors that are present to re-establish the community are considered. The ability to maintain a plant community is important because many other functions rely on a healthy and diverse riparian plant community.

Logic: The function is predicted by treating equally the structural components (extent, number of strata, tree density, and basal area) of the riparian plant community and by estimating the frequency of overbank flow.

9. Maintenance of Connectivity and Interspersion.

The ability to maintain characteristic wetland and non-wetland areas in the riverine area and at the landscape scale within the watershed is what this variable represents. It is important to many species to have an undegradated water column with a connected riparian area as well as landscape habitat to carry out their daily activities, such as feeding or resting, or to complete a particular phase of their life cycle.

FCI: (Valthhydro+ Vsubin + Vwetuse + Vwatersheduse + Vbarrier) /5

Valthhydro Vsubin
Vwetuse Vwatersheduse
Vbarrier

Effects On-site: Habitat fragmentation on site directly influences the residency of fish resources. As each species can withstand a certain amount of interference in their search for food, water, and cover, the condition of the habitat governs its quality. Species richness will occur in the most undisturbed habitat.

Effects Off-site: The "nearest neighbor" concept works well for reviewing at connectivity and interspersion. If the bordering environment is hostile to fish (rock wall or levee), then onsite conditions may not matter. The best conditions would be found in environments that present a balance and do not favor one species or one activity.

Rationale for Functional Capacity Index: It is important to many species to have an undegradated water column, with a connected riparian area, as well as landscape habitat to carry out their daily activities, such as feeding or resting, or to complete a particular phase of their life cycle.

Logic: Several elements are given equal rating to approximate this function. The impacts of humans on the hydrology (Valthydro + Vwetuse + Vwatersheduse) is additive in both concept and in reality. Also, the introduction of barriers (Vbarriers) to a stream will influence fish movement and productivity.

Table 9. List of Riverine Wetland Model Variables

Relationship of Variables to Wetland Functions for Riverine Wetlands.

Functions Variables	Meander	Dynamic Flood	Nutrient	Particulate Retention	Removal	Aquatic Biota	Coarse Wood	Riparian Vegetation	Connectivity
Valthydro	X				X				X
Vbarrier									X
Vchanrough	X		X			X			
Vcwin	X		X	X			X		
Vcwpot	X	X	X	X			X		
Vembedded						X			
Vfreq	X	X		X	X		X	X	
Vlogjam	X	X		X			X		
Vpebble-D50		X		X					
Vshade			X			X		X	
Vsoilperm			X		X				
Vstore		X							
Vstrata								X	
Vsubin			X		X	X			X
Vtreeba				X	X			X	
Vvegcov		X		X	X			X	
Vwatersheduse	X	X	X					X	X
Vwetuse	X					X		X	X

Table 10. List of Riverine Variables Organized by Data Collection Groups

Stream Channel	
1. Vpebble-D50	Median Particle Size (D50)
2. Vchanrough	Channel Bed Roughness (D84)
3. Vembedded	Embeddedness
4. Vcwpot	Potential Coarse Wood
5. Vcwin	In-Channel Coarse Wood
6. Vlogjams	Logjams
7. Vsubin	Subsurface Flow into the Water/Wetland
8. Vshade	Riparian Shade
Hydrology and Soils	
9. Valthydro	Alterations of Hydroregime
10. Vbarrier	Barriers to Fish Movement
11. Vfreq	Overbank Flood Frequency
12. Vstore	Flood Prone Area Storage Volume
13. Vsoilperm	Stream Bank Soil Permeability
Vegetation and Land Use	
14. Vtreeba	Tree Basal Area
15. Vvegcov	Total Vegetative Cover
16. Vstrata	Number of Vegetation Strata
17. Vwetuse	Land use of Assessment Area Use
18. Vwatersheduse	Watershed Land Use

Description and Scaling of the Riverine Model Variables

1. Median Particle Size-D50 (Vpebble-D50)

Definition: The median particle size of the channel (i.e., D50).

Measurement Protocol: Conduct a pebble count, taking 100 samples, which will serve as the basis for scaling two other variables (Vchanrough and Vembedded). To conduct a pebble count, take a random walk (meander) over the streambed within the Project Assessment Area reach. Be sure to walk both up and downstream. Over the toe of your right boot and with eyes closed or averted, touch an extended finger to the nearest rock or sand grain. Pick up the rock or sand, but not wood. Use a transparent ruler and hold the sample behind the scale. Measure along the intermediate or "B" axis (i.e. neither the longest or the shortest. Record your measurements in millimeters (mm). Be sure to record the lower limit of the size class into which the rock falls (Dunne and Leopold, 1978).

Input each measurement onto the Pebble Count Table. In doing so, you are constructing a "histogram" (bar chart) that shows the size distribution of the inorganic stream bed materials. Using standard statistical methods, determine the D50 as being the median particle size of the samples. This can be done in the office after the samples are measured.

Data: See Appendix 3.

Rationale for Selecting the Variable: Variation in characteristic bedload particles and size distribution indicates basin-wide processes (natural and anthropogenic) and affects characteristic channel dynamics (e.g., bed elevations, width to depth ratios, etc.).

Scaling Rationale: With the exception of artificial channelization, D50 provides an indicator of stream energy in reference standard and more natural stream conditions. D50 indicates stream energy that provides nutrient spiraling, increases oxygenation and aggregation, and decreases accumulation of sediments.

Scaling: Vpebble-D50

MEASUREMENT OR CONDITION FOR (VPEBBLE-D50)	INDEX
D50 is within the range of 12 mm to 113 mm and there is no evidence of large-scale human disturbance activities (e.g., large mass-wasting events, forestry practices, housing developments, etc.) in the watershed above or adjacent to the Project Assessment Area that would result in the input of fine sediment to the Project Assessment Area.	**1.0**
D50 is within the range of 12 mm to 113 mm and there is evidence of disturbance in the watershed above or adjacent to the Project Assessment Area that could result in the input of fine sediment to the Project Assessment Area (e.g., channelization, gravel mining, rip-rap, etc.).	**0.5**
D50 is not within the range of 12 mm to 113 mm and there is evidence of disturbance in the watershed above or adjacent to the Project Assessment Area that has resulted in the input of fine sediment to the assessment area (e.g., channelization, gravel mining, rip-rap, etc.) and/or bedload transport capacity has been reduced and/or eliminated (e.g., reduced flows in Duck Creek, Juneau, Alaska).	**0.1**
No bedload (e.g., dams, levees, major channel modifications) have eliminated bedload, e.g., Gold Creek, Juneau, Alaska.	**0.0**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Medium**

2. Channel Bed Roughness (Vchanrough)

Definition: The size of the larger inorganic streambed materials (the "D84" or 84th percentile). The "D84" is an estimate of the larger particle sizes that move into the Project Assessment Area channel during larger (e.g., >10-year return interval) floods.

Measurement Protocol: Conduct a pebble count. Take 100 samples. This count will serve as the basis for scaling two other variables (VpebbleD50 and Vembedded).

To conduct a pebble count, take a random walk (meander) over the streambed within the Project Assessment Area reach. Be sure to walk up and downstream. Over the toe of your right boot and with eyes closed or averted, touch an extended finger to the nearest rock or sand grain. Pick up the rock or sand, but not wood. Use a transparent ruler and hold the sample behind the scale. Measure along the intermediate or "B" axis (i.e., neither the longest nor the shortest. Record your measurements in millimeters (mm). Be sure to record the lower limit of the size class into which the rock falls (Dunne and Leopold, 1978).

Input each measurement onto the Pebble Count Table. In doing so, you are constructing a "histogram" (bar chart) that shows the size distribution of the inorganic stream bed materials. Using standard statistical methods, determine the D84 as being the particle size that is one standard deviation larger in size than the mean size particle. This calculation can be done in the office after the samples are measured and recorded.

Data: See Appendix 3

Rationale for Selecting the Variable: This variable represents the resistance to flow of surface water resulting from physical features (or the lack thereof) within the channel. The relationship between roughness and velocity of surface water flow determines the ability of the water column to keep sediment particles entrained. As roughness increases, the velocity of water decreases and thus sediment deposition occurs. Streambed roughness helps to limit the ability of water to perform work (i.e. limits kinetic energy) and thus to create hydraulic diversity (e.g., scour pools, bars, riffles, eddies, etc.) in the channel. Depth of flow is also important in determining roughness of the streambed. This is because as water depth increases, obstructions on the streambed are over topped. Consequently, roughness of the streambed decreases with increasing depth.

Scaling Rationale: Within the range of variation in longitudinal channel slopes the authors have observed that natural streambed roughness increases with the longitudinal gradient (slope) of the stream channel. Further, the authors have observed that human and natural disturbance of stream ecosystems (e.g., channelization, road construction, bank stabilization) tends to result in a decrease in natural streambed roughness. It is important to note that the factors that contribute to streambed roughness (e.g., rock, sand, riprap, etc.) change markedly away from reference standard conditions with increasing human disturbance. A fundamental assumption that the authors have made is that sediment inputs from human sources are detrimental and not consistent with maintenance of streambed roughness in the reference standard condition.

Scaling: Vchanrough

MEASUREMENT OR CONDITION FOR (VCHANROUGH)	INDEX
D84 is ≥106 mm **and** the site is not appreciably altered (e.g., logging >80 years ago; hiking trails in a green belt, etc.). Sediment inputs to the stream system can and do occur, but their sources are from naturally occurring disturbances (e.g. landslides, windthrow, streambank scour, etc.)	**1.0**
D84 ranges between ≥ 79 – 106 mm **and** the site is predominantly undisturbed and characterized by very minor and localized disturbance (i.e. 1-4% of the Project Assessment Area reach) to the streambed and little to no input of sediment to the stream from human disturbances.	**.75**
D84 ranges between >53 - 79 mm **and** in or near-stream projects have resulted in minor and localized (5-10% aerial extent) hardening of the streambed (e.g., a ford) within the Project Assessment Area reach. There are minor inputs of fine textured sediment to the stream channel from disturbances (e.g. adjacent yards, parking lots, log truck and skid roads, etc.).	**.50**
D84 ranges between >20 and ≤53 mm **and** in or near-stream projects (e.g., channelization or bank stabilization, buried pipe or powerline crossings) have resulted in hardening of portions (ie.10 - 20% aerial extent) of the stream bed (e.g., for footings or fords) or alteration of the flow regime within the Project Assessment Area reach. There is a high proportion of fine sediment inputs to the system from human sources (e.g., adjacent yards, landfills, placer mine tailings, parking lots, log truck and skid roads, etc.).	**.25**
D84 ranges between > 2 <19 mm and/or in or near-stream projects (e.g., channelization, bank stabilization, or buried pipe or powerline crossings) have resulted in hardening of large portions of the stream bed (e.g. for footings or placer mine tailings) within the Project Assessment Area reach. In low gradient streams (e.g., nearly level to <1% longitudinal slope) there are obvious sediment inputs to the system from disturbances (e.g., adjacent yards, landfills, snow dumps, log truck roads, etc.) In high gradient streams (e.g., channel slope >1%), there are obvious sediment inputs to the system from disturbances (e.g. adjacent yards, landfills, logging roads, etc.) and sediment is regularly flushed (winnowed) from the system by high energy flows. In **both** low and high gradient streams, the variable is recoverable and sustainable through natural processes if the existing land use is discontinued and restoration measures are applied.	**.10**
D84 is ≤ 2 mm and/or the channel bed is poured concrete or rip/rap with low to very low design channel bed roughness. Sediment (if any) has a very short residence time in the system. The variable is not recoverable or sustainable through natural processes if the existing land use is discontinued and no restoration measures are applied.	**.00**

Confidence that Reasonable Logic and/or Data Support the Calibration: **High**

3. **Embeddedness (Vembedded)**

Definition: The percent of fine sediment (clay, silt, and sand) surrounding gravel, cobble, and boulder particles in the Project Assessment Area reach.

Measurement Protocol: As part of the pebble count, take 100 samples. This count will also serve as the basis for scaling Vchanrough. To conduct a pebble count, take a random walk (meander) over the streambed within the Project Assessment Area reach. Be sure to walk up and downstream. Over the toe of your right boot and with eyes open determine the percent of sediment surrounding the nearest rock or sand grain. Record the percentage along with the measurement of the size of the rock.

Data: This is a new variable that was added to the model after the field data was collected. Therefore there is no reference data to support this variable. However, as noted below, there is a large body of literature and studies to support the importance and use of this field indicator.

Rationale for Selecting the Variable: The percent of embeddedness is a field indicator for amount of sediment. Recent studies have included embeddedness as a field indicator for habitat (National Marine Fisheries Service, 1996, indicators for "Properly Functioning," and EPA Aquatic Habitat Assessment Indicators, July 1999).

Scaling Rationale: Because the variable was added to the model after data was collected, the scaling uses the EPA Region 10 Aquatic Habitat Assessment Indicators, July 1999 Study, for riffle/run prevalence field indicators.

Scaling: Vembedded

MEASUREMENT OR CONDITION FOR (VEMBEDDED)	INDEX
Fine sediment surrounds 0-25% of the gravel, cobble, and boulder particles from the 100 sample pebble count.	**1.0**
Fine sediment surrounds >25 < 50% gravel, cobble, and boulder particles from the 100 sample pebble count.	**.75**
Fine sediment surrounds >50 < 75% gravel, cobble, and boulder particles from the 100 sample pebble count.	**.50**
Fine sediment surrounds >75 % gravel, cobble, and boulder particles from the 100 sample pebble count.	**.25**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Medium**

4. **Potential Coarse Wood (Vcwpot)**

Definition: The number of live trees (> 5" DBH) within 10 feet on either side of the bankfull margin and 100 feet upstream and 100 feet downstream of the channel cross-section.

Measurement Protocol: Count the number of trees that are >5" DBH at the midpoint within 10 feet from either side of the bankfull margin and within 100 feet upstream and 100 feet downstream of the channel cross-section. One transect should be upstream of the channel cross section and the second transect should be below the channel cross-section. Opposite banks should be sampled (i.e., if the left bank is assessed upstream then the right bank is assessed downstream and vice versa).

Data: See Appendix 3.

Rationale for Selecting the Variable: Trees provide channel bank stability through the establishment of root structure and biomass. They also contribute to coarse wood in-channel. Potential coarse wood contribute long term released carbon which contributes to the structural components of the ecosystem.

Scaling Rationale: The number of tree along the bank of streams varied between 5 to 33 trees at the reference standard sites. Therefore the index value of 1.0 was given to 5 - 33 trees. The other indexes were scaled to the lowest number of trees observed according to the impact ranking groups in the array sheets (see Appendix 3). Also, a few of the highest ranked impact sites had 27 – 30 trees. This can be attributed to the dense regrowth due to being harvested within 50 years ago or adjacent residential development-.

Scaling: Vcwpot

MEASUREMENT OR CONDITION FOR (VCWPOT)	INDEX
≥5 trees total within a 100-foot reach upstream and 100-foot downstream of the stream cross-section and within 10 ft of the bankfull margin; no evidence of human disturbance (i.e., within 10 ft of the bankfull margin).	**1.0**
2 to 4 trees total within 100 foot reach upstream and 100 foot downstream of the stream cross-section and within 10 ft of the bankfull margin: no evidence of human disturbance (i.e., within 10 ft of the bankfull margin).	**.50**
1 tree total within 100 foot reach upstream and 100 foot downstream of the stream cross-section and within 10 ft of the bankfull margin: no evidence of human disturbance (i.e., within 10 ft of the bankfull margin).	**.25**
No trees present within 100 foot reach upstream and 100 foot downstream of the stream cross-section and within 10 ft of the bankfull margin.: evidence of human disturbance (i.e., within 10 ft of the bankfull margin) of the project assessment area. Potential for restoration of the riparian forest exists.	**.10**
No trees present within 100 foot reach upstream and 100 foot downstream of the stream cross-section and within 10 ft of the bankfull margin.: evidence of human disturbance (i.e., within 10 ft of the bankfull margin) of the project assessment area. No potential for restoration of the riparian forest exists.	**.00**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Medium**

5. In - Channel Coarse Wood (Vcwin)

Definition: Single pieces of coarse (large) wood >4" diameter and longer than 10 feet located below the bankfull stage and not members of a log jam.

Measurement Protocol: Flag the stream reach 100 feet upstream and downstream of the main (representative) channel cross section within the Project Assessment Area. Count the number of single coarse wood pieces or logs that occur below bankfull stage that are not part of log jams. Record the diameter, length, decomposition class, and nurse log status of each piece.

Data: See Appendix 3.

Rationale for Selecting the Variable: In-channel coarse wood helps to alter the hydrodynamics of the stream by creating hydraulic diversity. For example, coarse wood can: (1) alter the course of the stream (e.g., avulsions around log jams), (2) affect the development of flood plains, (3) control channel bed elevations, (4) retain sediments, and (5) create scour and step pools.

In particular, coarse wood in the channel provides roughness, which causes turbulence and thus (1) limits stream water velocities, and (2) provides localized areas where water is oxygenated. Coarse wood limits and/or focuses scour and stabilizes the stream bed and bank (Murphy and Koski, 1989). Individual pieces of coarse wood constitute a portion of the source of wood for log jams. Coarse wood also provides a source of refractory organic carbon and nutrients, which contributes energy to aquatic food webs.

Coarse wood provides and/or helps to create in-stream habitat features such as scour pools, thalweg variability, back eddies, and zones of relatively still water within the main channel (i.e., slack water). Logs and other woody debris provide thermal, escape resting hiding and feeding cover, and a moist environment for a myriad of species including invertebrates (e.g., may flies, caddis flies), vertebrates (e.g., adult and juvenile salmonids), and plants (Hunter 1990).

Scaling Rationale: In general, in-channel coarse wood tends to decrease with increasing disturbance to the system. In addition, increasing development around the channel changes the sources, loading rates, and residence time of in-channel wood. Therefore, for the purposes of this model, in-channel coarse wood within the range of the reference standard conditions is optimum, and either too much or too little wood represents departure from reference conditions and thus degradation of the variable condition.

Note: The authors are seeking literature to support the best professional judgement that much large wood in a channel, caused by human disturbance, creates a negative influence on the functions that this variable represents. In some places in SE Alaska too much large wood occurs in the channel creating unstable channel conditions and extensive flooding because of logjams and subsequent dams. In areas where buffers blow down, the amount of large wood exceeds the ratings.

Scaling: Vcwin

MEASUREMENT OR CONDITION FOR (VCWIN)	INDEX
There are ≥ 8 pieces and < 25 pieces/200-ft reach of channel. The residence time of coarse wood in the channel is long, because the coarse wood is embedded and/or relatively stable (e.g., portions of the coarse wood are buried by sediments and the pieces are large, possibly interacting with other coarse wood and thus not capable of moving downstream except from catastrophic floods).	**1.0**
There are > 8 pieces and < 25 pieces per 200-ft reach of channel. The residence time of CW in the channel is long, because the CW is embedded or partially embedded and/or relatively stable (e.g., portions of the CW are buried by sediments and the pieces are large, possibly interacting with other CW and thus not capable of moving downstream, except from catastrophic floods).	**0.75**
There are ≥ 4 and < 8 pieces or >25 pieces of CW per 200-ft reach of channel. The residence time of CW debris in the channel is such that CW is mobile, but only on significant flood events (e.g., the 2-10 year flood).	**0.50**

MEASUREMENT OR CONDITION FOR (VCWIN)	INDEX
There are ≤ 4 pieces or >25 pieces of CW per 200-ft reach of channel. The residence time of CW in the channel is such that CW is mobile on 1-5 year flood events. The variable is recoverable in time through natural processes if the existing land/channel uses are discontinued.	**0.25**
There ≤ 2 pieces of CW per 200-ft reach of channel and there is not a source of, or roughness to trap CW. The residence time of CW in the channel is very short (i.e., CW will be moved out of the channel by normal storm flows or less). This condition is not recoverable through natural processes. However, the variable is recoverable through restoration measures that will eventually restore in-channel CW (e.g., planting trees along the stream banks or placing logs in the channel).	**0.10**
There are ≤ 2 pieces of CW per 200-ft reach of channel **AND** there is not a source of or roughness to trap CW (e.g., the channel below bankfull is poured concrete or confined in a culvert or flume) and therefore the residence time of wood in the channel is very short (i.e., CW will be moved out of the channel by normal storm flows or less). This condition is not recoverable through natural processes or through restoration.	**0.00**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Medium**

6. <u>Log jams (Vlogjams)</u>

Definition: Two or more anchored coarse wood pieces below bankfull stage that are in contact with each other constitute a logjam.

Measurement Protocol: Count and assess all logjams within a 200-foot reach of the channel. The 200-ft reach was defined by combining the upstream and downstream flagged 100-foot sections.

Data: See Appendix 3.

Rationale for Selecting the Variable: Provide structure, habitat diversity, and aquatic and terrestrial dependent taxa. Provide carbon and structure for plant growth.

Scaling Rationale: The authors have observed that throughout the subclass, the number of logjams increased as sites approached reference standard conditions.

Scaling: Vlogjams

MEASUREMENT OR CONDITION FOR (VLOGJAMS)	INDEX
Greater than 4 logjams and the site has not been logged for more than 80 years and there has not been other development activity.	**1.0**
3 to 4 logjams.	**.75**
Less than 3 logjams.	**.50**
No logjams within bankfull channel. Potential for accumulation of coarse wood into logjams exists.	**.10**

MEASUREMENT OR CONDITION FOR (VLOGJAMS)	INDEX
No logjams with in backfill channel. No potential for accumulation of coarse wood into log jams exists.	**.00**

Confidence that Reasonable Logic and/or Data Support the Calibration: **High**

7. <u>Subsurface Flow into the Wetland (Vsubin)</u>

Definition: Subsurface flow into the water/wetland from adjacent areas.

Measurement Protocol: Count the frequency of subsurface flow indicators along the channel bank 100 ft upstream and downstream of the center of the assessment area, including natural and human created locations. Subsurface flow indicators include water seeps flowing into the stream from the ground along the streambank, upwelling water in pools or backchannels within the stream, and flocculation of rust colored material concentrated near the streambank.

Data: See Appendix 3.

Rationale for Selecting the Variable: Subsurface flow into the wetland transports groundwater and elements and compounds used in nutrient spiraling for the wetland and stream. It also maintains base flow and contributes to stable stream water temperature.

Scaling Rationale: Field observations confirmed that increased subsurface flow toward a channel maintained more natural conditions. There was a clear trend in the data with the exception of continuous flows. The continuous Vsubin was discounted because it was caused by perturbations (such as channel alterations from large residential and street improvements).

Scaling: Vsubin

MEASUREMENT OR CONDITION FOR (VSUBIN)	INDEX
Areas adjacent to and upstream of the assessment area are predominately <u>undisturbed</u> native soils and plant communities **AND** there is direct evidence of subsurface flow into the assessment area (e.g., seeps, iron flock, artesian flow, upwelling).	**1.0**
Areas adjacent to and upstream of the assessment area are predominately <u>undisturbed</u> native soils and plant communities **AND** there is **NO** direct evidence of subsurface flow into the assessment area (e.g., seeps, iron flock, artesian flow, upwelling).	**.75**
Areas adjacent to and upstream of the assessment area are predominately <u>disturbed</u> (e.g., residential or recreational development) native soils, and plant communities **AND** there is **NO** direct evidence of subsurface flow into the assessment area (e.g., seeps, iron flock, artesian flow, upwelling).	**0.50**
Areas adjacent to the upstream of the assessment area are predominately impervious surfaces and direct evidence of subsurface flow to the water/wetland is observed (e.g., seeps, iron flock, artesian flow upwelling).	**0.25**
Areas adjacent to the upstream of the assessment area are predominately impervious surfaces and no direct evidence of subsurface flow to the water/wetland is observed.	**0.1**
The assessment area is contained within a concrete channel, culvert, etc.	**0.0**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Medium**

8. <u>Riparian Shade (Vshade)</u>

Definition: Tree cover, shrub cover, and overhanging vegetation within and near the bankfull channel.

Measurement Protocol: Measure percent of canopy cover over entire water surface as if the sun was directly overhead.

Data: See Appendix 3.

Rational for Selecting the Variable: Tree, sapling, and shrub cover provide shade that regulates water temperature and in-channel light interception. Overhanging vegetation provides potential food sources and habitat for aquatic dependent taxa.

Scaling Rationale: Data from the EPA Region 10 Aquatic Habitat Indicators, July 1999 study and best professional judgement was used to scale the variable.

Scaling: Vshade

MEASUREMENT OR CONDITION FOR (VSHADE)	INDEX
40% - 60% vegetative shading of stream surface area. A mixture of conditions where some areas of water surface are fully exposed to sunlight, and others receive various degrees of filtered light.	**1.0**
20% - 39% <u>or</u> 61% - 80% vegetative shading of stream surface area. Covered by sparse canopy, entire water surface receiving filtered light.	**.50**
1% - 19% or 81% - 100% vegetative shading of stream surface area. Water surface is approaching either complete vegetative shading or full exposure to overhead sunlight conditions.	**.25**
No vegetative shading of stream surface area. Variable is recoverable or sustainable through natural processes under current conditions (e.g., natural regeneration of riparian vegetation).	**.10**
No vegetative shading of water surface. Variable is not recoverable or sustainable through natural processes.	**0.0**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Medium**

9. <u>Alterations of Hydroregime (Valthydro)</u>

Definition: Alterations of in-channel hydroregime in the project assessment area (i.e., human disturbances that change flood frequency, duration, magnitude, etc.).

Measurement Protocol: Using visual observation note the human alterations that would affect the hydro regime. If there are any alterations such as dams, storm water structures, forest practices, etc., then on the field data sheets record a yes or "1." If there aren't any, then record a no or "0."

Data: See Appendix 3.

Rationale for Selecting the Variable: The variable was selected because alternations can result in stream channel morphology (bedload, coarse wood, logjams, bank stability, pool riffles, etc.).

Scaling Rationale: The authors scaled the variable using recorded field observations which supported the premise that alterations to the hydroregime degrade natural stream channel conditions.

Scaling: Valthydro

MEASUREMENT OR CONDITION FOR (VALTHYDRO)	INDEX
No additions, diversions, or damming of flow affecting the assessment area (e.g., 1) no stormwater management structures, water harvesting, forest practices, or 2) natural levee not associated with human activity, etc.).	**1.0**
Evidence of diversions with minor effects to flow. Examples include stabilized beaver dams, well designed bridge embankments and/or bridge pilings that do not restrict the width of the stream or adversely affect stream hydrology (e.g., stabilized slopes, no evidence of scouring or deposition in the vicinity of the structure, etc.).	**.75**
Evidence of additions, diversions, or damming of flow affecting the assessment area that have resulted in some impact, but not an appreciable impact to hydrologic functions. Examples include small stormwater management outfalls, small/stabilized stormwater ditches, individual wells or potable water intakes, forest practices that maintain adequate riparian buffers, road crossings that restrict peak flows but not ordinary high water flows, etc.	**.50**
Evidence of additions, diversions, or damming of flow affecting the assessment area that have appreciably impacted hydrologic functions. Examples include extensive storm water management or water withdrawal activities, forest practices or other activities that introduce sediment loading into the stream, undersized and/or unmaintained culverts, gravel dredging, alteration of channel morphology (width/depth ratios), nutrient loading (algae and diatom blooms), water diversion, undersized culverts, and flow reductions. Variable is recoverable nor sustainable through natural processes under current conditions.	**0.1**
Permanent alterations to the assessment area hydroregime. Variable is not recoverable, nor sustainable through natural processes under current conditions.	**0.0**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Medium**

10. <u>Barriers to Fish Movement (Vbarrier)</u>

Definition: Presence of man-made structures or other types of disturbances that prevent fish movement upstream.

Measurement Protocol: Using aerial photography, identify obstructions or barriers to stream channel flow. In addition to using the aerial photography pace 500 feet down stream of the boundary of the project assessment area. List type and number of human disturbances such as culverts, wide spanned bridges, temporary bridges, and other land uses within the observation area.

Data: See Appendix 3.

Rationale for Selecting the Variable: Land use surrounding the project assessment area can affect the capacity of a wetland to support wildlife species in a project and landscape context.

Habitat fragmentation can also occur from surrounding land use. The landscape context for the riverine subclass is driven by compressed, linear, and high gradient watersheds.

Scaling: Vbarrier

MEASUREMENT OR CONDITION FOR (VBARRIERS)	INDEX
No impact (e.g., instream structures may be present but do not affect water quality, quantity or natural migration patterns of aquatic species indigenous to the waterbody). Examples include downstream bridges or road crossings that don't constrict ordinary or flood flows, utility lines where pre-project conditions have been restored, minor water withdrawal activities, stream vehicle fords, etc.	**1.0**
Minimal impact (e.g., downstream structures affect passage during flows higher than ordinary high water events but do not affect passage at other times). No apparent sources of contaminants, sediments, etc. that affect water quality.	**.75**
Minimal impact (e.g., downstream structures affect passage during flows higher than ordinary high water events but do not affect passage at other times. Observable sources of contaminants and sediments that potentially affect water quality such as storm drains, parking lots, retaining walls, lawns, unstabilized slopes, etc.).	**.50**
Passage is affected at ordinary high water flows by inadequately installed or maintained culverts, barriers to migration or other features. Observable sources of contaminants and sediments that potentially affect water quality such as storm drains, parking lots, retaining walls, lawns, unstabilized slopes, etc.).	**.25**
Fish passage is blocked and water quality adversely impacted by heavily urbanized concentration of commercial/residential, airport, gravel pits, through-fill roads with ditches, parking lots, etc. Variable is not recoverable through natural processes.	**0.0**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Low**

11. <u>Overbank Flood Frequency (Vfreq)</u>

Definition: Estimate of the frequency of how often bankfull is exceeded.

Measurement Protocol:

A. Direct Measurement - Stream gauge information available: use the data from stream-gauging stations for estimates of this variable. Contact the US Geological Survey (USGS) in Juneau, Alaska at (907) 586-7216 to determine the availability of stream gauge information. The USGS also has an internet web page located at "ak.water.usgs.gov." The USGS can provide an estimate of the magnitude of a particular flooding event and a frequency of flooding estimate for the project assessment area, which should be used if available, prior to relying on visual field indicators having less precision.

10. Indirect Measurement - Gauge information not available: Visually use field indicators such as high water marks, silt lines, drift, seed and debris lines, grasses and other tall non-woody vegetation lying down as a result of overbank flows, tree bark damaged by floating debris, and evidence of channel scour and sediment deposition. These indicators can reflect recent flooding or an infrequent event and may not be particularly helpful in establishing the flood return interval at a

particular site. The use of the indicators in conjunction with an assessment of the depth of organic litter, decomposition stage, and vegetation type (e.g., woody or herbaceous) provides an estimate of the frequency of overbank flooding in the project assessment area. Site characteristics are compared to range of conditions expressed in the variable indexes.

Data: See Appendix 3.

Rationale for Selecting the Variable: The annual frequency at which a channel overtops its banks (when bankfull discharge is exceeded or water is delivered from upland sources) is important as a driving force for several wetland functions. Hydrologic implications include dynamic water storage, energy dissipation, and maintaining characteristic channel meander belts. Biogeochemical implications include nutrient spiraling, organic carbon export, particulate retention, and removal of imported elements and compounds. Habitat implications include maintenance of characteristic vegetation (overbank flooding facilitates the dispersal of plant seeds and other propagates), maintenance of detrital biomass, and maintenance of aquatic dependent taxa.Scaling: Vfreq

MEASUREMENT OR CONDITION FOR (VFREQ)		
Indirect Measure	**Direct Measure**	**INDEX**
No litter to a very thin layer (< 1 cm) of non-decomposed material present on wetland surface. Presence of high water marks, silt lines, drift, seed and debris lines, and/or scattered grasses lying down as a result of overbank flows. Evidence of channel scour and sediment deposition present. Fluvial deposited logs and organic debris on channel banks with little moss, lichen, seedlings or leaf litter accumulations on these surfaces. Overall percent cover of herbaceous vegetation is low and vegetation consists of species typical of primary colonization. If trees are present they may appear stressed from frequent inundation unless established on larger nurse logs or on coarser/ better drained sediments adjacent to channel bank. Estimated flood frequency is 1-2 year return intervals.	Gauge data extrapolated to project assessment area reflects 1-2 year return interval.	**1.0**
Thin litter cover (1-3 cm) ranging from recent to partly or completely decomposed material. Fluvial deposited logs and organic debris on channel banks with moss, lichen, seedlings, or decomposing leaf litter accumulations on these surfaces. Natural levees present immediately adjacent to the channel bank. Mature trees present along with some species typical of primary colonization. Bark of trees may show indications of damage from floating debris, and red squirrel midden accumulations may be concentrated at base of larger trees in the wetland. Estimated flood frequency is 2-10 year return intervals.	Gauge data extrapolated to project assessment area reflects 2-10 year return interval.	**0.75**
Thick litter cover (>3 cm) with lower layer completely decomposed. No evidence of overbank deposits and fluvial transported debris not present. Dominant vegetation is mature trees (unless artificially manipulated - e.g., lawn or timber harvested). Estimated flood frequency is > 10 year return interval.	Gauge data extrapolated to project assessment area reflects > 10 year return interval.	**0.5**
Artificial flood control features that affect assessment area present (e.g., man-made levees, flood control channels, upstream flood control impoundments, etc.).	Gauge data extrapolated to project assessment area indicates that no overbank flooding is likely.	**0.0**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Medium**

12. <u>Flood Prone Area Storage Volume (Vstore)</u>

Definition: Ratio of flood prone area width divided by channel width at bankfull.

Measurement Protocol: Identification and bounding of the flood prone area are key measurements because they establish the boundary of the assessment area and riverine wetland subclass.

1. Use either the methods below to determine flood prone area (riverine boundary).

   A. Visual Estimate: If you are familiar with the subclass and river morphology you can estimate the width of the flood prone area visually. A crude estimate can be made using aerial photos, topographic maps, and field indicators. This should be done only if you have experience in the area. OR

   B. Direct Measurement: The flood prone area can be defined by projection of a plane at twice the bankfull thalweg depth (deepest part of the stream, see Figure 10 Stream Channel cross-section and measurements).

      i) Determine the width of the channel by using a measuring tape, measure from the edge of bankfull on one side of the stream to the bankfull on the opposite side of the stream.
      ii) Determine the point on the stream channel transect at the deepest point of the stream (thalweg depth). Measure the depth from the transect line.
      iii) Double the thalweg depth measurement and project it vertically up. At that point extend a horizontal plane out past bankfull to determine the boundary of the flood prone area on each side of the stream (See Figure 10).

2. Calculate a ratio by dividing the flood prone area (2x thalweg) width by the channel width (bankfull).
3. Based on the estimates above, scale the variable using the scaling index below.

Data: See Appendix 3.

Rational for Selecting the Variable: This variable represents the volume that is available for storing surface water during flood events. It is designed to detect changes in storage volume that result from levees, roads or other man-made structures that have been placed in areas prone to flooding. Flood prone area is a rough approximation of the 50-year flood plain and represents the boundary for riverine wetland subclass within the reference domain. As the ratio decreases, flood prone area storage volume decreases.

Scaling: Vstore

DIRECT MEASUREMENTS FOR (VSTORE)	INDEX
Ratio > 2.5	1.0
Ratio 1.3 to 2.5	.50
Ratio 1.0 to 1.3	.10

Confidence that Reasonable Logic and/or Data Support the Calibration: **Low**

13. Stream Bank Soil Permeability (Vsoilperm)

Definition: Permeability is defined as the ease with which gases, liquids or plant roots penetrate or pass through a bulk mass of soil or a layer of soil. The type of soil parent material that makes up the stream bank below bankfull depth is a fair estimate of soil permeability.

Measurement Protocol: Dig a soil pit from bankfull depth to channel bed and determine if the soil material is organic, mineral or a mixture of organic/mineral layers. In addition, determine the dominant size fraction of the mineral (e.g., clay, silt, sand, gravel, stones).

Data: See Appendix 3.

Rational for Selecting the Variable: The type of soil in the bank of a stream will influence the rate of water gain or loss into a channel. If the dominant size fraction is coarse, the rate of loss/gain may be high, whereas if the material is fine (sand, clay, or sapric material), the rate will be much slower. This is a rough estimate of hydaulic conductivity and may play an important role in nutrient spiraling and organic carbon export as well as aquatic habitat functions. Stream banks also regulate the amount and size of the sediment. If the banks are sandy and unstable, the probability of having sand-sized sediment is high. That is in contrast to having clay banks, which can be unstable but, due to the small size of the clay particles, generally don't contribute to sediment loading.

Scaling: Vsoilperm

INDIRECT MEASURE FOR (VSOILPERM)	INDEX
Sandy or gravelly material has porosity and is able to transmit water either into or from the channel. Organic soil is dominated with fibric- sized material.	**1.0**
Silty soil material that has limited porosity and not likely to transmit much water into or from a channel. Organic soil is dominated with hemic-sized material.	**.5**
Clay soil material that has no porosity and not able to transmit water into or from a channel. Organic soil is dominated with sapric-sized material.	**.1**
No natural stream banks (e.g., concrete) or impervious channel liner.	**0**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Medium**

14. Tree Basal Area (Vtreeba)

Definition: Basal area of trees (>5" DHB) within the assessment area.

Measurement Protocol: Establish a point-center-quarter (PCQ) at least 30 ft from bankfull in a representative area of the floodplain. Using a prism, angle gauge measurement or other comparable instrument, stand at the center of the PCQ and count the trees within a 1/10 acre plot. Multiply the number of tree falling within the range of the cruise angle by the Basal Area Factor (BAF) which is indicated on the prism or angle gauge value, to determine the sq ft /acre of each tree species. Repeat this procedure to take a second measurement at a location that is ecologically similar to the first. For example, if the first BAF is done in coniferous forest, the second one should also be done in coniferous forest and not in emergent vegetation or a large gap etc.

Data: See Appendix 3.

Rationale for Selecting the Variable: Off-channel trees are sources of organic carbon. Off-channel trees contribute refractory wood, leaves, stems, detritus, etc., to the channel (i.e., mobile and refractory organic carbon source). Average appear reasonable, however the variation is wide.

Scaling: Vtreeba

MEASUREMENT OR CONDITION FOR (VTREEBA)	INDEX
Forest not appreciably altered (i.e., not harvested within > 80 years. Stand basal areas may vary due to natural gap processes.	**1.0**
Greater evidence of human disturbance > 200 feet^2/acre.	**.75**
Basal areas range > 150 < 200 feet^2 /acre.	**.50**
Basal areas are <150 feet^2/acre. Evidence of human activity (e.g., selective logging).	**.25**
No trees present and riparian forest has been clear-cut or modified by human disturbance. Variable is recoverable or sustainable through natural processes under current conditions.	**.10**
No trees present and riparian forest has been clear-cut or modified by human disturbance. Variable is NOT recoverable or sustainable through natural processes under current conditions.	**.00**

Confidence that Reasonable Logic and/or Data Support the calibration: **Medium**

15. <u>Total Vegetative Cover (Vvegcov)</u>

Definition: Sum of the percent cover of the six types of vegetative cover in the assessment site: 1) mosses and lichen, forbs, graminoids and herbs, 2) shrub, 3) seedlings, 4) small trees, 5) trees, and 6) snags.

Measurement Protocol: Visually determine the total percent canopy cover by adding each strata within 0.1 acre plots. For sites dominated by herbaceous vegetation, and low shrub vegetation, a line intercept method is used for cover measurements.

Use the following Cover Class Midpoints table for estimating the percent canopy cover for each of the vegetative strata:

% Cover	Midpoint
<1	0.5
1-5	3
6-15	10.5
16-25	20.5
26-50	38
51-75	63
76-95	85.5
>95	98

Use the following tables to list the most common species and their estimated percent cover using the cover class midpoint.

Tree Species	Cover Class Midpoint
Total Cover :	

Small Trees Strata (>3’ & <10’, single stem)	
Species	Cover Class Midpoint
Total Percent :	

Shrubs Strata (multiple stems) and Seedlings (≤ 3’, single stem)	
Species	Cover Class Midpoint
Total Cover :	

Herbaceous Strata: Forbs, Graminoids, Ferns and Fern Allies	
Species	Cover Class Midpoint

Herbaceous Strata: Forbs, Graminoids, Ferns and Fern Allies	
Species	**Cover Class Midpoint**
Total Cover :	

Mosses and Lichens Strata	
Species	**Cover Class Midpoint**
Total Cover :	

Summary Table	
1. Total percent cover of Moss / Lichen Strata	
2. Total percent cover of herbaceous Strata	
3. Total percent cover of Shrub Strata	
4. Total percent cover of Tree Strata	
Total Percent Vegetative Cover:	

Data: See Appendix 3.

Rationale for Selecting the Variable: Total cover was used in this model since the cover for individual strata was highly variable. Vegetative cover is an indicator of the ability of the site to support native plant communities and animal habitat.

Scaling Rationale: The variability of the individual strata (trees, small trees, shrub, herbs, mosses and lichen) was significant. However, the data did show that the sum of the individual vegetative strata correlated with the disturbance grouping of the data.

Scaling: Vvegcov

MEASUREMENTS OR CONDITIONS FOR (VVEGCOV)	INDEX
Greater than or equal to 120% total vegetative cover and site is not appreciably altered by human activity and dominated by native plant species.	**1.0**
Greater than or equal to 120% total vegetative and site minimal disturbance by human activity and dominated by native plant species (i.e. foot trails, selective cutting).	**.75**
> or equal to 120 % total vegetative and site significantly altered by human activity and dominated by native plant species (tree removal for ROW, heavy selective cutting).	**.50**

MEASUREMENTS OR CONDITIONS FOR (VVEGCOV)	INDEX
< or equal to 120 % total vegetative and site significantly altered by human activity. The variable is recoverable to reference standard conditions and sustainable through natural processes.	**.10**
< or equal to 120 % total vegetative and site is NOT recoverable to reference standard conditions and sustainable through natural processes.	**.00**

Confidence that Reasonable Logic and/or Data Support the calibration: **Medium**

16. <u>Number of Vegetative Strata (Vstrata)</u>

Definition: The average number of vegetation strata present within the Project Assessment Area. Vegetation strata were defined the same as for the variable (Vvegcov): trees (single-stem, woody species >10 ft tall); small trees (single-stem, woody species > 3 to 10 ft (>1 to < 3 m tall); shrubs (multiple-stem, woody species); herbs, including forbs, graminoids, ferns and fern allies; and mosses, lichens, and liverworts.

Measurement Protocol: Use the information in the previous variable (Vvegcov) to help determine how many strata you have present in the HGM Assessment Area. For example if you have species recorded for trees and shrubs only, you have two strata present.

The average number of strata is calculated for the transect, and rounded to the nearest integer to yield an estimate for the Project Assessment Area.

Data: See Appendix 3.

Rationale for Selecting the variable: The number of strata characteristic of reference standard conditions is an indicator of the development and maintenance of native plant communities. In addition, number of strata represent the presence of the habitat structure and complexity necessary to support faunal assemblages. Similarly, the numbers and types of vegetation strata represent the diversity of habitat niches, as well as the types and amount of food and cover resources available.

Scaling Rationale: The variable was scaled using reference data, field observation, and best scientific judgment. The variable was also scaled according to a disturbance scale. The disturbance scale was developed by the Interdisciplinary Team Based upon field observation and best scientific judgment.

Scaling: Vstrata

MEASUREMENTS AND CONDITIONS FOR (VSTRATA)	INDEX
Three or more vegetative strata present and dominated by native plant species.	**1.0**
Three or more vegetative strata present and dominated by native plant species (i.e., foot trails, selective cutting).	**.75**
Two or three vegetative strata present and dominated by native plant species (tree removal for ROW).	**.50**
One vegetative strata present and may include native and non-native plants.	**.25**

MEASUREMENTS AND CONDITIONS FOR (VSTRATA)	INDEX
Site historically forested but no forest strata present and site significantly altered by human activity. The variable is recoverable to reference standard conditions and sustainable through natural processes.	**.10**
Site historically forested but no forest strata present and site significantly altered by human activity. The variable is **NOT** recoverable to reference standard conditions or sustainable through natural processes.	**.00**

Confidence that Reasonable Logic and/or Data Support the Calibration: **High**

17. <u>Land Use of Assessment Area (Vwetuse)</u>

Definition: Predominant land use within the Project Assessment Area.

Measurement Protocol: Examine the Project Assessment Area, and estimate the percent of the area covered by the following land use categories: (0) Undisturbed, (1) Recreation /Historic Forestry, (2) Rural, and (4) Urban/Recent Forestry. The following calculations should then be made:

1) Multiply this percent of the area covered by the "Land Use Multiplier" to obtain a score for each land use category.

2) Add the scores to obtain a measurement for **Vwetuse.**

Data: See Appendix 3.

Rationale for Selecting the Variable: Predominant land use affects the condition (i.e., more or less disturbed) of the project assessment area and the ability of the site to support native plant communities. In addition, land use strongly influences the ability of the site to support functions and/or attributes, such as interspersion and connectivity with surrounding habitats, habitat patch size, and the extent of contiguous native vegetation.

Category Ranking for Land Uses

Land Use Categories	Multiplier
Undisturbed: No human induced activity, except for narrow human footpaths or trail, and bridges that do not restrict base flow.	**0**
Recreation / Historic Forestry: Clearing of some vegetation for low impact outdoor recreational use, clearing of woody vegetation for right-of-ways, logging with temporary roads (no fill), timber harvesting > 60 years.	**1**
Rural: Low density housing (>5 acre lots), roads with no apparent hydrologic impact.	**2**
Urban/Recent Forestry: Medium to high density residential (< 5 acre lots), commercial/industrial, airports, gravel pits, heavy timber harvesting activity, roads with hydrologic impact with ditches, parking lots.	**3**

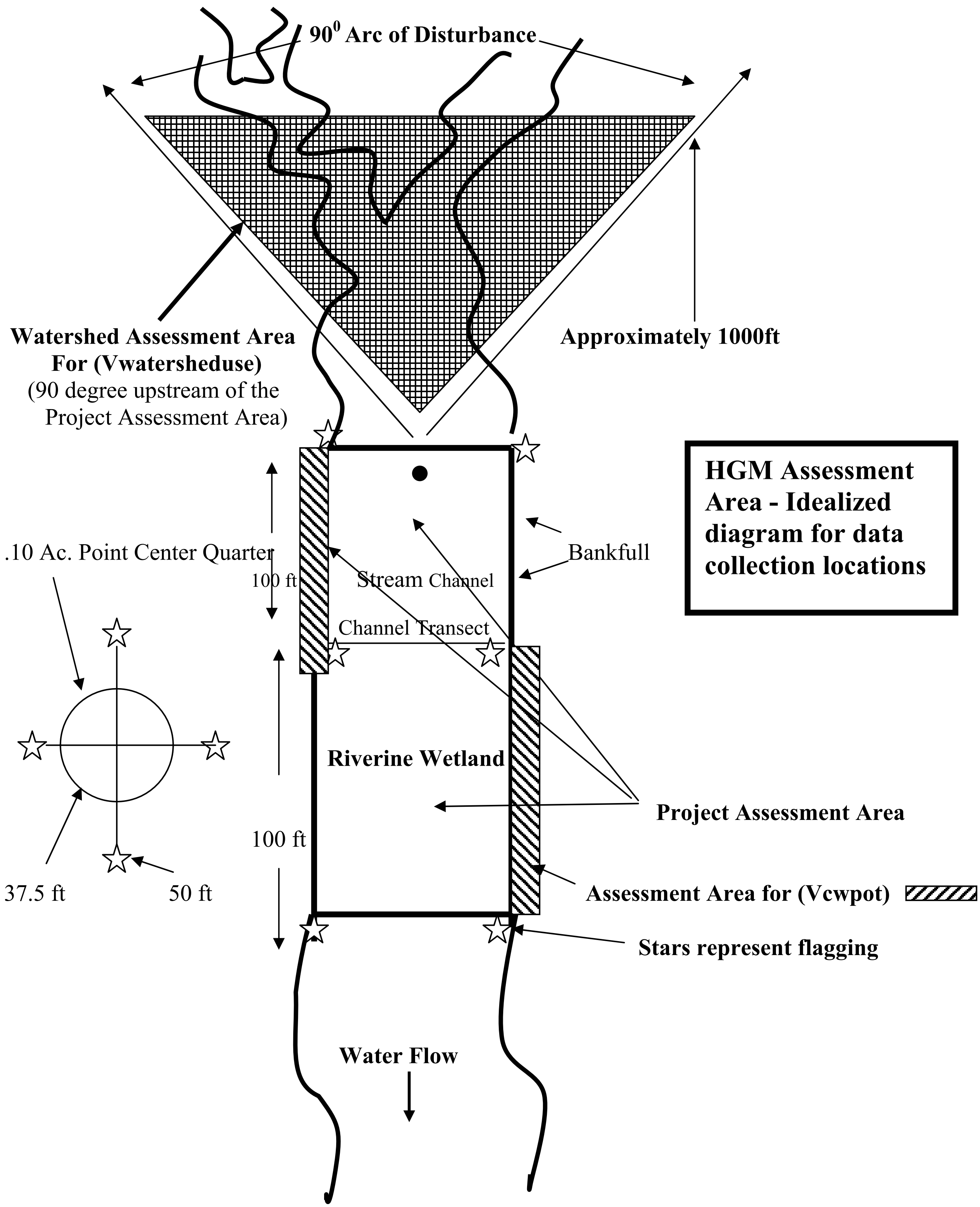
Scaling Rationale: The variable was scaled using reference data, field observations, and best scientific judgment. Vwetuse was scaled according to a disturbance scale, ranging from unaltered reference standard conditions dominated by native vegetation to permanent alteration of the native communities and replacement with non-native vegetation or human disturbances (i.e., buildings, roads). The disturbance scale was developed by the Development Team using field observations and best scientific judgment.

Scaling: Vwetuse

MEASUREMENT OR CONDITION FOR SCALING FOR (VWETUSE)	INDEX
Total Project Assessment Area use impact score is 0 – 100.	1.0
The Project Assessment Area use impact score ranges from 100- 200. An example of how this impact score can be achieved: 50% of the project assessment area is urban, 50% is Recreational/Historic Forestry (50 x 2) + (50 x 1) = 150).	0.75
The Project Assessment Area use impact score ranges from 201 - 250. An example of how this impact score can be achieved: 50% of the project assessment area is urban, 50% is rural ((50 x 3) + (50 x 2) = 250).	0.50
The wetland land use impact score ranges from 251 – 300.	0.25
Total wetland land use impact score is 301 or more. The variable is recoverable to reference standard conditions and sustainable through natural processes even if the existing land use is discontinued and restoration measures are applied.	0.10
Total wetland land use impact score is 301 or more. The variable is neither recoverable to reference standard conditions nor sustainable through natural processes even if the existing land use is discontinued and restoration measures are applied.	0.0

Confidence that Reasonable Logic and/or Data Support the Calibration: **High**

Figure 13. HGM Assessment Area Diagram for Riverine Wetlands



18. <u>Watershed Land Use (Vwatersheduse)</u>

Definition: Land uses and conditions between: 1) the boundary of the project assessment area to 500 ft, and 2) the area from the upstream boundary of the project assessment area to 1000 ft upstream within the 90^0 arc of the project assessment area (See Chapter 5 / Field Guide).

Measurement Protocol: Use visual observation, arial photography, and other office or field resources and tools to: 1) estimate 500 feet beyond of the boundary of the project assessment area and 2) facing upstream estimate a 90^0 arc centered over upstream and pointed toward the stream watershed to 1000 ft, estimate the percent and type of disturbance within the 90^0 arc and within the watershed (See Appendix 1 Field Collection Protocol).

Estimate the percent of the area covered by the following land use categories: (0) Undisturbed, (1) Recreation/Historic Forestry (2) Rural, and (3) Urban/Recent Forestry. The following calculations should then be made:

1. Multiply the percent for each land use category by the category rank (provided in Table 11) to achieve a weighted score.
2. Add all weighted scores to get the total surrounding land use impact score.

Category Ranking for Land Uses

Land Use Categories	Multiplier
Undisturbed: No significant human induced disturbances, except for natural or controlled burns, bridges that do not restrict base flow.	**0**
Recreation/Historic Forestry: Clearing of vegetation, clearing for right-of-ways, logging with temporary roads (no fill), pasture and croplands.	**1**
Rural: Low density housing (>5 acre lots), through-fill roads without ditches, forestry main haul roads (with through-fill and some ditches).	**2**
Urban/Recent Forestry: Medium to high density residential (<5 acre lots), commercial/industrial, airports, gravel pits, through-fill roads with ditches, parking lots.	**3**

Data: See Appendix 3.

Rationale for Selecting the Variable: Land use surrounding the project assessment area can affect the capacity of a wetland to support wildlife species in a project and landscape context. Habitat fragmentation can also occur from surrounding land use. The landscape context for the riverine subclass is driven by insisted, compressed, linear, and high gradient watersheds. Using the “disturbance approach” from other Alaska HGM models was considered but not selected because it is less specific than using stream corridor reaches to analyze the watershed of the riverine wetland subclass.

Scaling: Vwatersheduse

MEASUREMENT OR CONDITION FOR (VWATERSHEDUSE)	INDEX
The watershed land use impact score ranges from 0 – 100.	1.0
The watershed land use impact score ranges from 101 - 250.	0.75
The watershed land use impact score ranges from 251 - 400.	0.50
The watershed land use impact score ranges from 401 - 500.	0.25
The watershed land use impact score is > 500. The variable is recoverable to reference standard conditions and sustainable through natural processes, if the existing land use is discontinued and no restoration measures are applied.	0.10
The watershed land use impact score is > 500. The variable is neither recoverable to reference standard conditions nor sustainable through natural processes, if the existing land use is discontinued and no restoration measures are applied.	0.0

Confidence that Reasonable Logic and/or data support the Calibration: **High**

Slope River Proximal Model

The following is the model (functions and variables) for assessing Slope River Proximal wetlands. The model is outlined below:

A. List of Slope River Proximal Functions

B. Description of Slope River Proximal Functions and Corresponding Functional Capacity Indexes (FCI)

C. List of Slope River Proximal Model Variables

D. Description and Scaling of Slope River Proximal Model Variables

List of Slope River Proximal Wetland Functions

The Slope River Proximal models are a work in progress. The models are based on data and information collected and analyzed from 33 Riverine and 15 Slope River Proximal reference sites.

Hydrologic

1. Dynamic Flood Water Storage Capacity
2. Subsurface Water Retention Capacity

Biogeochemical

3. Nutrient Recycling
4. Organic Carbon Export
5. Integrity of the Root Zone

Habitat

6. Maintenance of Native Plants
7. Maintenance of Wildlife Habitat

Description of Slope River Proximal Functions and Corresponding Functional Capacity Indexes (FCI)

1. Dynamic Flood Water Storage Capacity

The characteristic floodplain ability to dissipate energy and detain (temporarily store) floodwater. Attributes include width of flood prone area and storage volume (Vstore), presence and number of coarse wood jams, presence of active beavers, microtopography, soil permeability, and density of armoring vegetation along secondary channels. Overbank flood flows (Vfreq) must be present before this function can occur.

FCI: (Vfreq + Vcwslope + Vsoilperm + Vmicro + Vvegcov + Vstore) / 6

Vfreq Vcwslope Vvegcov
Vmicro Vsoilperm Vstore

2. Subsurface Water Retention Capacity

Retention (holding) of water in the temporally saturated soil horizons (i.e., above the permanent water table) is the basis for this function. Storage mechanisms are related to thickness, permeability, and drainage of the acrotelm horizon and evapotranspiration.

FCI: (Vsource + (Vacrco + Vsoilperm +Vdecomp)/3 + Vmicro + Vadjuse)/ 4

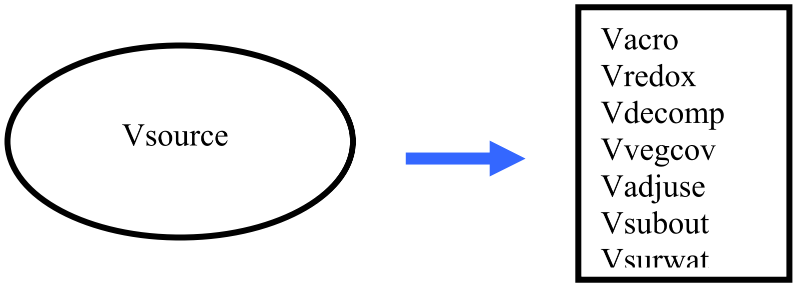
Vsource → Vacro Vsoilperm Vmicro Vdecomp Vadjuse

Biogeochemical

3. Nutrient Recycling

The abiotic and biotic processes that convert elements from one form to another normally occur within the acrotelm layer of an organic soil, or in the litter and surface layer of a mineral soil. These conversions represent the capacity of the wetland to cycle and transport elements such as organic carbon, nitrogen, and phosphorus in dissolved and particulate forms to downstream aquatic ecosystems. Mechanisms for recycling are the condition of the surface vegetation, adjacent land use, the amount of surface and subsurface water, the extent of water filled depressions soil permeability, and soil redox reactions characteristics.

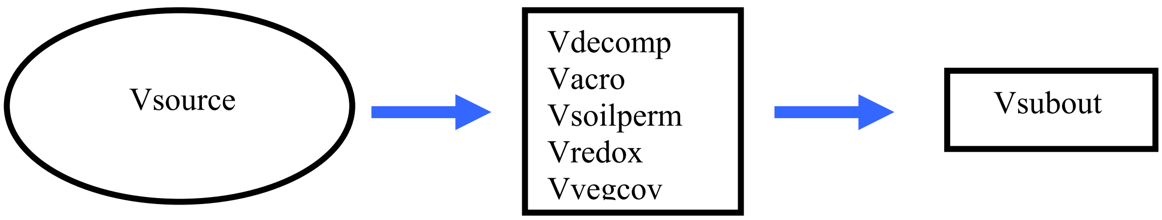
FCI: (Vadjuse + Vsurwat + Vvegcov + (Vsource + Vsubout) /2 +
(Vacro + Vredox + Vdecomp/3) /5



4. Organic Carbon Export

This function represents export of dissolved and particulate organic carbon. Export mechanisms include leaching, displacement, and erosion through horizontal and vertical surface water and shallow groundwater hydrology.

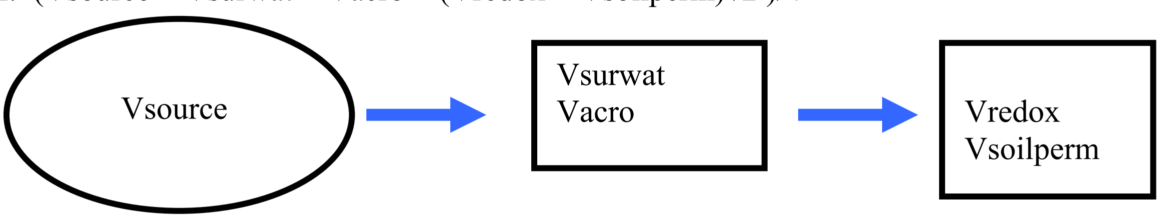
FCI: (Vsource + (Vacro + Vegcov + Vsoilperm + Vdecomp + Vredox) / 5 + Vsubout) / 3



5. Integrity of the Root Zone

Growth and maintenance of roots in the litter and fibric layers of the soil contribute to soil development and protect underlying soil horizons from erosion. Roots are sources of oxygen to the soil as well as remediators of elements and compounds. They promote stable slopes and help retain sediment. Physical barriers like high water table, cold soils or low oxygen levels in the soils restrict root development, health, and growth.

FCI: (Vsource + Vsurwat + Vacro + (Vredox + Vsoilperm) /2)/4

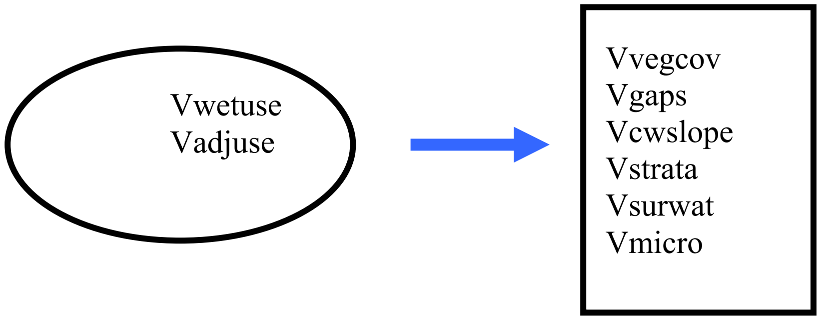


Habitat

6. Maintenance of Wildlife Habitat Structure

Capacity of the ecosystem to maintain self-sustaining wildlife and waterfowl populations through mechanisms that provide vertical and horizontal spatial structure (food, water, and cover).

FCI: (Vvegcov + Vadjuse + Vwetuse + (Vsurwat + Vmicro) /2 +Vstrata +
(Vgaps + Vcwslope) /2) /6



7. <u>Maintenance of Plants</u>

Ability of the terrestrial and aquatic habitats to maintain characteristic indigenous native vegetation.

FCI:(Vwetuse + Vvegcov + Vsource + Vtreeba (Vsurwat + Vacro) /2 + Vsoilperm)/ 6

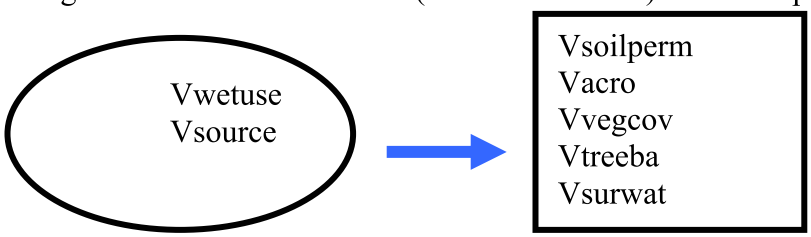


Table 11. Relationship of Slope River Proximal Wetland Functions to Variables

Functions/ Variables	Dynamic Flood Water Retention	Dynamic Subsurface Retention	Nutrient Recycling	Organic Carbon Export	Root Zones	Wildlife Habitat	Plant Communities
Vacro		X	X	X	X		X
Vadjuse		X	X				
Vcwslope	X					X	
Vdecomp		X	X	X			
Vfreq	X						
Vgaps						X	
Vmicro	X	X				X	
Vredox			X	X	X		X
Vsoilperm	X	X		X	X		X
Vsource		X	X	X	X		
Vstore	X						
Vstrata						X	
Vsubout			X	X			
Vsurwat					X	X	X
Vtreeba						X	X
Vvegcov	X		X	X		X	X
Vwetuse						X	X

Table 12. List of Slope River Proximal Variables Organized by Data Collection Groups

SOILS, HYDROLOGY, AND LAND USE	
1. V_{redox}	Redoximorphic Features
2. Vacro	Presence and Structure of the Acrotelm Horizon
3. Vsoilperm	Stream Bank Soil Permeability
4. V_{source}	Source of Water
5. Vsubout	Subsurface Flow from the Wetland
6. Vfreq	Overbank Flood Frequency
7. Vstore	Flood Prone Area Storage Volume
8. Vwetuse	Assessment Area Land Use
9. Vadjuse	Adjacent Land Use
MICROTOPOGRAPHY	
10. Vmicro	Microtopography
11. Vsurwat	Surface Water Storage
VEGETATION AND COURSE WOOD	
12. Vvegcov	Total Vegetative Cover
13. Vstrata	Number of Vegetation Strata
14. Vgaps	Canopy Gaps
15. Vtreeba	Tree Basal Area
16. Vdecomp	Logs in Various Stages of Decomposition
17. Vcwslope	Slope Coarse Wood

Description and Scaling of Slope River Proximal Model Variables

To perform a Slope River Proximal HGM Rapid Assessment use the following seventeen River Proximal Slope variables.

1. Presence of Redoximorphic Features V(redox)

Definition: This variable represents the reduction and oxidation history of the soil. Hydric soil indicators include redoximorphic features, accumulation of organic matter, or other indicators discussed in the National Technical Committee for Hydric Soils publication on hydric soil indicators (USDA, 1998).

Rationale for Selecting the Variable: Redoximorphic features indicate long term saturation (epi and/or endo) and the presence of anaerobic conditions that reflect important biogeochemical processes such as elemental cycling and carbon export. The presence of redoximorphic features implies soil saturation of a sufficient duration to induce reduction in the top 30 cm (approximately one foot) of the soil profile. It is assumed that soil reduction in the upper part has more influence on the wetland ecosystem than at greater depths. The presence of redoximorphic features anywhere in the top 30 cm (or approximately one foot) is positive evidence that the soil is undergoing periodic reduction and oxidation.

Measurement Protocols: Dig several soil pits 30-cm deep or approximately one foot, in representative areas in the assessment area. Then describe and record redoximorphic features using Hydric Soil Indicators (NRCS, 2002).

Data: See Appendix 3.

Scaling Rationale: In Southeast Alaska reference wetlands, redoximorphic features ranged from present to absent. Based on the presence of redoximorphic features at 60% of the reference sites, a variable index of 1.0 was assigned to the presence of redoximorphic features. Sites where redoximorphic features are absent are assigned an index of .1 based on the assumption that even in the absence of redoximorphic features, reduction takes place at some low level.

Scaling: Vredox

MEASUREMENT OR CONDITION For (VREDOX)	INDEX
Redoximorphic features are present in a majority of the soil pits in the assessment area. Soil conditions have not been altered by natural or human induced disruption of the soil profile or hydrology by churning.	**1.0**
Redoximorphic features are absent in a majority of the soil pits in the project assessment area due to disruption of the soil and hydrology. The variable is recoverable and sustainable through natural processes if the existing land use is discontinued or restoration measures are applied.	**.5**
Redoximorphic features are absent in the soil pits in the assessment area and the source of water to create saturated soil conditions has been removed and cannot be restored without major efforts.	**.1**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Fair.**

The field data supports scaling, but variability is high in all sites.

2. <u>Presence and Structure of the Acrotelm Horizon V(acro)</u>

Definition: The Acrotelm is the surface fibric zone commonly called the Oi soil horizon. It serves as a permeable layer for the overland flow of water. Surface water transport is enhanced with an intact Acrotelm. A healthy system is indicated with a thick, well-developed surface fibric layer.

Rationale for Selecting the Variable: The Acrotelm is the litter layer in organic soils. Organic soils are porous, oxygen rich, and not saturated with water. These are sites of most of the nutrient exchanges, habitat for soil biological communities, and where the roots of most of the wetland plants abound. The lateral movement of water through this layer is quick and efficient. Water movement downslope is unimpeded through the Acrotelm and acts as the source for many of the small streams and pools found in wetlands throughout the Reference Domain.

Measurement Protocol: Using the same 30-cm or approximately 1 foot deep soil pits previously dug for the (Vredox) variable, determine the thickness of the “Acrotelm” layer.

Data: The data can be found in individual soil profile descriptions.

Scaling Rationale: The depth of the Oi horizon for reference standard sites were frequently greater than 4.0 inches. Though not all sites met this criterion, this depth separated the impacted sites from the reference standard sites. Impacted sites had very little accumulation, generally less than 0.5 inches.

Scaling: Vacro

MEASUREMENT OR CONDITION FOR (VACRO)	INDEX
Oi present at the soil surface and has a depth greater than 4.0 inches. The lateral movement of water is unimpeded.	**1.0**
Oi present with a minimum depth of 2.5 inches and the lateral movement of water is unimpeded. Or, the Oi is greater than 2.5 inches depth, but the flow of water through the Oi layer has been disrupted. The function is recoverable with restoration efforts.	**.50**
Oi absent or damaged and not recoverable. The Oi is either absent or disrupted to such an extent that the function is not operational.	**.10**
There is no soil present on the site.	**0.0**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Fair.** The data is representative of the sites and fits the scaling moderately. However, there is a great deal of variability in the depth throughout the sites. There are many sites with no measurable Oi Horizon

3. <u>Stream bank Soil Permeability (Vsoilperm)</u>

Definition: Permeability is defined as the ease with which gases, liquids or plant roots penetrate or pass through a bulk mass of soil or a layer of soil. The type of soil parent material that makes up the stream bank below bankfull depth is a fair estimate of soil permeability.

Measurement Protocol: Dig a soil pit from bankfull depth to channel bed and determine if the soil material is organic, mineral or a mixture of organic/mineral layers. In addition, determine the dominant size fraction of the mineral (eg: clay, silt, sand, gravel, stones).

Data: See Appendix 3.

Rational for Selection of the Variable: The type of soil in the bank of a stream will influence the rate of water gain or loss into a channel. If the dominant size fraction is coarse, the rate of loss/gain may be high, whereas if the material is fine (sand or clay), the rate will be much slower. This is a rough estimate of hydraulic conductivity and may play an important role in nutrient spiraling and organic carbon export as well as aquatic habitat functions. Stream banks also regulate the amount and size of the sediment. If the banks are sandy and unstable, the probability of having sand sized sediment is high. That is in contrast to having clay banks, which can be unstable but, due to the small size of the clay particles, generally don't contribute to the sediment loading.

Scaling: Vsoilperm

INDIRECT MEASURE	DIRECT MEASURE	INDEX
Sandy or gravelly material has porosity and is able to transmit water either into or from the channel. Organic soil is dominated with fibric-sized material.	Using standard methods, perform a soil permeability test of each dominant layer and determine if the average rate is greater than 50 mm/hr.	**1.0**
Silty soil material that has limited porosity and not likely to transmit much water into or from a channel. Organic soil is dominated with hemic-sized material.	Using standard methods, perform a soil permeability test of each dominant layer and determine if the average rate is between 5-50 mm/hr.	**.5**
Clay soil material that has no porosity and not able to transmit water into or from a channel. Organic soil is dominated with sapric-sized material.	Using standard methods, perform a soil permeability test of each dominant layer and determine if the average rate is less than 5 mm/hr.	**.1**
No natural stream banks (e.g., concrete) or impervious channel liner.		**0**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Medium**

4. Source of Water (Vsource)

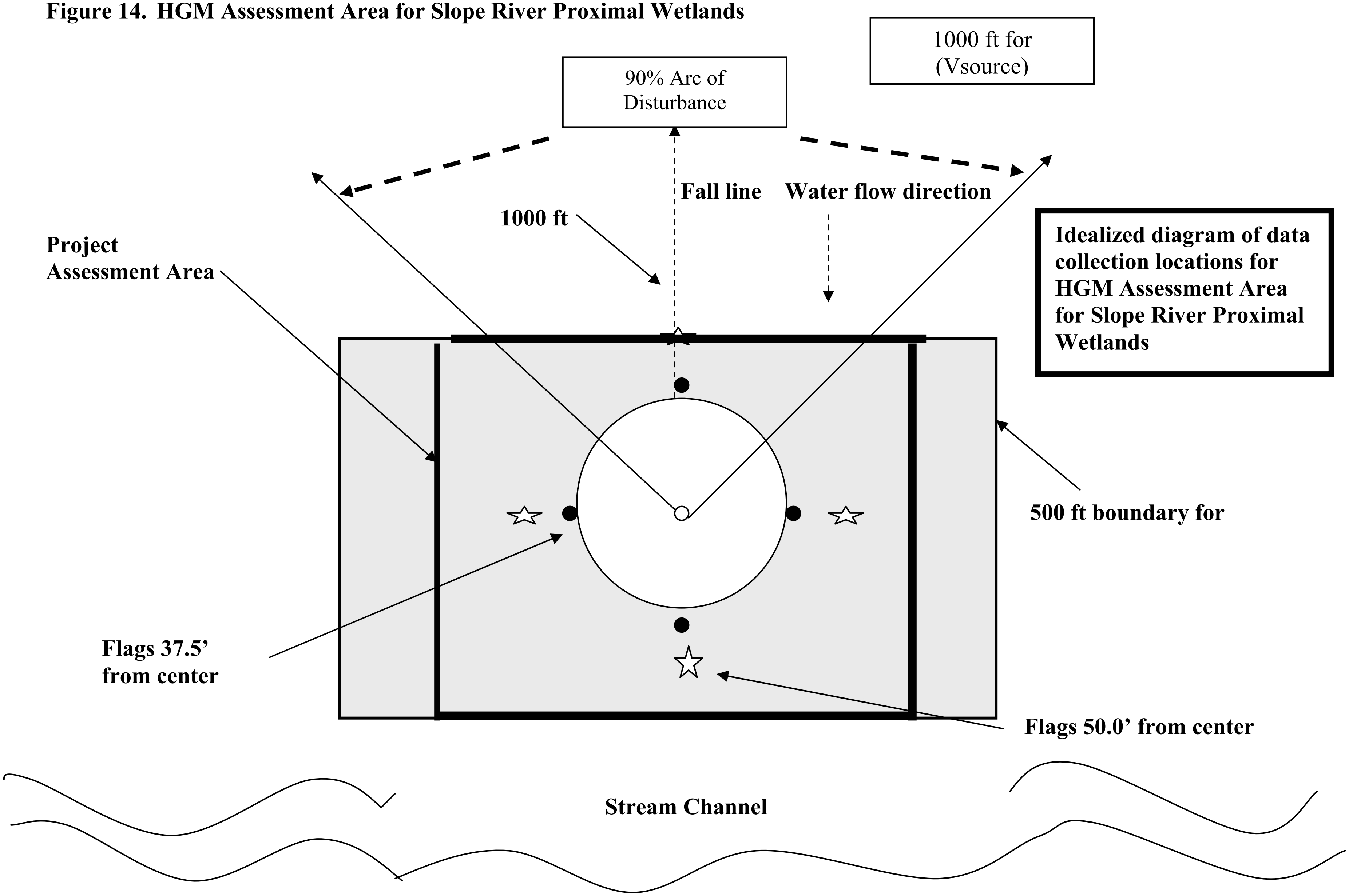
Definition: A 90°arc upslope of the assessment area is used to describe the area of hydrologic contribution (i.e., surface and shallow subsurface waterflow). The variable (Vsource) is a measurement of the condition of the hydrologic source area.

Rationale for Selecting the Variable: Quantity and quality of flow of water drives fundamental processes in slope wetlands (e.g., surface and shallow subsurface water storage). Condition of the source area will determine the volume, timing, distribution, and quality of water flowing into the wetland (Glass 1984). Disturbance to the source area, such as breaking longitudinal connectivity of flow by placement of fill, may result in decreased flow of water to the wetland.

Measurement Protocol: By convention (see definition) the hydrologic source area is described as a 90° arc (measured using a compass) looking up-gradient from the center of the assessment area.

a) Standing in the center of the assessment area, facing upslope extend your arms out and form a 90° arc using the reference points such as trees or buildings.

Figure 14. HGM Assessment Area for Slope River Proximal Wetlands



b) Within the 90° arc describe and estimate the number of degrees within the 90° arc that include disturbances (see the following “Category Ranking for Land Uses ” table).

The use of a non-linear scale (i.e., 0, 1, 3, and 4) for the land use categories reflects the significant difference in impacts to hydrologic regimes caused by the disturbances described in the Recreational/Historic Forestry category (value 1) and the Rural category (value 3). The following table shows the four land use types used in the assessment and the multiplier applied to each type.

Category Ranking for Land Uses

Land Use Categories	Multiplier
Undisturbed: No significant human induced perturbation, except for natural or controlled burns.	0
Recreation/Historic Forestry: Clearing of vegetation, clearing for right-of-ways, logging with temporary roads (no fill), pasture and croplands.	1
Rural: Low density housing (>5 acre lots), through-fill roads without ditches, forestry main haul roads (with through-fill and some ditches).	3
Urban/Recent Forestry: Medium to high density residential (<5 acre lots), commercial/industrial, airports, gravel pits, through-fill roads with ditches, parking lots.	4

c) The angle of all disturbances are individually measured and categorized

Individual Disturbances	Angle of Disturbance
(example) Urban	(example) 25°

d) Convert the total arc Length for each category into a percent of the 90° source arc length using the following formula:

Total arc length ÷ 90 X 100 = Percent of he Source Arc Length

Disturbance Types	Arc length Percentage
Undisturbed	
Recreation/Historic Forestry	
Rural	
Urban/Recent Forestry	

e) Multiply each Arc length percentage by the perturbation multiplier and total the results.

Data: See Appendix 3.

Scaling Rationale: Impacts to source areas contributing to Slope River Proximal wetlands may result in change of water quantity and quality to water delivered to the wetland. With particular respect to water quantity, increases or decreases may result in ponding, stream development (incision), cessation of shallow subsurface flow, desiccation, oxidation of peat, or total loss of flow. Input of water with altered quality from source areas (e.g., anoxic water) can result in changes in the rate of a) geochemical cycles including decomposition, and b) water movement through soil media. Similarly, output chemical characteristics from the wetland (e.g., redox status) to adjacent waters could be altered if source area inputs are degraded.

For the purposes of scaling, disturbances such as urban development (e.g., impervious surfaces, storm drainages, buildings, roads, etc.) had more significant impact than some recreational practices and forestry. At the same time, the disturbances that impact 100% of the source areas will obviously have a greater impact on source area than disturbances to 10% of the area.

Reference standard sites sampled had hydrologic source impact scores ranging from 0 - 180. Therefore, the authors assigned a variable index score of 1.0 to this range. The most degraded non-reference standard sites sampled by the field team scored 720. Although it is theoretically possible to have higher scores, this field-measured value as a score that would receive a variable index score of 0.0. The remaining variable index scores were developed using a linear model.

Scaling: Vsource

MEASUREMENT OR CONDITION FOR (VSOURCE)	INDEX
Hydrologic source impact scores range from 0 to 180.	**1.0**
Hydrologic source impact scores range from > 180 to 360.	**0.75**
Hydrologic source impact scores range from >360 to 450.	**0.50**
Hydrologic source impact scores range from > 450 to 720.	**0.25**
Hydrologic source impact score is >720. The variable is recoverable to reference standard conditions and sustainable through natural processes if the existing land use is discontinued and restoration measures are applied.	**0.10**
Hydrologic source impact score is > 720. The variable is not recoverable (e.g., parking lot, fill pad, paved road).	**0.0**

Confidence that reasonable logic and/or data support the calibration**: Medium**

5. <u>Subsurface Flow From the Wetlands (Vsubout)</u>

Definition: Subsurface flow from the Slope River Proximal wetland into the adjacent riverine wetland.

Measurement Protocol: Determine presence of seeps, springs, etc. that occur at and downslope of the interface between the riverine and slope wetland. Ice bulges during very cold seasons can be used as a visual indication of this variable.

Rationale for Selecting the Variable: Subsurface flows that are processed through slope wetlands provide a source of nutrients and organic carbon to receiving riverine wetlands, which support important biogeochemical and habitat functions as well as contributing to base flow.

Data: See Appendix 3.

Scaling Rationale: Generally, undisturbed sites with indications of ground water expression near the slope-riverine wetland interface contribute to downslope wetland functions. The level of functional support decreases with decreasing visual indicators or increasing disturbance.

Scaling: Vsubout

MEASUREMENT OR CONDITION FOR (VSUBOUT)	INDEX
Areas upslope of the riverine/slope interface within the project assessment area are predominantly undisturbed, native soils, and plant communities **AND** direct evidence of subsurface flow is observed along the interface (e.g., seeps, upwellings, iron-floc discharge points, etc.).	1.0
Areas upslope of the riverine/slope interface within the project assessment area are predominantly undisturbed, native soils, and plant communities **AND** no direct evidence of subsurface flow along the interface is observed. **OR** Areas upslope of the riverine/slope interface within the project assessment area are predominantly disturbed soils and/or plant communities **AND** direct evidence of subsurface flow along the interface is observed.	0.5
Areas upslope of the riverine/slope interface within the project assessment area are predominantly hard surfaces or fill **AND** direct evidence of subsurface flow along the interface is observed.	0.25
Areas upslope of the riverine/slope interface are predominantly hard surfaces or fill **AND** no direct evidence of subsurface flow along the interface is observed.	0.0

Confidence that Reasonable Logic and/or Data Support the Calibration: **Low.** Variable scaling has not been field tested.

6. Overbank Flood Frequency (Vfreq)

Definition: Estimate of the frequency of how often bankfull is exceeded.

Measurement Protocol: (a) Stream gauge information available - Data from stream-gauging stations are reliable estimates of this variable. Contact the US Geological Survey (USGS) in Juneau, Alaska at (907) 586-7216 to determine the availability of stream gauge information. The USGS also has an internet web page located at "ak.water.usgs.gov." The USGS can provide an estimate of the magnitude of a particular flooding event and a frequency of flooding estimate for the project assessment area, which should be used if available, prior to relying on visual field indicators having less precision.

(b) Gauge information not available - Other field indicators include high water marks, silt lines, drift, seed and debris lines, grasses, and other tall non-woody vegetation lying down as a result of overbank flows, tree bark damaged by floating debris, and evidence of channel scour and sediment deposition. These indicators can reflect recent flooding or an infrequent event and may not be particularly helpful in establishing the flood return interval at a particular site. However, the use of the indicators in conjunction with an assessment of the depth of organic litter, decomposition stage, and vegetation type (e.g., woody or herbaceous) provides an estimate of the frequency of overbank flooding in the project assessment area. Site characteristics are compared to range of conditions expressed in the variable indexes.

Data: See Appendix 3.

Rationale for Selecting the Variable: The annual frequency at which a channel overtops its banks (when bankfull discharge is exceeded or water is delivered from upland sources) is important as a driving force for several wetland functions. Hydrologic implications include dynamic water storage, energy dissipation, and maintaining characteristic channel meander belts. Biogeochemical implications include nutrient spiraling, organic carbon export, particulate retention, and removal of imported elements and compounds. Habitat implications include maintenance of characteristic vegetation (overbank flooding facilitates the dispersal of plant seeds and other propagates), maintenance of detrital biomass, and maintenance of aquatic dependent taxa.

Scaling: Vfreq

MEASUREMENT OR CONDITION FOR (VFREQ)		
Indirect Measure	**Direct Measure**	**Index**
No litter to a very thin layer (< 1 cm) of non-decomposed material present on wetland surface. Presence of high water marks, silt lines, drift, seed and debris lines, and/or scattered grasses lying down as a result of overbank flows. Evidence of channel scour and sediment deposition present. Fluvial deposited logs and organic debris on channel banks with little moss, lichen, seedlings or leaf litter accumulations on these surfaces. Overall percent cover of herbaceous vegetation is low and vegetation consists of species typical of primary colonization. If trees are present they may appear stressed from frequent inundation unless established on larger nurse logs or on coarser/ better drained sediments adjacent to channel bank. Estimated flood frequency is 1-2 year return intervals.	Gauge data extrapolated to project assessment area reflects 1-2 year return interval.	1.0
Thin litter cover (1-3 cm) ranging from recent to partly or completely decomposed material. Fluvial deposited logs and organic debris on channel banks with moss, lichen, seedlings, or decomposing leaf litter accumulations on these surfaces. Natural levees present immediately adjacent to the channel bank. Mature trees present along with some species typical of primary colonization. Bark of trees may show indications of damage from floating debris, and red squirrel midden accumulations may be concentrated at base of larger trees in the wetland. Estimated flood frequency is 2-10 year return intervals.	Gauge data extrapolated to project assessment area reflects 2-10 year return interval.	0.75
Thick litter cover (>3 cm) with lower layer completely decomposed. No evidence of overbank deposits and fluvial transported debris not present. Dominant vegetation is mature trees (unless artificially manipulated - e.g., lawn or timber	Gauge data extrapolated to project assessment area	0.5

MEASUREMENT OR CONDITION FOR (VFREQ)		
Indirect Measure	**Direct Measure**	**Index**
harvested). Estimated flood frequency is > 10 year return interval.	reflects > 10 year return interval.	
Artificial flood control features that affect assessment area present (e.g., man-made levees, flood control channels, upstream flood control impoundments, etc.).	Gauge data extrapolated to project assessment area indicates that no overbank flooding is likely.	0.0

Confidence that Reasonable Logic and/or Data Support the Calibration: **Medium**

7. Flood Prone Area Storage Volume (Vstore)

Definition: Ratio of flood prone area width divided by channel width at bankfull.

Measurement Protocol: Identification and bounding of the flood prone area are key measurements because they establish the boundary of the assessment area and riverine wetland subclass.

1. Use either the methods below to determine flood prone area (riverine boundary).

   A. Visual Estimate: If you are familiar with the subclass and river morphology you can estimate the width of the flood prone area visually. A crude estimate can be made using aerial photos, topographic maps, and field indicators. This should be done only if you have experience in the area. OR

   B. Direct Measurement: The flood prone area can be defined by projection of a plane at twice the bankfull thalweg depth (deepest part of the stream, see Figure 10 Stream Channel cross-section and measurements).

   i) Determine the width of the channel by using a measuring tape, measure from the edge of bankfull on one side of the stream to the bankfull on the opposite side of the stream.

   ii) Determine the point on the stream channel transect at the deepest point of the stream (thalweg depth). Measure the depth from the transect line.

   iii) Double the thalweg depth measurement and project it vertically up. At that point extend a horizontal plane out past bankfull to determine the boundary of the flood prone area on each side of the stream (See Figure 10).

2. Calculate a ratio by dividing the flood prone area (2x thalweg) width by the channel width (bankfull).

3. Based on the estimates above, scale the variable using the scaling index below.

Data: See Appendix 3.

Rational for Selecting the Variable: This variable represents the volume that is available for storing surface water during flood events. It is designed to detect changes in storage volume that result from levees, roads or other man-made structures that have been placed in areas prone to flooding. Flood prone area is a rough approximation of the 50-year flood plain and represents the boundary for riverine wetland subclass within the reference domain. As the ratio decreases, flood prone area storage volume decreases.

Scaling: Vstore

DIRECT MEASUREMENTS FOR (VSTORE)	INDEX
Ratio > 2.5	1.0
Ratio 1.3 to 2.5	.50
Ratio 1.0 to 1.3	.10

Confidence that Reasonable Logic and/or Data Support the Calibration: **Low**

8. <u>Assessment Area Land Use (Vwetuse)</u>

Definition: Predominant land use within the project assessment area.

Measurement Protocol: Examine the project assessment area and estimate the percent of the area covered by the following land use categories: (0) Undisturbed, (1) Recreation /Historic Forestry, (2) Rural, and (3) Urban/Recent Forestry. The following calculations should then be made:

1) Multiply the percent for each land use category by the category ranking provided in the table below.

2) Add all weighted scores to get the total Project Assessment Area Use impact score.

Data: See Appendix 3.

Rationale for Selecting the Variable: Predominant land use affects the condition (i.e., more or less disturbed) of the project assessment area and the ability of the site to support native plant communities. In addition, land use strongly influences the ability of the site to support functions and/or attributes, such as interspersion and connectivity with surrounding habitats, habitat patch size, and the extent of contiguous native vegetation.

Category Ranking for Land Uses

Land Use Categories	Multiplier
Undisturbed: No human induced activity, except for narrow human footpaths or trail, and bridges that do not restrict base flow.	0
Recreation / Historic Forestry: Clearing of some vegetation for low impact outdoor recreational use, clearing of woody vegetation for right-of-ways, logging with temporary roads (no fill), timber harvesting > 60 years.	1

Rural: Low density housing (>5 acre lots), roads with no apparent hydrologic impact.	2
Urban/Recent Forestry: Medium to high density residential (<5 acre lots), commercial/industrial, airports, gravel pits, heavy timber harvesting activity, roads with hydrologic impact with ditches, parking lots.	3

Scaling Rationale: The variable was scaled using reference data, field observations, and best scientific judgment. Vwetuse was scaled according to a disturbance scale, ranging from unaltered reference standard conditions dominated by native vegetation to permanent alteration of the native communities and replacement with non-native vegetation or human disturbances (i.e., buildings, roads). The disturbance scale was developed by the interdisciplinary team based upon field observation and best scientific judgement.

Scaling: Vwetuse

MEASUREMENT OR CONDITION FOR (VWETUSE)	INDEX
Total Project Assessment Area use impact score is 0 – 100.	**1.0**
The Project Assessment Area use impact score ranges from 100- 200. An example of how this impact score can be achieved: (a) 50% of the project assessment area is urban , 50% is Recreational/Historic Forestry ((50 x 2) +(50 x 1) = 150).	**0.75**
The Project Assessment Area use impact score ranges from 201 - 250. An example of how this impact score can be achieved: (a) 50% of the project assessment area is urban, 50% is rural ((50 x 3) + (50 x 2) = 250).	**0.50**
The wetland land use impact score ranges from 251 – 300.	**0.25**
Total wetland land use impact score is 301 or more. The variable is recoverable to reference standard conditions and sustainable through natural processes if the existing land use is discontinued and or restoration measures are applied.	**0.10**
Total wetland land use impact score is 301 or more. The variable is neither recoverable to reference standard conditions nor sustainable through natural processes if the existing land use is discontinued and or restoration measures are applied.	**0.0**

Confidence that Reasonable Logic and/or data support the calibration: **High**

9. <u>Adjacent Land Use (Vadjuse)</u>

Definition: Land uses and conditions in the area between the boundary of the Project Assessment Area outward to 500 ft upstream and downstream adjacent to the project assessment area.

Measurement Protocol: Using visual observation, arial photography, and other office or field resources and tools record land use disturbances within 500 ft beyond of the boundary (upstream and downstream of the project assessment area and (See Figure ___ and Appendix 1- Field Guide). Estimate the percent of the area covered by the following land use categories: (0)

Undisturbed, (1) Recreation/Historic Forestry, (2) Rural, and (3) Urban/Recent Forestry. The following calculations should then be made:

1. Multiply the percent for each land use category by the category rank (provided in the table below) to achieve a weighted score.
2. Add all weighted scores to get the total Adjacent Land Use impact score (use the same process used in Vsource and Vwetuse).

Category Ranking for Land Uses

Land Use Categories	Multiplier
Undisturbed: No significant human induced perturbation, except for natural or controlled burns, bridges that do not restrict base flow.	0
Recreation/Historic Forestry: Clearing of vegetation, clearing for right-of-ways, logging with temporary roads (no fill), pasture, and croplands.	1
Rural: Low density housing (>5 acre lots), through-fill roads without ditches, forestry main haul roads (with through-fill and some ditches).	2
Urban/Recent Forestry: Medium to high density residential (<5 acre lots), commercial/industrial, airports, gravel pits, through-fill roads with ditches, parking lots.	3

Data: See Appendix 3.

Rationale for Selecting the Variable: Land use adjacent to the project assessment area can affect the capacity of a wetland to support wildlife species in a project and landscape context. Habitat fragmentation can also occur from surrounding land use. The landscape context for the riverine subclass is driven by insisted, compressed, linear, and high gradient watersheds. Using the disturbance approach from other Alaska HGM models was considered and not selected because it is less specific.

Scaling: Vadjuse

MEASUREMENT OR CONDITION FOR (Vadjuse)	SCORE
The adjacent land use impact score ranges from 0 – 100.	1.0
The adjacent land use impact score ranges from 101 - 250.	0.75
The adjacent land use impact score ranges from 251 - 400.	0.50
The adjacent land use impact score ranges from 401 - 500.	0.25
The adjacent land use impact score is 500. The variable is recoverable to reference standard conditions and sustainable through natural processes, if the existing land use is discontinued and restoration measures are applied.	0.10
The adjacent land use impact score is 500. The variable is neither recoverable to reference standard conditions or sustainable through natural processes, even if the existing land use is discontinued and restoration measures are applied.	0.0

Confidence that Reasonable Logic and/or data support the Calibration**: High.**

The Development Team used both data from the reference system and best scientific judgment to describe watershed land uses and conditions in order to scale the variable.

10. Microtopographic Features V(micro)

Definition: Small scale topographic relief in the form of pit-and-mound or hummock-and-hollow patterns that occur in the wetland.

Measurement Protocol: Using a 100-foot measuring tape, at every ten feet determine if there is a 50 cm deflection from the general soil surface or forest floor (See Appendix 1 for specific procedures).

Rationale for Selecting the Variable: Microtopographic features contribute to off-channel roughness, which influences how water flows through the wetland. These features are important components of several hydrologic, biogeochemical, and habitat functions. For example, small depressions provide areas for temporary storage of surface water, which provides sinks conducive to elemental cycling and organic soil development. Microtopographic relief also provides for more diverse vegetation communities by creating topographic complexity and varying substrates which, in turn, creates more diverse habitat structure for wildlife.

Data: See Appendix 3.

Scaling Rationale: Generally, undisturbed sites having greater microtopographic complexity contribute to wetland functions to a greater degree than sites with planar features or greater degrees of disturbance.

Scaling: Vmicro

MEASUREMENT OR CONDITION FOR (VMICRO)	INDEX
The project assessment area is characterized by complex microtopographic relief (e.g., 50->80% of observed features are non-planar) AND assessment area is predominantly undisturbed, native soils, and plant communities.	1.0
The project assessment area is characterized by moderately complex microtopographic relief (e.g., 25-50% of observed features are non-planar) AND assessment area is predominantly undisturbed, native soils, and plant communities.	0.75
The project assessment area is characterized by moderately complex microtopographic relief (e.g., 25-50% of observed features are non-planar) AND assessment area is predominantly disturbed, native soils, and/or plant communities.	0.50
The project assessment area is characterized by some microtopographic relief (e.g., 1-25% of observed features are non-planar) AND assessment area is predominantly disturbed or undisturbed, native soils, and/or plant communities.	0.25
Microtopographic features are absent.	0.0

Confidence that Reasonable Logic and/or Data Support the Calibration – **Low.**

11. <u>Presence of Surface Water (Vsurwat)</u>

Definition: Detention of water in wetland surface features. Sources include precipitation and subsurface and surface flow into the wetland. Mechanisms for storage are position and depth of depressions and depth to the water table.

Measurement Protocol: Conduct a visual reconnaissance or measured 100-ft transect, of the assessment area and determine the percent cover of ponds and other depressions that store water.

Data: See Appendix 3.

Rationale for Selecting the Variable: Surface water ponding, short and long term storage of surface water, and shallow subsurface water augments accumulation of organic matter in surface horizons, establishes a variety of substrates and hydrologic regimes for vegetative communities, and provides areas for invertebrate production. Exchange of water between surface and shallow subsurface components facilitates biogeochemical processes associated with elemental cycling and organic carbon export and contributes to subsurface flow out of the wetland and/or recharge to the water table.

Scaling Rationale: Generally, undisturbed sites with a high ratio of pond to non-pond area support wetland functions to a greater degree than sites with fewer ponding features or greater degrees of disturbance.

Scaling: Vsurwat

MEASUREMENT OR CONDITION FOR (VSURWAT)	INDEX
Observations or evidence of surface water or ponds in >50% or more of the assessment area, project assessment area is either predominantly undisturbed soils and native plant communities OR Observations or evidence of surface water or ponds in >50% or more of the assessment area, minor anthropogenic modifications may be present but no substantial impact to site topography is apparent (e.g., vegetation clearing, foot paths, wooden walkways, etc.).	**1.0**
Observations or evidence of surface water or ponds in 10-50% of the assessment area, project assessment area is predominantly undisturbed soils and native plant communities OR Observations or evidence of surface water or ponds in 10-50% of the assessment area, minor human disturbances or modifications may be present but no substantial impact to site topography is apparent (e.g., vegetation clearing, foot paths, wooden walkways, etc.).	**.75**
Observations or evidence of surface water or ponds in <10% of the assessment area, minor human disturbances or modifications may be present but no substantial impact to site topography is apparent (e.g., vegetation clearing, foot paths, wooden walkways, etc.)	**.50**
No observations or evidence of surface water or ponds within assessment area, project assessment area is predominantly undisturbed soils and native plant communities.	**.25**
No observations or evidence of surface water or ponds within assessment area, project assessment area is predominantly disturbed by human activities but recoverable through natural processes.	**.10**
No observations or evidence of surface water or ponds within assessment area, variable is not recoverable through natural processes.	**.00**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Low**. Variable scaling has not been extensively field tested.

12. Total Vegetative Cover (Vvegcov)

Definition: Sum of the percent cover of the six types of vegetative cover in the assessment site: 1) mosses and lichen, forbs, graminoids and herbs, 2) shrub, 3) seedlings, 4) small trees, 5) trees.

Measurement Protocol: Visually determine the total percent canopy cover by adding each strata within 0.1 acre plots. For sites dominated by herbaceous vegetation, and low shrub vegetation, a line intercept method is used for cover measurements.

Use the following Cover Class Midpoints table for estimating the percent canopy cover for each of the vegetative strata:

% Cover	Midpoint
<1	0.5
1-5	3
6-15	10.5
16-25	20.5
26-50	38
51-75	63
76-95	85.5
>95	98

Use the following tables to list the most common species and their estimated percent cover using the cover class midpoint.

Tree Species	Cover Class Midpoint
Total Cover :	

Small Trees Strata (>3’ & <10’, single stem)	
Species	Cover Class Midpoint
Total Percent :	

Shrubs Strata (multiple stems) and Seedlings (≤ 3', single stem)	
Species	**Cover Class Midpoint**
Total Cover :	

Herbaceous Strata: Forbs, Graminoids, Ferns and Fern Allies	
Species	**Cover Class Midpoint**
Total Cover :	

Mosses and Lichens Strata	
Species	**Cover Class Midpoint**
Total Cover :	

Summary Table	
1. Total percent cover of Moss / Lichen Strata	
2. Total percent cover of herbaceous Strata	
3. Total percent cover of Shrub Strata	
4. Total percent cover of Tree Strata	
Total Percent Vegetative Cover:	

Data: See Appendix 3.

Rationale for Selecting the Variable: Total cover was used in this model since the cover for individual strata was highly variable. Vegetative cover is an indicator of the ability of the site to support native plant communities and animal habitat.

Scaling Rationale: The variability of the individual strata (trees, small trees, shrub, herbs, mosses and lichen) was significant. However, the data did show that the sum of the individual vegetative strata correlated with the disturbance grouping of the data.

Scaling: Vvegcov

MEASUREMENTS OR CONDITIONS FOR (VVEGCOV)	INDEX
Greater than or equal to 120% total vegetative cover and site is not appreciably altered by human activity and dominated by native plant species.	**1.0**
Greater than or equal to 120% total vegetative and site minimal disturbance by human activity and dominated by native plant species (i.e. foot trails, selective cutting).	**.75**
> or equal to 120 % total vegetative and site significantly altered by human activity and dominated by native plant species (tree removal for ROW, heavy selective cutting).	**.50**
< or equal to 120 % total vegetative and site significantly altered by human activity. The variable is recoverable to reference standard conditions and sustainable through natural processes.	**.10**
< or equal to 120 % total vegetative and site is NOT recoverable to reference standard conditions and sustainable through natural processes.	**.00**

Confidence that Reasonable Logic and/or Data Support the calibration: **Medium**

13. <u>Number of Vegetative Strata (Vstrata)</u>

Definition: The average number of vegetation strata present within the Project Assessment Area. Vegetation strata were defined the same as for the variable (Vvegcov): trees (single-stem, woody species >10 ft tall); small trees (single-stem, woody species > 3 to 10 ft (>1 to < 3 m tall); shrubs (multiple-stem, woody species); herbs, including forbs, graminoids, ferns and fern allies; and mosses, lichens, and liverworts.

Measurement Protocol: Use the information in the previous variable (Vvegcov) to help determine how many strata you have present in the HGM Assessment Area. For example if you have species recorded for trees and shrubs only, you have two strata present.

The average number of strata is calculated for the transect, and rounded to the nearest integer to yield an estimate for the Project Assessment Area.

Data: See Appendix 3.

Rationale for Selecting the Variable: The number of strata characteristic of reference standard conditions is an indicator of the development and maintenance of native plant communities. In addition, number of strata represent the presence of the habitat structure and complexity necessary to support faunal assemblages. Similarly, the numbers and types of vegetation strata represent the diversity of habitat niches, as well as the types and amount of food and cover resources available.

Scaling Rationale: The variable was scaled using reference data, field observation, and best scientific judgement. The variable was also scaled according to a disturbance scale. The disturbance scale was developed by the Interdisciplinary Team Based upon field observation and best scientific judgement.

Scaling: Vstrata

MEASUREMENTS AND CONDITIONS FOR (VSTRATA)	NDEX
Three or more vegetative strata present and dominated by native plant species.	**1.0**
Three or more vegetative strata present and dominated by native plant species (i.e., foot trails, selective cutting).	**.75**
Two or three vegetative strata present and dominated by native plant species (tree removal for ROW).	**.50**
One vegetative strata present and may include native and non-native plants.	**.25**
Site historically forested but no forest strata present and site significantly altered by human activity. The variable is recoverable to reference standard conditions and sustainable through natural processes.	**.10**
Site historically forested but no forest strata present and site significantly altered by human activity. The variable is **NOT** recoverable to reference standard conditions or sustainable through natural processes.	**.00**

Confidence that Reasonable Logic and/or Data Support the Calibration: **High**

14. Canopy Gaps (Vgaps)

Definition: Abundance of canopy openings created by tree mortality or removal.

Measurement Protocol: A series of line transects on 10-meter centers are established within the Assessment Area. Using a vertical siting perspective (rather than oblique), estimate or measure the abundance of canopy gaps (percent cover as projected to the forest floor) within the forest. Gaps may be measured directly (e.g., project the openings to the forest floor, define with flagging and measure the footprint), or estimated. If estimated rather than measured, the field assessor may find that mentally moving the openings together to determine the gap percentage within the Assessment Area will improve precision. For large areas, this variable may be estimated using aerial photography reflective of current site conditions. Data is recorded as percent cover.

Rational for Selecting the Variable: Natural disturbance is the ecological counterpoint to succession; plant communities develop through succession and are altered through disturbance. Differing regeneration strategies of particular vegetation types lead to characteristic patterns of plant succession following disturbance. Within and adjacent to stream channels in Southeast Alaska, flooding, landslides and channel migration are typically the dominant natural sources of disturbance.

Data: No data was collected for this variable.

Scaling Rationale: Canopy gaps greatly influence the rates of understory development, vegetation growth and reproduction, and serial conditions within the Assessment Area. Canopy gaps make more water, nutrients, and sunlight available on a site and new species (herbs, shrubs, and trees) become established because of the moist, fertile, and open conditions. As a result, wildlife can simultaneously access and exploit the resources of more than one cover (or habitat) type, however protection from winter snow loads is also required. Large wood introduced into stream systems as a result of gap forming processes supports several wetland functions, including channel meander belt maintenance, nutrient cycling, dynamic surface water storage, and particulate retention.

Scaling: Vgaps

MEASUREEMENT OR CONDITION FOR (VGAPS)	INDEX
No human disturbance evident within the Project Assessment Area, however site may reflect minor to severe natural disturbance. Forest canopy can intercept a large portion of snowfall, arboreal lichens typically present. Gaps comprise approximately 25-35% of the forest canopy.	**1.0**
Canopy gaps comprise 25-35% of the Project Assessment Area. Human disturbance may be present but minor in nature (i.e., individual tree selection, boardwalks or limited use recreational trails, isolated recreational cabins, small communication towers, etc.). Forest canopy is dense enough to intercept a large portion of snowfall, arboreal lichens typically present.	**0.75**
Forest has been logged >5 years ago, but in early successional stage and regenerating. Herbaceous and shrub vegetation established, some trees reaching mid-canopy levels.	**0.50**
Forest has been recently (within 5 years) clear cut **or** second growth is dense with canopy closed such that gaps comprise <5% of forest within Project Assessment Area. Recovery is possible through forestry management activities or natural processes. Forest floor composed primarily of logging debris or leaf litter with little herbaceous or shrub growth.	**0.25**
Human disturbance is such that recovery is not possible (i.e., site is paved and/or all vegetation is otherwise permanently removed).	**0.0**

Confidence that Reasonable Logic and/or Data Support the Calibration: **Medium**

15. <u>Tree Basal Area (Vtreeba)</u>

Definition: Basal area of trees (>5" DHB) within the assessment area.

Measurement Protocol: Establish a point-center-quarter (PCQ) at least 30 ft. from bankfull in a representative area of the floodplain. Using a prism, angle gauge measurement or other comparable instrument, stand at the center of the PCQ and count the trees within a 1/10 acre plot. Multiply the number of tree falling within the range of the cruise angle by the Basal Area Factor (BAF) which is indicated on the prism or angle gauge value), to determine the sq ft/ acre of each tree species. Repeat this procedure to take a second measurement at a location that is ecologically similar to the first. For example, if the first BAF is done in coniferous forest, the second one should also be done in coniferous forest and not in emergent vegetation or a large gap etc.

Data: See Appendix 3.

Rationale for Selecting the Variable: Off channel trees are a source of organic carbon. Off channel trees contribute refractory wood, leaves, stems, detritus, etc., to the channel (i.e., mobile and refractory organic carbon source). Average appears reasonable, however the variation is wide.

Scaling: Vtreeba

MEASUREMENT OR CONDITION FOR (VTREEBA)	INDEX
Forest not appreciably altered (i.e., not harvested with in > 80 years. Stand basal areas may vary due to natural gap processes.	1.0
Greater evidence of human disturbance(> 200 feet^2/acre.	.75
Basal areas range. > 150 < 200 feet^2 /acre.	.50
Basal areas are <150 feet^2/acre. Evidence of human activity (e.g. selective logging).	.25
No trees present and riparian forest has been clear-cut or modified by human disturbance. Variable is recoverable nor sustainable through natural processes under current conditions.	.10
No trees present and riparian forest has been clear-cut or modified by human disturbance. Variable is NOT recoverable nor sustainable through natural processes under current conditions.	.00

Confidence that Reasonable Logic and/or data support the calibration: **Medium**

16. <u>Log Decomposition (Vdecomp)</u>

Definition: Number of decomposition classes of logs present (up to 5 feet) in assessment area.

Measurement Protocol: Count the number of logs using a point-center quarter (PCQ) method. The plot center should be located beyond thirty feet from the bankfull width of the stream channel. After identifying a log, use the chart below to identify the class of decay for the log. Then count the number of classes and scale according to the Scaling chart below.

COARSE WOOD DECAY CLASSES	Y /N
1. Logs Recently fallen, bark attached, leaves and fine twigs present.	
2. Logs with loose bark, no leaves/fine twigs, fungi present.	
3. Logs w/o bark, few stubs of branches, fungi present.	
4. Logs w/o branches or bark, heartwood in advanced decay state.	
5. Logs decayed into the ground and covered.	

Rationale for Selecting the Variable: Logs in various stages of decomposition provide a continuous source of refractory organic carbon.

Data: See Appendix 3.

Scaling Rationale: Generally, undisturbed sites having a greater number of logs and a greater number of classes of logs in decomposition.

Scaling: Vdecomp

MEASUREMENT OR CONDITION FOR (VDECOMP)	INDEX
Greater than or equal to 3 decomposition classes present with in the assessment area **AND** assessment area is predominantly undisturbed, native soils and plant communities.	1.0
2 decomposition classes present with in the assessment area **AND** assessment area is predominantly undisturbed, native soils and plant communities.	0.50
1 Decomposition class present with in the assessment area **AND** assessment area is predominantly disturbed, native soils and/or plant communities.	0.25
No logs present within assessment area and coarse woody debris sources have been altered/eliminated by human disturbance, variable is recoverable nor sustainable through natural processes under current conditions.	0.10
No logs present within assessment area and coarse woody debris sources have been altered/eliminated by human disturbance, variable is **NOT** recoverable nor sustainable through natural processes under current conditions.	0.0

Confidence that Reasonable Logic and/or Data Support the Calibration: **Moderate**.

There are sites with data that support a general trend and linear indexing of the variable.

17. <u>Coarse Wood in Slope Assessment Area (Vcwslope)</u>

Definition: The number of coarse wood in the Slope River Proximal Assessment Area.

Rationale for Selecting the Variable: Coarse wood is incorporated into the soil profile as it undergoes decomposition. A change, therefore, can alter soil-building processes. Alterations in soil processes can change characteristics of the soil profile (Daubenmire, 1974). Furthermore, the presence of coarse wood can help stabilize the soil and prevent erosion, provide a substrate for plant growth, and provide cover for birds and small mammals.

Measurement Protocol: Count the number of coarse wood pieces using a point-center quarter (PCQ) method. The plot center should be located beyond thirty feet from the bankfull width of the stream channel.

Data: See Appendix 3.

Scaling Rationale: Scaling is largely based on best professional judgement and data from 20 sites. The data array sheets used the average distance to the nearest piece of coarse wood. There was significant variability in the data at the reference standard sites (i.e., 8 – 20 feet to the nearest coarse wood. The authors scaled the variable linearly from the nearest piece of coarse wood to the outside of the 0.10 acre plot.

Scaling: Vcwslope

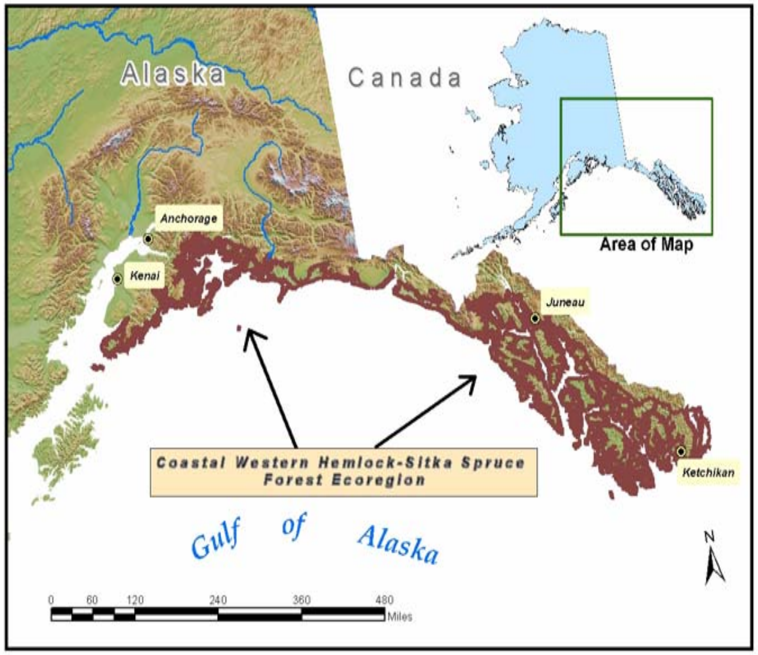
MEASUREMENT OR CONDITION FOR (VCWSLOPE)	INDEX
Using the PCQ method, the average distance to the first piece of coarse wood is equal to or < 20 feet.	**1.0**
Using the PCQ method, the average distance to the first piece of coarse wood is > 20 feet and < 30 feet.	**.75**

MEASUREMENT OR CONDITION FOR (VCWSLOPE)	INDEX
> 30 feet and < 37.5 feet.	**.50**
No coarse wood found in the PCQ plot. The variable is recoverable to reference standard conditions and sustainable through natural processes.	**.10**
No coarse wood found in the PCQ plot. The variable is NOT recoverable to reference standard conditions or sustainable through natural processes.	**.00**

Confidence that Reasonable Logic and/or Data Support the Calibration: **High**

Field Guide and Data Collection Procedures (Appendix 1)

Riverine and Slope River Proximal Wetlands in Coastal Southeast & Southcentral Alaska
Operational Draft Guidebook
Using the HGM Approach



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June 2003

Field Guide and Data Collection Procedures

Riverine and Slope River Proximal Wetlands in Coastal Southeast & Southcentral Alaska
Operational Draft Guidebook
Using the HGM Approach

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Alaska Department of Natural Resources (ADNR)

USDA Natural Resources Conservation Service (NRCS)
U.S. Environmental Protection Agency (EPA)
U.S. Army Corps of Engineers (COE)
USDA Forest Service (USFS)
USDA U.S. Forest Service, Pacific Northwest Research Station
Alaska Department of Fish and Game (ADF&G)
U.S. Geological Survey, Water Resources Division (USGS)
Alaska Department of Environmental Conservation (ADEC).

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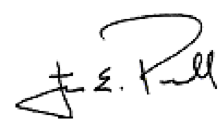
Disclaimer

This field guide is the same as Appendix 1 in the "Operational Draft Guidebook For Assessing the Functions of Riverine and Slope River Proximal Wetlands in Coastal Southeast & Southcentral Alaska."

This field guide was developed for applying an HGM functional assessment model of riverine wetlands and slope river proximal wetlands in Coastal Southeast and Southcentral Alaska. It is intended to be used in its present form consistent with the *National Action Plan to Develop the Hydrogeomorphic Approach for Assessing Wetland Functions (Federal Register,* August 16, 1996 (Vol. 61, No. 160) at page 42603). This field guide and the Operational Draft Guidebook upon which it is based will be used and reviewed for a two-year period by regulatory and resource agencies. Other organizations, and other parties will have an opportunity to use the Operational Draft Guidebook during this two-year period and provide recommendations for improvement. After the Operational Draft Guidebook has been used in the field for two years it may be revised incorporating comments and corrections identified by the Guidebook Development Team. The revised Operational Draft Guidebook will be reviewed and approved by the COE/WES as a Final Guidebook.



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Contents

Preface

Purpose of this Field Guide

This field guide is intended to provide guidance and field procedures necessary for completing a rapid assessment report using the HGM approach. It is also designed to supplement the Operational Draft Guidebook for riverine wetlands, and slope river proximal wetlands on low permeability deposits and bedrock in Coastal Southeastern and Southcentral Alaska. This field guide is included in the Operational Draft Guidebook as Appendix 1.

The field guide is designed to be used in the field with the equipment suggested below:

Suggested Equipment List

1	100 ft Measuring Tape (English units)
1	Soil Color Chart (i.e. Munsell Soil Chart)
1	Prism or angle gauge measurement for measuring the basal area of trees
1	Flagging: one to two rolls
1	Shovel (sharp shooter or soil spade)
1	6 inch transparent measurement ruler (metric)
1	Small measuring tape (metric)
2	Small wooden or tent stakes
1	Waterproof hip boots
1	DBH measuring tap (English units)
1	Handheld calculator
1	Plant identification key

How to use this Field Guide

This field guide is designed to be used in the field as a reference for collecting the necessary information to rapidly assess wetland functions for riverine and slope river proximal wetlands in Southcentral and Southeast Alaska. If you are familiar with the Hydrogeomorphic Approach and have a copy of the Operational Draft Guidebook for Riverine and Slope River Proximal (http://www.state.ak.us/dec/dawq/nps/wetlands.htm#WET5) the following procedure can be used to develop a HGM Rapid Assessment Report. This report can be used for designing projects, determining mitigation and for fulfilling the requirements for functional assessments for permitting wetland projects.

Procedure for Developing an HGM Rapid Assessment Report:

A) Copy the Field Data Collection Sheets For ease of collecting data and assembling the HGM Rapid Assessment Report the sheets used for recording data and information are located at the end of this field guide. Copy these sheets on rain resistant paper:

Field Data Collection Sheets:

1) Step 1. Preliminary HGM Classification
2) Step 2. Site Information (completed in the office or field)
3) Step 3. Sketch a Map of Project Assessment Area.
4) Pebble Count & Embeddedness Work Sheet
5) Variable (15) Vegetative Cover (Vvegcov) worksheets.
6) Variable and Functional Scoring Sheets (4 pgs. in all) located at the end of this field guide. These sheets are for recording your results and information collected from the field.

B) Follow the Six -Step Process for Developing an HGM Functional Assessment Report outlined on the following pages.

C) After completing the Six-Step Process and calculating the Functional Capacity Indexes (FCIs), assemble the Field Data Collection Sheets into one report. This constitutes an HGM rapid assessment report.

Functional Assessment Report for Riverine and Slope River Proximal Wetlands Using the HGM Approach

Six-Step Process for Developing an HGM Functional Assessment Report

Before conducting a functional assessment you need to determine if the Project Assessment Area includes jurisdictional wetlands and the type or subclass of wetlands you are assessing. The key on the next page is designed to help in determining if this field guide is appropriate for the type of wetlands you are assessing (i.e., riverine or slope river proximal wetlands). After you have determined that you are assessing riverine and/or river proximal wetlands then the following six-step process can be used to complete a report for a rapid assessment for these wetlands. (Note: If the assessment area includes both wetland classes then the following six-step process is required for each class).

Six-Step Process

1. Conduct a Preliminary HGM Classification.
2. Complete the Site Information Sheet.
3. Sketch a map of the Project Assessment Area.
4. Collect the field measurements for each variable and record them in the field measurement column of the **Variable Scoring Sheet.**
5. Determine the variable score using the field measurements and the variable index scoring table. Record the variable score in the Variable Index score column of the **Variable Scoring Sheet.**

C) Determine the Functional Capacity Index (FCI) of each function by entering the appropriate score into an electronic spreadsheet (included in the Operational Draft Guidebook's appendices). Or, manually calculate the score using the F**unctional Scoring Sheet.** A copy of the electronic spreadsheet that is available on the State of Alaska, Department of Environmental Conservation website: (http://www.state.ak.us/us/dec/dawq/nps/wetlands.htm#wet5).

Key to Riverine & Slope River Proximal Wetlands in Coastal SE & SC Alaska

1a. The assessment area is not a jurisdictional wetland according to the Corps of Engineers Wetland Delineation Manual (U.S. Army Corps of Engineers 1987). For example, (1) the area is a deepwater aquatic habitat. Deepwater aquatic habitats are areas that are permanently inundated at mean annual water depths > 6.6 ft or permanently inundated areas ≤ 6.6 ft that do not support rooted-emergent or woody plant species: **Non-wetland: Guidebook not applicable.**

1b. The assessment area is a jurisdictional wetland according to the Corps of Engineers Wetland Delineation Manual: **2**

2a. The wetland is tidally influenced, glacially driven water source, in a closed depression (e.g., pothole on glacial moraine), or is adjacent to a lake where the water elevation of the lake maintains the water table in the wetland: **Guidebook not applicable.**

2b. The wetland is a river or within 200 feet adjacent to a river : **go to 3**

3a. The slope of the land or water surface exceeds 25%: **Guidebook not applicable.**

3b. The slope of the land or water surface 0.002 ≤ 25%: **go to 4**

4a. The wetland is located in valley bottoms, within 200 feet of the bank- full of a river channel, and ground or surface waterflow driven. **YES. Use the Slope River Proximal Subclass in this guidebook**.

4b. The wetland is in an active river channel, a higher order stream reach derived from non-glacial water sources, occurring on valley bottoms, and corresponds with Rosgen Stream types "B" or "C" and USFS Tongass National Forest Channel Types 1) Moderate Gradient Mixed Control, 2) Moderate Gradient Contained, or 3) Flood Plain process groups. **YES. Use the Riverine Subclass in this guidebook.**

Step 1. Preliminary HGM Classification

Identify, verify, and document the rationale used for recognizing HGM classes and subclasses within the project assessment area. Determine if the assessment area is a ***RIVERINE and/or SLOPE RIVER PROXIMAL Wetland Subclass by using the dominant characteristics outlined below.***

Show how the project assessment area satisfies a subclass definition provided in the guidebook by completing the form below. Specifically, include a discussion of the site characteristics and show how they are consistent with the dominant characteristics of the subclass.

Riverine Wetland Dominant Characteristics

CHARACTERISTIC	DESCRIPTION
Hydrologic Source	Unidirectional flow, higher order streams, derived from non-glacial water sources
Vegetation	Any vegetation life form (e.g., trees, shrubs, herbaceous, etc.) that are not in a marine, or estuarine system, nor directly influenced (i.e., actively flooded) by those systems.
Landforms	Occur in valley bottoms, flow predominantly on bedrock, glacial till or glacial marine deposits. Low elevation stream reaches may flow on Pleistocene or Holocene alluvial gravel deposits, or deltaic estuarine deposits raised in elevation by tectonic lift.
Slope	0.001% to ≤ 2.2%
Parent Materials	Upper reaches: exposed bedrock, glacial till, and colluvium over bedrock, alluvial sand, and gravel. Lower reaches: dense basal till, marine lucustrine and glacial fluvial sediments, and alluvial sand and gravel.
Soils	Sand, silt, and gravel deposits with occasional surface organic matter accumulation.

Provide the site Characteristics:

Hydrologic Source ____________________

Vegetation ____________________

Landform, soils ____________________

Slope ____________________

Slope River Proximal Wetland Dominant Characteristics

CHARACTERISTIC	DESCRIPTION
Location	Located within 200 feet of the bankfull of a river channel.
Hydrologic Source	Ground or surface water flow.
Vegetation	Any vegetation life form (e.g., trees, shrubs, herbaceous, etc.) that are not in a marine, or estuarine system nor directly influenced (i.e., actively flooded) by those systems.
Landforms	Occur adjacent to streams and valley sides. Occur in valley bottoms, flow predominantly on bedrock, glacial till or glacial marine deposits. Low elevation stream reaches may flow on Pleistocene or Holocene alluvial gravel deposits, or deltaic estuarine deposits raised in elevation by tectonic lift. **Note**: wetlands in closed depressions are out of the subclass.
Slope	0.1% to ≤25%
Parent Materials	Upper reaches: exposed bedrock, thin till, and colluvium over bedrock. Lower reaches: dense basal till deposited by flowing glacial ice, outwash, gravel.
Soils	Sand, silt, and gravel deposits with occasional surface organic matter accumulation.

Provide the site Characteristics:

Hydrologic Source ____________________

Vegetation ____________________

Landform ____________________

Slope ____________________

Parent Materials ____________________

Soils ____________________

Step 2. Site Information (Completed in the Field or Office)

Dates of Site Visit ________________________________

Team Members ________________________________

Field Notes/Observations ________________________________

Collect and review information relevant to the site. This includes, but is not limited to*:*

- *USGS, state, local, and other maps (at various scales)*
- *Geotechnical, soils, or environmental reports*
- *Correspondence, construction plans on the proposed project*
- *Published literature*

Identify the documents that were collected and reviewed. Include a detailed description of each document (e.g., citation, date, scale, quadrangle name, etc.). If possible, attach copies of each document.

- USGS, state, borough, and other maps (at various scales):
  1. ________________________________
  2. ________________________________
- Air photos and other imagery:
  1. ________________________________
  2. ________________________________
- Relevant geotechnical, soils, or environmental reports:
  1. ________________________________
  2. ________________________________
- Correspondence, construction plans, and specifications, etc. on the proposed project:

  ____
- Relevant published literature:

  ____
- Other documents:

- Other Questions:

  Is a cataloged anadromous fish stream adjacent to or part of the assessment area?

  Is the assessment area used by any federally listed threatened or endangered species?

  Is the assessment area adjacent to a state listed impaired waterbody?

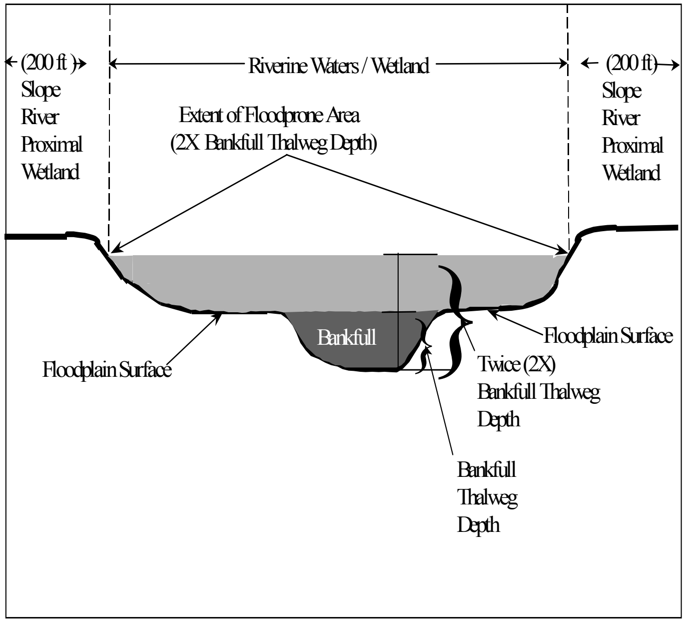
  Is the assessment area listed as a historic or cementary?

Step 3. Sketch a map of Project Assessment Area

Image source, date, and scale: ______________________________

Step 4 (a) Summary of Riverine Variables

Stream Channel	
Variables	***Description***
1) **Vpebble-D50**	Conduct pebble count (D50) & visually estimate embeddedness
2) **Vchanrough**	Determine channel roughness (D84)
3) **Vembed**	Estimate the percent of pebble embeddedness
4) **Vcwpot**	Determine if there is coarse wood upstream of assessment area
5) **Vcwin**	Count coarse wood in channel
6) **Vlogjam**s	Count the number of logjams (2 or more logs embedded in channel)
7) **Vsubin**	Count the number of subsurface flows into the river channel
8) **Vshade**	Measure the percent of shade in the stream channel
Hydrology and Soils	
9) **Valthydro**	Determine if there are alterations to the hydrology upstream of the assessment area
10) **Vbarrier**	Determine if there are barriers to fish movement down stream
11) **Vfreq**	Along the stream bank, look for indicators of overbank flooding
12) **Vstore**	Determine if there are direct or indirect indicators of water storage areas in the flood prone area.
13) **Vsoilperm**	Slice a cross-section of the stream bank and determine permeability
Vegetation and Land Use	
14) **Vtreeba**	Estimate the basal area of trees
15) **Vvegcov**	Estimate the percent vegetative cover
16) **Vstrata**	Count number of vegetative strata
17) **Vwetuse**	Determine land use in assessment area
18)**Vwateruse**	Determine land use in watershed area

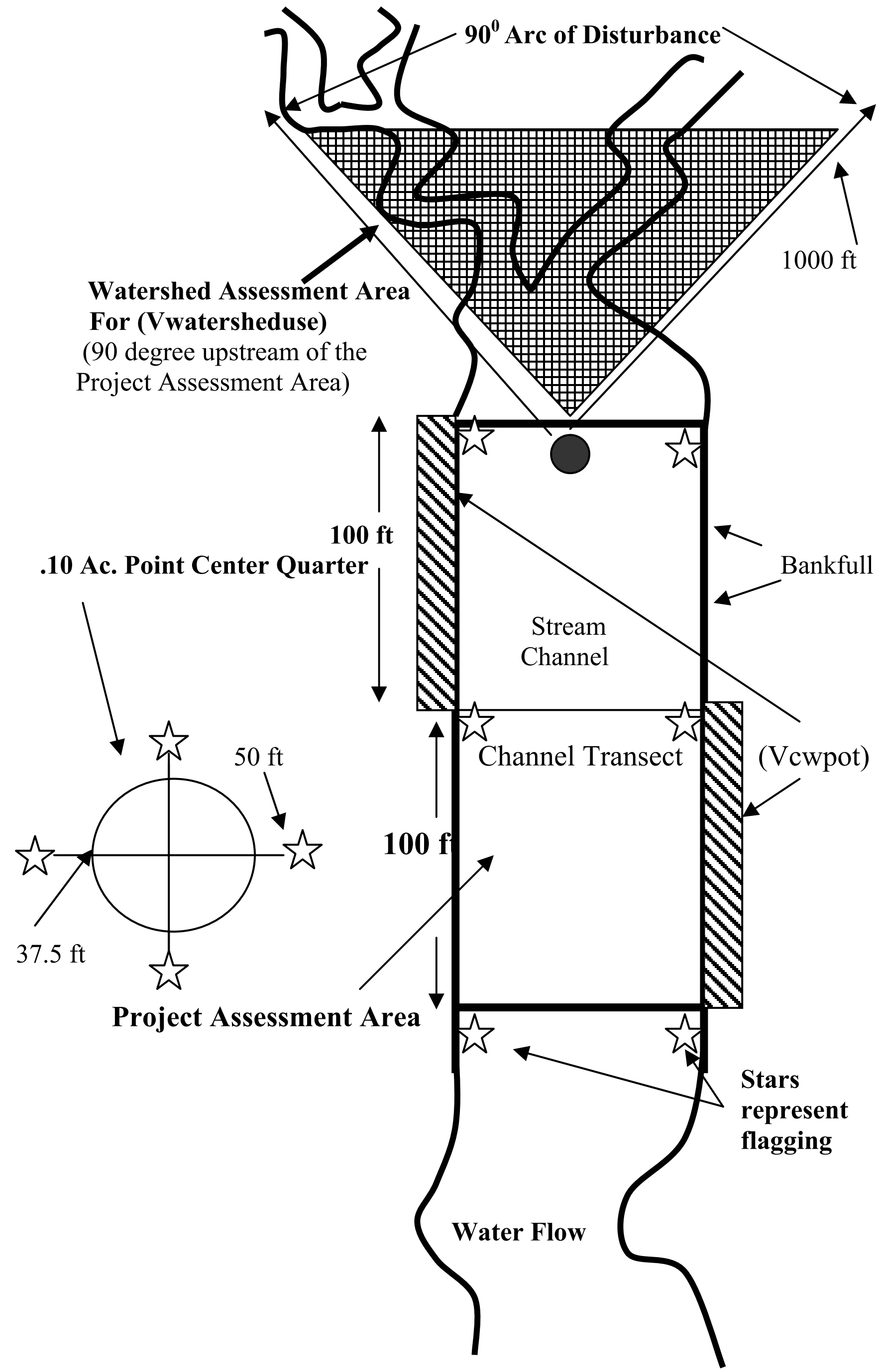


Stream Channel Cross-section and Measurements

NOTE: 1) The floodprone area is the area defined by the projection of a plain at twice the bankfull thalweg depth.

2) In some instances, the floodprone, as defined by the projection of a plain at 2X bankful thalweg depth, will extend into areas that are slope wetlands. Riverine waters/wetlands include those areas that are predominated by fluvial processes (i.e., uni-directional flow, overbank flooding). Slope river proximal wetlands are those areas that are dominated by ground water flow.

Figure 1. HGM Assessment Area Diagram for Riverine Wetlands



<u>Establish a Channel Transect and Assessment Area (Figures 1 & 2)</u>
Mark the channel bankfull width at one side of the stream and extend a measuring tape to the opposite side to establish the cross channel transect. The channel transect should be perpendicular to the stream flow. Measure upstream and downstream 100 ft from the cross channel transect to establish the assessment area. **The assessment area will be referred to as such for variable measurement below.**

Riverine Wetlands

Stream Channel Measurements

1) Median Pebble Size D50, (VpebbleD50)
2) Channel Bed Roughness (Vchanrough)
3) Embeddedness (Vembedded)
4) Potential Coarse Wood (Vcwpot)
5) In-Channel Coarse Wood (Vcwin)
6) Logjams (Vlogjams)
7) Subsurface Flow (Vsubin)
8) Characteristic Riparian Shade (Vshade)

For each variable:

a. Collect field measurements as directed below and record them in the field measurement column of the **Variable Scoring Sheet**.

b. Determine the variable score using the field measurements and the variable index scoring table. Record the variable score in the Variable Index score column of the **Variable Scoring Sheet**.

c. Determine the Functional Capacity of each function by entering the appropriate score into an electronic spreadsheet included in the Operational Draft Guidebook's Appendices. Or, manually calculate the score using the **Functional Scoring Sheet**.

Pebble Count:

Take a random walk in the stream channel within the assessment area. While taking the walk, occasionally stop and plant your right foot. Over the toe of your right boot and with eyes closed or averted, touch an extended finger to the nearest rock or sand grain (includes: gravel, cobble, and boulders >2mm). Pick up the rock or sand, and using a transparent ruler measure along the intermediate axis (i.e. neither the longest nor the shortest). Record your measurements in millimeters (mm) in the appropriate size class. (Table 4). Start at the bottom of each size class and fill in each row. (Dunne and Leopold, 1978). In doing so, you are constructing a "histogram" (bar chart) that shows the size distribution of the inorganic stream bed materials. The pebble count is used for scaling two variables: Median Pebble Size D50 (VpebbleD50) and Channel Bed Roughness (Vchanrough). <u>Also</u>, during the pebble count determine the percent of sediment surrounding the nearest pebble rock or sand grain for scaling embeddedness (Vembedded).

1) Median Pebble Size D50 (Vpebble-D50):

Determine the median pebble size (D50) of the samples by using the Pebble Count Table following the procedure outline above.

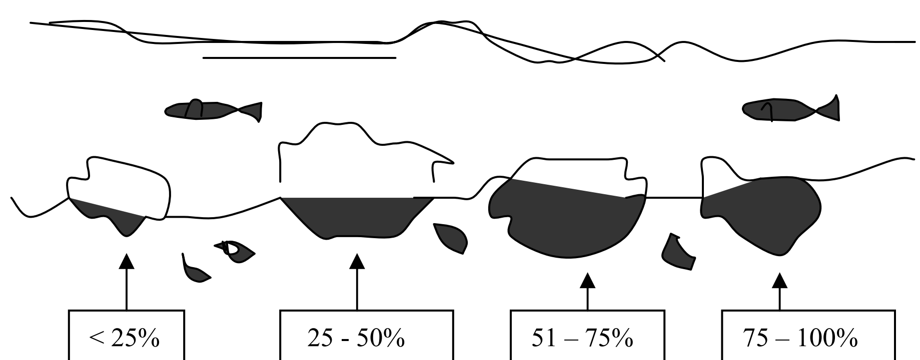
Pebble Count & Embeddedness Work sheet

>2	2-4	5-8	9-16	17-32	33-64	65-128	129-256	257-512	512-1024	> 1024

Embeddness Work Sheet

0 – 25%	26 – 50%	51 – 75%	76 – 100%

Examples of embedded pebbles:



Scaling : (Vpebble-D50)

Measurement or Condition	Index
D50 is within the range of 12 mm to 113 mm and there is no evidence of large-scale human disturbance activities (e.g., large mass-wasting events, forestry practices, housing developments, etc.) in the watershed above or adjacent to the assessment area that would result in the input of fine sediment to the assessment area.	**1.0**
D50 is within the range of 12 mm to 113 mm and there is evidence of disturbance in the watershed above or adjacent to the assessment area that could result in the input of fine sediment to the assessment area (e.g., channelization, gravel mining, rip-rap, etc.).	**0.5**
D50 is not within the range of 12 mm to 113 mm and there is evidence of disturbance in the watershed above or adjacent to the assessment area that has resulted in the input of fine sediment to the assessment area (e.g., channelization, gravel mining, rip-rap, etc.) and/or bedload transport capacity has been reduced and/or eliminated (e.g., reduced flows in Duck Creek, Juneau, Alaska).	**0.1**
No bedload (dams, levees, major channel modifications have eliminated the bedload, e.g., Gold Creek, Juneau, Alaska).	**0.0**

2) Channel Roughness (Vchanrough D84):

Determine the pebble size that is one standard deviation larger than the mean size particle. This is the D84th or 84th percentile that is an estimate of the larger particle sizes that move into the assessment area. Using the pebble count worksheet determine one standard deviation.

Scaling: for (Vchanrough)

Measurement or Condition	Index
D84 is ≥106 mm **and** the site is not appreciably altered (e.g., logging >80 years ago, hiking trails in a green belt, etc.). Sediment inputs to the stream system can and do occur, but their sources are from naturally occurring disturbances (e.g. landslides, windthrow, streambank scour, etc.).	**1.0**
D84 ranges between ≥ 79 - 106 mm **and** the site is predominantly undisturbed and characterized by very minor and localized disturbance (i.e. 1-4% of the assessment area) to the streambed and little to no input of sediment to the stream from human disturbances.	**0.75**
D84 ranges between >53 - 79 mm **and** in or near-stream projects have resulted in minor and localized (5-10% aerial extent) hardening of the streambed (e.g., a ford) within the assessment area reach. There are minor inputs of fine textured sediment to the stream channel from disturbances (e.g., adjacent yards, parking lots, log truck, and skid roads, etc.).	**0.50**
D84 ranges between >20 and ≤53 mm, **and** in or near-stream projects (e.g. channelization or bank stabilization, buried pipe or powerline crossings) have resulted in hardening of portions (i.e.,10 - 20% aerial extent) of the stream bed (e.g. footings or fords) or alteration of the flow regime within the assessment area reach. There is a high proportion of fine sediment inputs to the system from human sources (e.g. adjacent yards, landfills, placer mine tailings, parking lots, log truck and skid roads, etc.).	**0.25**
D84 ranges between > 2 <19 mm and/or in or near-stream projects (e.g. channelization, bank stabilization, or buried pipe or powerline crossings) have resulted in hardening of large portions of the stream bed (e.g. footings, placer mine tailings) within the project assessment area reach. In low gradient streams (e.g., nearly level to <1% longitudinal slope) there are obvious sediment inputs to the system from disturbances (adjacent yards, landfills, snow dumps, log truck roads, etc.). In high gradient streams (channel slope >1%), there are obvious sediment inputs to the system from disturbances (e.g. adjacent yards, landfills, logging roads, etc.). and sediment is regularly flushed (winnowed) from the system by high energy flows. In **both** low and high gradient streams, the variable is recoverable and sustainable through natural processes if the existing land use is discontinued and restoration measures are applied.	**0.10**
D84 is ≤ 2 mm and/or the channel bed is poured concrete or rip/rap with low to very low design channel bed roughness. Sediment (if any) has a very short residence time in the system. The variable not is recoverable nor sustainable through natural processes if the existing land use is discontinued and restoration measures are applied.	**0.0**

3) Embeddedness (Vembedded):

Estimate the amount (as percent of particle covered) of fine sediment (<2 mm) surrounding gravel, cobble, and boulder particles.

Scaling : (Vembed)

Measurement or Condition	Index
Fine sediment surrounds 0 - 25% of particles	**1.0**
Fine sediment surrounds 26 - 50% of particles	**0.75**
Fine sediment surrounds 51 - 75% of particles	**0.50**
Fine sediment surrounds 76 - 100% of particles	**0.25**

4) Potential for Coarse Wood (Vcwpot):

Count the number of live trees >5" DBH within 10 feet on either side of the bankfull margin and 100 feet upstream and 100 feet downstream of the channel cross-section. One transect should be upstream of the channel cross-section and the second transect should be downstream of the channel cross-section. Opposite banks should be sample (i.e., if the left bank is assessed upstream then the right bank is assessed downstream and vice versa).

Scaling: (Vcwpot)

Measurement or Condition	Index
≥5 trees total within 100-foot reach upstream and 100-foot downstream of the stream cross-section and within 10 ft of the bankfull margin; no evidence of human disturbance (i.e., within 10 ft of the bankfull margin).	**1.00**
2 to 4 trees total within 100-foot reach upstream and 100-foot downstream of the stream cross-section and within 10 ft of the bankfull margin; no evidence of human disturbance (i.e., within 10 ft of the bankfull margin).	**0.50**
1 tree total within 100-foot reach upstream and 100-foot downstream of the stream cross-section and within 10 ft of the bankfull margin; no evidence of human disturbance (i.e., within 10 ft of the bankfull margin).	**0.25**
No trees present within 100-foot reach upstream and 100-foot downstream of the stream cross-section and within 10 ft of the bankfull margin; evidence of human disturbance (i.e., within 10 ft of the bankfull margin). Potential for restoration of the riparian forest exists	**0.10**
No trees present within 100-foot reach upstream and 100-foot downstream of the stream cross-section and within 10 ft of the bankfull margin; evidence of human disturbance (i.e., within 10 ft of the bankfull margin). **NO** potential for restoration.	**0.00**

5) In - Channel Coarse Wood (Vcwin)

Count the number of single coarse wood pieces or logs >5" DBH that occur below bankfull stage within the assessment area that are not part of logjams. Record the diameter length, of each piece.

Scaling : (Vcwin)

Measurement or Condition	Index
There are > 8 pieces and < 25 pieces per 200 ft reach of channel. The residence time of coarse wood in the channel is long, because the coarse wood is embedded and/or relatively stable (e.g. portions of the coarse wood are buried by sediments and the pieces are large, possibly interacting with other coarse wood, and thus not capable of moving downstream except in catastrophic floods).	**1.0**
There are ≥ 8 pieces and < 25 pieces per 200 ft reach of channel. The residence time of CW in the channel is long, because the CW is embedded or partially embedded and/or relatively stable (e.g. portions of the CW are buried by sediments and the pieces are large, possibly interacting with other CW and thus not capable of moving downstream, except in catastrophic floods).	**0.75**
There are ≥ 4 and <8 pieces or >25 pieces of CW per 200 ft reach of channel. The residence time of CW debris in the channel is such that CW is mobile, but only during significant flood events (e.g. the 2-10 year flood).	**0.50**
There are ≤ 4 pieces or >25 pieces of CW per 200 ft reach of channel. The residence time of CW in the channel is such that CW is mobile during 1 - 5 year flood events. The variable is recoverable in time through natural processes if the existing land/channel uses are discontinued.	**0.25**
There ≤2 pieces of CW per 200 ft reach of the channel and there is not a source of, or roughness to trap CW. The residence time of CW in the channel is very short (i.e. CWD will be moved out of the channel by normal storm flows). This condition is not recoverable through natural processes. However, the variable is recoverable through restoration measures that will eventually restore in-channel CW (e.g. planting trees along the stream banks or placing logs in the channel).	**0.10**
There are ≤ 2 pieces of CW per 200 ft reach of the channel **and** there is not a source of, or roughness to trap CW (e.g. the channel below bankfull is poured concrete or confined in a culvert or flume) and therefore the residence time of wood in the channel is very short (i.e. CW will be moved out of the channel by normal storm flows). This condition is not recoverable through natural processes or through restoration.	**0.00**

6) Log jams (Vlogjams)

Count all logjams within the 200-ft HGM assessment area reach of the channel.

Scaling: (Vlogjams) :

Measurement or condition	Index
Greater than 4 logjams and the site is undisturbed (e.g. logging > 80 years or no development activity).	**1.0**
3 to 4 logjams.	**0.75**
1 to 3 logjams.	**0.50**
No logjams within bankfull channel. Potential for accumulation of coarse wood into logjams exists.	**0.10**
No logjams within bankfull channel. No potential for accumulation of coarse wood into logjams exists.	**0.0**

7) Subsurface Flow into the Water/Wetland (Vsubin)

Determine if there are subsurface flow indicators (seeps from the soil) along the channel bank within the HGM assessment area.

Scaling: (Vsubin)

Measurement or Condition	Index
Areas adjacent to and upstream of the assessment area are predominately undisturbed, native soils, and plant communities **AND** there is direct evidence of subsurface flow into the assessment area (e.g., seeps, iron flock, artesian flow, upwelling).	**1.0**
Areas adjacent to and upstream of the assessment area are predominately undisturbed , native soils, and plant communities **AND** there is **NO** direct evidence of subsurface flow into the assessment area (e.g.,. seeps, iron flock, artesian flow, upwelling)).	**0.75**
Areas adjacent to and upstream of the assessment area are predominately disturbed (for example: residential or recreational development), native soils, and plant communities **AND** there is **NO** direct evidence of subsurface flow into the assessment area (e.g., seeps, iron flock, artesian flow, upwelling).	**0.50**
Areas adjacent to and upstream of the assessment area are predominately impervious surfaces and direct evidence of subsurface flow to the water/wetland is observed. (e.g. seeps, iron flock, artesian flow (upwelling).	**0.25**
Areas adjacent to and upstream of the assessment area are predominately impervious surfaces and no direct evidence of subsurface flow to the water/wetland is observed.	**0.1**
The assessment area is contained within a concrete channel, culvert, etc.	**0.0**

8) Riparian Shade (Vshade)

Measure the percentage of canopy cover over the entire water surface as if the sun was directly overhead.

Scaling : (Vshade)

Measurement or Condition	Index
40 % - 60 % vegetative shading of stream surface area. Mixtures of conditions where some areas of water surface are fully exposed to sunlight, and other areas receive various degrees of filtered light.	**1.0**
20% - 39% or 61% - 80% vegetative shading of stream surface area. Covered by sparse canopy, entire water surface receiving filtered light.	**0.50**
1% - 19% or 81% - 100% vegetative shading of stream surface area. Water surface is approaching either complete vegetative shading or full exposure to overhead sunlight conditions.	**0.25**
No vegetative shading of stream surface area. Variable is recoverable and sustainable through natural processes under current conditions (e.g., natural regeneration of riparian vegetation).	**.10**
No vegetative shading of water surface. Variable is neither recoverable nor sustainable through natural processes.	**0.00**

Riverine Wetlands: Hydrology and Soils

9) Alterations of Hydroregime (Valthydro)
10) Barriers to Fish Movement (Vbarrier)
11) Frequency of Overbank Flooding (Vfreq)
12) Flood Prone Area Water Storage (Vstore)
13) Soil Permeability (Vsoilperm)

For each variable:

a) Collect field measurements as directed below and record them in the field measurement column of the **Variable Scoring Sheet**.

b) Determine the variable score using the field measurements and the variable index scoring table. Record the variable score in the Variable Index score column of the **Variable Scoring Sheet**.

c) Determine the Functional Capacity of each function by entering the appropriate score into an electronic spreadsheet included in the Operational Draft Guidebook's Appendices. Or, manually calculate the score using the **Functional Scoring Sheet**.

9) Alterations of Hydroregime (Valthydro)

Note the human or natural alterations that influence the hydroregime. Examples of alterations include: dams, storm water structures, forest practices, beaver dams, etc.

Scaling: (Valthydro)

Measurement or Condition	Index
No additions, diversions, or damming of flow affecting the assessment area (e.g. no stormwater management structures, water diversion, forest practices, or natural levee not associated with human activity, etc.).	**1.0**
Evidence of diversions with minor effects to flow. Examples include stabilized beaver dams, well designed bridge embankments and/or bridge pilings that do not restrict the width of the stream or adversely affect stream hydrology (e.g., stabilized slopes, no evidence of scouring or deposition in the vicinity of the structure).	**.75**
Evidence of additions, diversions, or damming of flow affecting the assessment area that have resulted in some impact, but not an appreciable impact to hydrologic functions. Examples include small stormwater management outfalls, small/stabilized stormwater ditches, individual wells or potable water intakes, forest practices that maintain adequate riparian buffers, road crossings that restrict peak flows, but not ordinary high water flows.	**.50**
Evidence of additions, diversions, or damming of flow affecting the assessment area that have appreciably impacted hydrologic functions. Examples include extensive storm water management or water withdrawal activities, forest practices or other activities that introduce sediment loading into the stream, undersized and/or unmaintained culverts, gravel dredging, alteration of channel morphology (width/depth ratios), nutrient loading (algae and diatom blooms), water diversion, undersized culverts, and flow reductions. Variable is recoverable and sustainable through natural processes under current conditions	**0.1**
Permanent alterations to the assessment area hydroregime. Variable is neither recoverable nor sustainable through natural processes under current conditions.	**0.0**

10) Barriers to Fish Movement (Vbarrier)

Using aerial photography identify obstructions or barriers to stream channel flow. In addition to, or in place of, using aerial photography, pace 500 ft downstream of the boundary of the assessment area. List type and number of natural (beaver dams etc.) and human disturbances such as culverts, wide spanned bridges, temporary bridges, & other land uses within the observation area.

Scaling: (Vbarrier)

Measurement or Condition	Index
No impact (e. g., instream structures may be present but do not affect water quality, quantity or natural migration patterns of aquatic species indigenous to the waterbody). Examples include downstream bridges or road crossings that don't constrict ordinary or flood flows, utility lines where pre-project conditions have been restored, minor water withdrawal activities, stream vehicle fords, etc.	**1.0**
Minimal impact (e.g., downstream structures affect passage during flows higher than ordinary high water events but do not affect passage at other times). No apparent sources of contaminants, sediments, etc. that affect water quality.	**.75**
Minimal impact (e.g., downstream structures affect passage during flows higher than ordinary high water events but do not affect passage at other times. Sources of contaminants and sediments observed that potentially affect water quality such as storm drains, parking lots, retaining walls, lawns, unstabilized slopes, etc.	**.50**
Passage is affected at ordinary high water flows by inadequately installed or maintained culverts, barriers to migration or other features. Sources of contaminants and sediments observed that potentially affect water quality such as storm drains, parking lots, retaining walls, lawns, unstabilized slopes, etc.	**.25**
Fish passage is blocked and water quality adversely impacted by heavily urbanized concentration of commercial/residential, airport, gravel pits, through-fill roads with ditches , parking lots, etc. Variable is not recoverable through natural processes.	**0.0**

11) Frequency of Overbank Flooding (Vfreq)

Measurement Protocol:

Direct Measurement - Stream gauge information available: use the data from stream-gauging stations for estimates of this variable. Contact the US Geological Survey (USGS) in Juneau, Alaska at (907) 586-7216 to determine the availability of stream gauge information. The USGS also has an Internet web page located at "ak.water.usgs.gov." The USGS can provide an estimate of the magnitude of a particular flooding event and a frequency of flooding estimate for the project assessment area, which should be used if available, prior to relying on field indicators having less precision.

Indirect Measurement - Gauge information not available: Use field indicators such as high water marks, silt lines, drift, seed and debris lines, grasses and other tall non-woody vegetation laying down as a result of overbank flows, tree bark damaged by floating debris, and evidence of channel scour and sediment deposition. These indicators can reflect recent flooding or an infrequent event and may not be particularly helpful in establishing the flood return interval at a particular site. The use of the indicators in conjunction with an assessment of the depth of organic litter, decomposition stage, and vegetation type (e.g., woody or herbaceous) provides an estimate of the frequency of overbank flooding in the project assessment area. Site characteristics are compared to range of conditions expressed in the variable indices.

Scaling : (Vfreq)

Measurement or Condition		
Indirect Measure	**Direct Measure**	**Index**
No litter to a very thin layer (< 1 cm) of non-decomposed material present on wetland surface. Presence of high water marks, silt lines, drift, seed and debris lines, and/or scattered grasses lying down as a result of overbank flows. Evidence of channel scour and sediment deposition present. Fluvial deposited logs and organic debris on channel banks with little moss, lichen, seedlings or leaf litter accumulations on these surfaces. Overall percent cover of herbaceous vegetation is low and vegetation consists of species typical of primary colonization. If trees are present they may appear stressed from frequent inundation unless established on larger nurse logs or on coarser/ better drained sediments adjacent to channel bank. Estimated flood frequency is 1-2 year return intervals.	Gauge data extrapolated to project assessment area reflects 1-2 year return interval.	**1.0**

Measurement or Condition		
Indirect Measure	**Direct Measure**	**Index**
Thin litter cover (1-3 cm) ranging from recent to partly or completely decomposed material. Fluvial deposited logs and organic debris on channel banks with moss, lichen, seedlings, or decomposing leaf litter accumulations on these surfaces. Natural levees present immediately adjacent to the channel bank. Mature trees present along with some species typical of primary colonization. Bark of trees may show indications of damage from floating debris, and red squirrel midden accumulations may be concentrated at base of larger trees in the wetland. Estimated flood frequency is 2-10 year return intervals.	Gauge data extrapolated to project assessment area reflects 2-10 year return interval.	**0.75**
Thin litter cover (1-3 cm) ranging from recent to partly or completely decomposed material. Fluvial deposited logs and organic debris on channel banks with moss, lichen, seedlings, or decomposing leaf litter accumulations these surfaces. Natural levees present immediately adjacent to the channel bank. Mature trees present along with some species typical of primary colonization. Bark of trees may show indications of damage from floating debris, and red squirrel midden accumulations may be concentrated at base of larger trees in the wetland. Estimated flood frequency is 2-10 year return intervals.	Gauge data extrapolated to project assessment area reflects 2-10 year return interval.	**0.50**
Thick litter cover (>3 cm) with lower layer completely decomposed. No evidence of overbank deposits and fluvial transported debris not present. Dominant vegetation is mature trees (unless artificially manipulated - e.g., lawn or timber harvest). Estimated flood frequency is > 10 year return interval.	Gauge data extrapolated to project assessment area reflects > 10 year return interval.	**0.5**
Artificial flood control features that affect assessment area present (e.g. man-made levees, flood control channels, upstream flood control impoundments, etc.).	Gauge data extrapolated to project assessment area indicates that no overbank flooding is likely.	**0.0**

12) Flood Prone Area Storage Volume (Vstore)

Identification and bounding of the flood prone area are key measurements because they establish the boundary of the assessment area and riverine wetland subclass.

1. Use either of the methods below to determine riverine boundary.

   A) Visual Estimate: Estimate the width of the flood prone area visually. A crude estimate can be made using aerial photos or topographic maps. This should be done only if you have experience in the area**.** **OR**

   B) Direct Measurement: The flood prone area can be defined by the projection of a plane at twice the bankfull thalweg depth (deepest part of the stream, see the table and diagram on Riverine Wetland Terminology).
      i. Determine the width of the channel by using a measuring tape and measuring from the edge of bankfull on one side of the stream to the bankfull on the opposite side of the stream.
      ii. Determine the point on the stream channel transect at the deepest point of the stream. Measure the depth from the transect line.
      iii. The flood prone area is defined by the projection of a plane at twice the bankfull thalweg depth. (See fig. 2).

2. Calculate a ratio by dividing the flood prone area width by the channel width.

3. Based on the estimates above, scale the variable using the scaling index below.

Scaling: (Vstore)

Direct measurements	Index
Ratio > 2.5	**1.0**
Ratio 1.3 to 2.5	**.50**
Ratio 1.0 to 1.3	**.10**

13) Soil Permeability (Vsoilperm)

Slice a cross section of soil at the edge of the stream channel to determine if the soil material is organic, mineral or a mixture of organic/mineral layers. In addition, determine the dominant size fraction of the mineral (eg: clay, silt, sand, gravel, stones).

Scaling: (Vsoilperm)

Condition or Measurement	Index
Sandy or gravelly material has porosity and is able to transmit water either into or from the channel. Organic soil is dominated with fibric sized material.	**1.0**
Silty soil material that has limited porosity and not likely to transmit much water into or from a channel. Organic soil is dominated with hemic sized material.	**.50**
Clay soil material that has no porosity and not able to transmit water into or from a channel. Organic soil is dominated with sapric sized material.	**.10**
No natural stream banks (e.g. concrete) or impervious channel liner.	**0.0**

Riverine Wetlands: Vegetation and Land use

14) Tree Basal Area (Vtreeba)
15) Total Vegetative Cover (Vvegcov)
16) Number of Vegetative Strata (Vstrata)
17) Land Use of the Project Assessment Area (Vwetuse)
18) Land Use of Watershed Land use (Vwatersheduse)

14) Tree Basal Area (Vtreeba)

Establish a point center quarter (PCQ) at least 30 ft from bankfull in a representative area of the floodplain. Using a prism, angle gauge measurement or other comparable instrument, stand at the center of the PCQ and count the trees within a 1/10 acre plot. Multiply the number of trees falling within the range of the cruise angle by the Basal Area Factor (BAF) which is indicated on the prism or angle gauge value, to determine the sq ft/acre of each tree species. Repeat this procedure to take a second measurement at a location that is ecologically similar to the first. For example, if the first BAF is done in coniferous forest, the second one should also be done in coniferous forest and not in emergent vegetation or a large gap, etc.

1) Number of trees (each species) counted ____ X _____BAF value = _____feet^2/acre.

Scaling: (Vtreeba)

Measurement or Condition	Index
Forest not appreciably altered (i.e., not harvested within > 80 years. Stand basal areas may vary due to natural gap processes.	**1.0**
Greater evidence of human disturbance (> 200 feet^2/acre).	**.75**
Basal areas range > 150 < 200 feet^2/acre.	**.50**
Basal areas are <150 feet^2/acre. Evidence of human activity (e.g. selective logging).	**.25**
No trees present and riparian forest has been clearcut or modified by human disturbance. Variable is recoverable and sustainable through natural processes under current conditions.	**.10**
No trees present and riparian forest has been clearcut or modified by human disturbance. Variable is neither recoverable nor sustainable through natural processes under current conditions.	**.00**

15) Total Vegetative Cover (Vvegcov)

1) Visually estimate the total percent canopy cover by adding each strata (forested, scrub/shrub, herbaceous, and moss and lichen). within 0.1 acre using the PCQ method. For sites dominated by herbaceous vegetation and low shrub vegetation, a line intercept method is used for cover measurements.

Cover Class Midpoints are obtained from the following table:

% Cover	Midpoint
<1	0.5
1-5	3
6-15	10.5
16-25	20.5
26-50	38
51-75	63
76-95	85.5
>95	98

Use the following tables to list the most common species and their estimated percent cover using the cover class midpoint.

Tree Species	Cover Class Midpoint
Total Cover	

Small Trees Strata (>3' & <10', single stem)	
Species	**Cover Class Midpoint**
Total Cover	

Shrubs Strata (multiple stems) and Seedlings (≤3', single stem)	
Species	**Cover Class Midpoint**
Total Cover	

Herbaceous Strata: Forbs, Graminoids, Ferns and Fern Allies	
Species	**Cover Class Midpoint**
Total Cover	

Mosses and Lichens Strata	
Species	**Cover Class Midpoint**
Total Cover	

1. Total percent cover of Moss / Lichen Strata	
2. Total percent cover of Herbaceous Strata	
3. Total percent cover of Shrub Strata	
4. Total percent cover of Tree Strata	
Total Percent Vegetative Cover	

Scaling: (Vvegcov)

Condition	Index
Greater than or equal to 120% total vegetative cover and site is not appreciably altered by human activity and dominated by native plant species.	**1.0**
Greater than or equal to 120% total vegetative and site has minimal disturbance by human activity and dominated by native plant species (i.e., foot trails, selective cutting).	**.75**
> or equal to 120 % total vegetative and site significantly altered by human activity and dominated by native plant species (tree removal for ROW, heavy selective cutting).	**.50**
< or equal to 120 % total vegetative and site significantly altered by human activity. The variable is recoverable to reference standard conditions and sustainable through natural processes.	**.10**
< or equal to 120 % total vegetative and site is not recoverable to reference standard conditions nor sustainable through natural processes.	**.00**

16) Number of Vegetative Strata (Vstrata)

Determine the number of strata that have a total cover of >10 %

Scaling: (Vstrata)

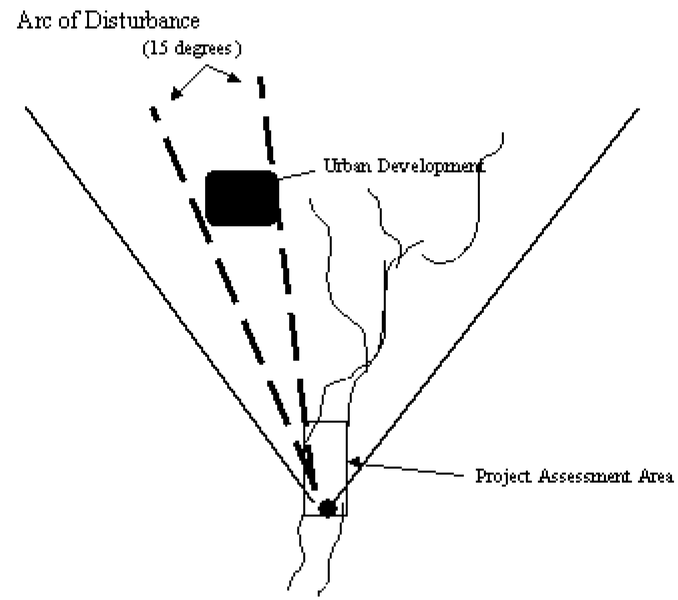
Condition	Index
Three or more forest strata present and dominated by native plant species.	**1.0**
Three or more forest strata present and dominated by native plant species (i.e. foot trails, selective cutting).	**.75**
Two or three forest strata present and dominated by native plant species (tree removal for ROW).	**.50**
One forest strata present and may include native and non-native plants.	**.25**
Site historically forested but no forest strata present and site significantly altered by human activity. The variable is recoverable to reference standard conditions and sustainable through natural processes.	**.10**
Site historically forested but no forest strata present and site significantly altered by human activity. The variable is neither recoverable to reference standard conditions or sustainable through natural processes.	**.00**

Riverine Land Use Assessment

Review of land use is done in the field and with aerial photographs if available. Aerial photographs of the assessment and watershed provide more accurate and efficient evaluation of the land use variables. It is recommended that the aerial photographs be at a scale between 1:12,000 and 1:40,000. When using aerial photographs, obtain or produce a clear template showing a 1,000-foot radius for the photo scale used.

Impacts to the assessment area are described as a 90^0 arc (measured using a compass) looking upstream from the downstream edge of the project assessment area. The center of the axis of the 90^0 arc is the fall line (most direct line of water flow). Visually mark the boundaries of the arc using reference marks such as trees, buildings or flagging.

Within the 90^0 arc described above, angles of disturbance are measured by siting the arc distance of each disturbance (see diagram below). Measurements of disturbance should be made to the edge of the contributing area or to 1000 feet, which ever is less. The angle of all disturbances are individually measured and categorized (see Table 18). In the example below, urban development has an



arc distance of 15^0. The remaining portion of the disturbance arc is undisturbed.

If multiple disturbances occur within the same arc, disturbances with the highest ranking (see the table below) take precedence over lower ranking disturbances that occur upslope. The lower ranking impacts are not considered in this case. Lower ranking impacts are measured if they occur down slope of higher-ranking impacts.

Within the arc of source described above, angles of disturbance are measured by siting the arc distance of each disturbance. Below is an example.

The following table shows the four-land use types used in the assessment area and the multiplier applied to each type.

Land Use Categories

Undisturbed: No significant human induced perturbation, except for natural or controlled burns.
Recreation/Historic Forestry: Clearing of vegetation, clearing for right of ways, logging with temporary roads (no fill), pasture, and croplands.
Rural: Low density housing (>5 acre lots), through-fill roads without ditches, forestry main haul roads (with through-fill and some ditches).
Urban/Recent Forestry: Medium to high-density residential (<5 acre lots),

commercial/industrial, airports, gravel pits, through-fill roads with ditches, parking lots.

17) Land Use of Project Assessment Area (Vwetuse)

Examine the project assessment area in the field and estimate the percent of the area covered by the four land use categories.

Multiply this percent by the "Land Use Multiplier" to obtain a score for each land use category. Add the scores to obtain a measurement for **Vwetuse.**

Land Use Category	% of Assessment Area	Land use Multiplier	Score
Undisturbed		0	
Recreation/ Historic Forestry		1	
Rural		2	
Urban/Recent Forestry		3	
		TOTAL SCORE	

Using the total score above for landuse, scale the Vwetuse variable using the index below and record the results in the **Variable Scoring Sheet**.

Scaling: (Vwetuse)

Measurement or Condition	Score
Total Project Assessment Area use impact score is 0 - 100.	**1.0**
The Project Assessment Area use impact score ranges from 100 - 200. An example of how this impact score can be achieved: 50% of the project assessment area is urban, 50% is Recreational/Historic Forestry (50 x 2) + (50 x 1) = 150).	**0.75**
The Assessment Area use impact score ranges from 201 - 250. An example of how this impact score can be achieved: (50%of the project assessment area is urban, 50% is rural ((50 x 3) + (50 x 2) = 250).	**0.50**
The wetland land use impact score ranges from 251 – 300.	**0.25**
Total wetland land use impact score is 301 or more. The variable is recoverable to reference standard conditions and sustainable through natural processes if the existing land use is discontinued and restoration measures are applied.	**0.10**
Total wetland land use impact score is 301 or more. The variable is neither recoverable to reference standard conditions nor sustainable through natural processes if the existing land use is discontinued and	**0.0**

Measurement or Condition	Score

18) Land use of the Watershed (Vwatersheduse)

Standing upstream at the edge of the assessment area establish a 90 ^{0} arc of disturbance by using a compass (e.g., Silva Ranger, or equivalent) and markers such as trees or buildings. The source angle can also be measured in the office using aerial photographs (stereo) and topographic maps. Describe the land use within the 90^{0} arc of disturbance of the watershed (see figure on the preceeding pages).

If multiple disturbances occur within the same arc, disturbances with the highest ranking take precedence over lower ranking disturbances that occur upslope. The lower ranking impacts are not considered in this case. Lower ranking impacts are measured if they occur downslope of higher-ranking impacts.

Examine the land use conditions outside of the assessment area within the 1000 feet beyond the assessment area and the upstream watershed. Estimate the percent of the area covered by the four land use categories.

Category Ranking for Land Uses

Land use Category	Mulitplier
Undisturbed: No human induced activity, except for narrow human footpaths or trail, and bridges that do not restrict base flow.	**0**
Recreation / Historic Forestry: Clearing of some vegetation for low impact, outdoor recreational use, clearing of woody vegetation for right of ways, logging with temporary roads (no fill), timber harvesting > 60 years.	**1**
Rural: Low density housing (>5 acre lots), roads with no apparent hydrologic impact.	**2**
Urban/Recent Forestry: Medium to high density residential (<5 acre lots), commercial/industrial, airports, gravel pits, heavy timber harvesting activity, roads with hydrologic impact with ditches, parking lots.	**3**

Multiply this percent by the "Land Use Multiplier" to obtain a score for each land use category using the chart below. Add the scores to obtain a measurement for Vwatersheduse.

Land Use Category	% of 90^0 arc of Disturbance	Land use Multiplier	Score
Undisturbed		0	
Recreation/Historic Forestry		1	
Rural		2	
Urban/Recent Forestry		3	
		TOTAL SCORE	

Using the total score above for land use, scale the Vwetuse variable using the index below and record the results in the **Variable Scoring Sheet**.

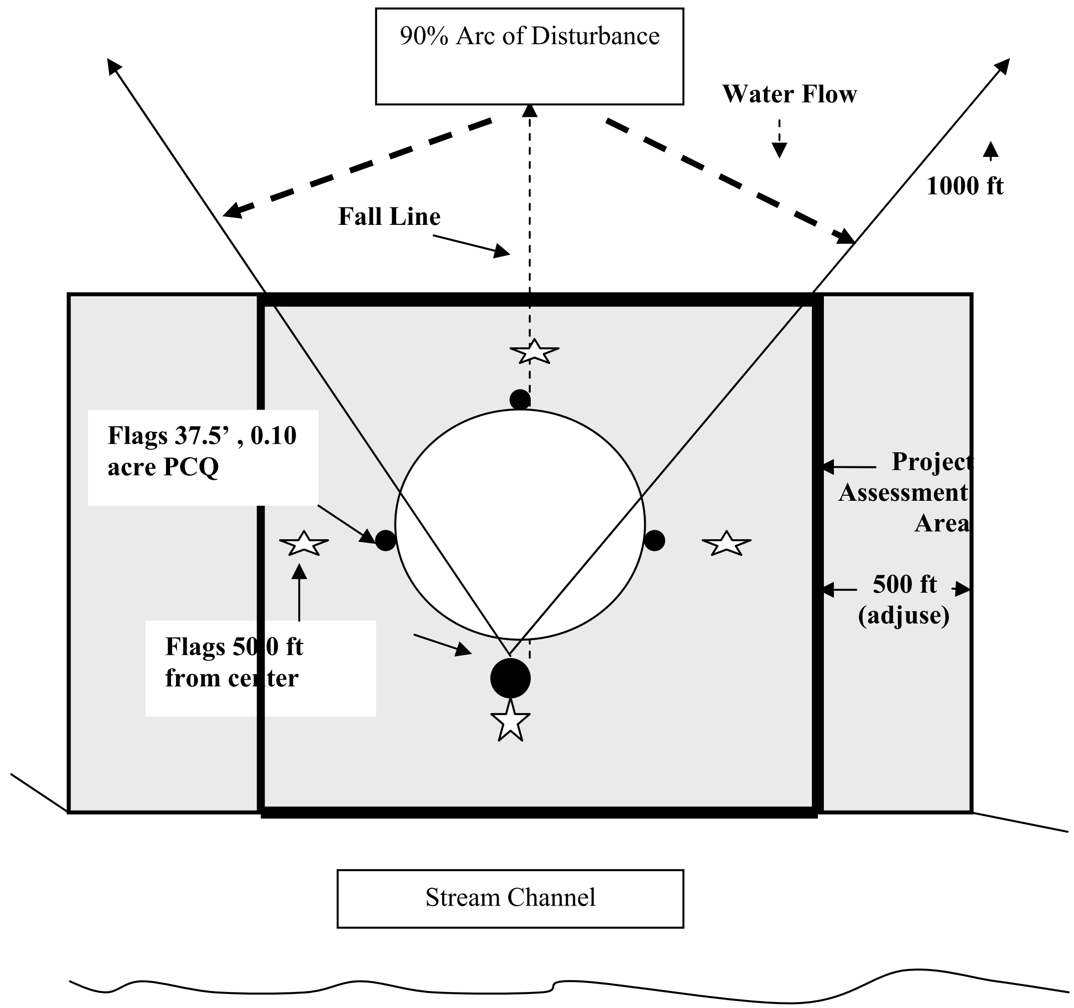
Scaling: (Vwatersheduse)

Measurement or Condition	Index
Total Project Assessment Area use impact score is 0 – 100.	**1.0**
The Project Assessment Area use impact score ranges from 101-250. An example of how this impact score can be achieved: 50% of the project assessment area is urban , 50% is Recreational/Historic Forestry (50 x 2 + 50 x 1 = 150).	**0.75**
The Assessment Area use impact score ranges from 251-400. An example of how this impact score can be achieved: 50%of the project assessment area is urban, 50% is rural ((50 x 3) + (50 x 2) = 250).	**0.50**
The wetland land use impact score ranges from 401 – 500.	**0.25**
Total wetland land use impact score is > 500. The variable is recoverable to reference standard conditions and sustainable through natural processes if the existing land use is discontinued and restoration measures are applied.	**0.10**
Total wetland land use impact score is > 500. The variable is neither recoverable to reference standard conditions nor sustainable through natural processes if the existing land use is discontinued and restoration measures are applied.	**0.0**

Step 4 (b) Summary of Slope River Proximal Variables

Slope River Proximal Wetlands HGM Rapid Assessment Field Process		
Soils, Hydrology & Land Use		
1	Vredox	Dig a soil pit and examine for redox features
2	Vacro	Determine thickness of acrotelm layer
3	Vsoilperm	Determine dominant soil characteristics
4	Vsource	Determine impact to upslope water source
5	Vsubout	Look for indicators of seeps
6	Vfreq	Look for indicators of high water marks
7	Vstore	Determine if there are direct & indirect indicators of water storage areas
8	Vwetuse	Determine land use in project assessment area
9	Vadjuse	Determine land use in adjacent area
Microtopography		
10	Vmicro	Measure microtopography
11	Vsurwat	Measure water storage
Vegetation and Coarse Wood		
12	Vvegcov	Estimate the total % of vegetative cover
13	Vstrata	Count the number of vegetative strata
14	Vgaps	Count the number of gaps in the veg. canopy
15	Vtreeba	Measure tree basal area
16	Vdecomp	Count the number of logs in different stages of decomposition
17	Vcwd	Count the number of coarse wood pieces

HGM Asessment Area: Slope River Proximal Wetlands



Slope Riverine Proximal Wetlands:

Soils, Hydrology, and Land use Measurements

1) Presence of Redoximorphic Features (Vredox)
2) Presence and Structure of the Acrotelm Horizon V(acro)
3) Soil Permeability (Vsoilperm)
4) Water Sources (Vsource)
5) Subsurface Flow from the Wetlands (Vsubout)
6) Overbank Flood Frequency (Vfreq)
7) Flood Prone Area Storage Volume (Vstore)
8) Land Use of the Project Assessment Area (Vwetuse)
9) Adjacent Land Use (Vadjuse)

For each variable:

a) Collect field measurements as directed below and record them in the field measurement column of the **Variable Scoring Sheet**.

b) Determine the variable score using the field measurements and the variable index-scoring table. Record the variable score in the Variable Index score column of the **Variable Scoring Sheet**.

c) Determine the Functional Capacity of each function by entering the appropriate score into an electronic spreadsheet shown in the Operaitonal Draft Guidebook's Appendices. Or, manually calculate the score using the **Functional Scoring Sheet.**

1) Presence of Redoximorphic Features (Vredox)

Measurement Protocols:

Dig several soil pits 30-cm deep in representative areas in the assessment area. Describe and record redoximorphic features using Hydric Soil Indicators (NRCS, 2002). Representative soils are those that occur in at least 75% of the project assessment area.

Scaling: (Vredox)

Measurement or Condition	Index
Redoximorphic features are present in a majority of the soil sample locations in the project assessment area. Soil conditions have not been altered by natural or human induced disruption of the soil profile or by the hydrology of the area.	**1.0**
Redoximorphic features are absent in a majority of the soil sample locations in the assessment area due to disruption of the soil and hydrology. The variable is recoverable and sustainable through natural processes if the existing land use is discontinued or restoration measures are applied.	**.5**
Redoximorphic features are absent and the source of water to create saturated soil conditions has been removed and cannot be restored without major efforts.	**.1**

2) Presence and Structure of the Acrotelm Horizon (Vacro)

Using the same soil pits previously dug for the (Vredox) variable, determine the thickness of the "Acrotelm" layer. The Acrotelm is the surface undecomposed organic material. This zone is commonly called the Oi or fibric soil horizon.

Scaling: (Vacro)

Measurement or Condition	Index
Oi present at the soil surface and has a depth greater than 4.0 inches. The lateral movement of water is unimpeded.	**1.0**
Oi present with a minimum depth of 2.5 inches and the lateral movement of water is unimpeded. Or, the Oi is greater than 2.5 inches depth, but the flow of water through the Oi layer has been disrupted. The function is recoverable with restoration efforts.	**.5**
Oi absent or damaged and not recoverable. The Oi is either absent or disrupted to such an extent that the function is not operational.	**.1**
There is no soil present on the site.	**0.0**

3) Soil Permeability (Vsoilperm)

Dig a soil pit from bankfull depth to channel bed and determine if the soil material is organic, mineral or a mixture of organic/mineral layers. Determine the dominant size fraction of the mineral (eg: clay, silt, sand, gravel, stones).

Scaling: (Vsoilperm)

Condition or Measurement	Index
Sandy or gravelly material that has high porosity and is able to transmit water either into or from the channel. Organic soil is dominated with fibric sized material.	**1.0**
Silty soil material that has limited porosity and not likely to transmit much water into or from the channel. Organic soil is dominated with hemic sized material.	**.5**
Clay soil material that has no porosity and not able to transmit water into or from a channel. Organic soil is dominated with sapric sized material.	**.1**
No natural stream banks (eg: concrete) or impervious channel liner.	**0**

4) Water Sources (Vsource)

Definition: Vsource is the condition of the contributing area for water (i.e., surface and shallow subsurface waterflow) upslope of the assessment area within a 90^0 arc.

1) Looking upslope from the center of the assessment area, project a 90^0 arc using reference points such as trees or buildings.

2) Within the 90^0 arc, measure the extent of each disturbance as a fraction of the arc in degrees. The angle of all disturbances are individually measured and categorized (see "Category Ranking for disturbance table below). If multiple disturbances occur within the same arc, measure the disturbance with the highest ranking (see the table below) and all other disturbances between that point and the assessment area. The following calculations should then be made:

3) Sum all segments of disturbance arc length that fall into the same category of disturbance (See the following "Category Ranking for Perturbations" table). Express as a percent of total source arc length.

4) Multiply the total arc length for each category by the category rank (provided in the following tables) to achieve a weighted arc length. Add all weighted arc length percentages to get the hydrologic source impact score.

The following table shows the four land use types used in the assessment and the multiplier applied to each type.

Land Uses and Multiplier

Undisturbed: No significant human induced disturbance.	0
Recreation/Historic Forestry: Clearing of vegetation, clearing for right of ways, logging with temporary roads (no fill), pasture and croplands.	1
Rural: Low density housing (>5 acre lots), through-fill roads without ditches, forestry main haul roads (with through-fill and some ditches).	3
Urban/Recent Forestry: Medium to high-density residential (<5 acre lots), commercial/industrial, airports, gravel pits, through-fill roads with ditches, parking lots.	4

Scaling: (Vsource)

Measurement or Condition	Score
Hydrologic source impact scores range from 0 to 180.	**1.0**
Hydrologic source impact scores range from > 180 to 360.	**0.75**
Hydrologic source impact scores range from > 360 to 450.	**0.50**
Hydrologic source impact scores range from > 450 to 720.	**0.25**
Hydrologic source impact scores range from >720 and the variable is recoverable.	
Hydrologic source impact score is >720 and the variable is not recoverable (e.g., parking lot, fill pad, paved road).	**0.0**

5) Subsurface Flow From the Wetlands (Vsubout)

Determine presence of seeps, springs, etc. that occur at and downslope of the interface between the riverine and slope wetland. Ice bulges during very cold seasons can be used as a visual indication of this variable.

Scaling: (Vsubout)

Measurement or Condition	Index
Areas upslope of the riverine/slope interface within the assessment area are predominantly undisturbed, native soils, and plant communities AND direct evidence of subsurface flow is observed along the interface (e.g., seeps, upwellings, iron-floc discharge points, etc.).	**1.0**
Areas upslope of the riverine/slope interface within the assessment area are predominantly undisturbed, native soils, and plant	**0.5**

communities AND no direct evidence of subsurface flow along the interface is observed. OR Areas upslope of the riverine/slope interface within the assessment area are predominantly disturbed soils and/or plant communities AND direct evidence of subsurface flow along the interface is observed.	
Areas upslope of the riverine/slope interface within the assessment area are predominantly hard surfaces or fill AND direct evidence of subsurface flow along the interface is observed.	**0.25**
Areas upslope of the riverine/slope interface are predominantly hard surfaces or fill AND no direct evidence of subsurface flow along the interface is observed.	**0.0**

6) Overbank Flood Frequency (Vfreq)

Follow the protocol below depending upon whether stream gauge information is available or not.

(a) Stream gauge information available - Data from stream-gauging stations are reliable estimates of this variable. Contact the US Geological Survey (USGS) in Juneau, Alaska at (907) 586-7216 to determine the availability of stream gauge information. The USGS also has an Internet web page located at "ak.water.usgs.gov." The USGS can provide an estimate of the magnitude of a particular flooding event and a frequency of flooding estimate for the project assessment area, which should be used if available, prior to relying on visual field indicators having less precision.

(b) Gauge information not available - Other field indicators include high water marks, silt lines, drift, seed and debris lines, grasses and other tall non-woody vegetation laying down as a result of overbank flows, tree bark damaged by floating debris, and evidence of channel scour and sediment deposition. These indicators can reflect recent flooding or an infrequent event and may not be particularly helpful in establishing the flood return interval at a particular site. However, the use of the indicators in conjunction with an assessment of the depth of organic litter, decomposition stage, and vegetation type (e.g., woody or herbaceous) provides an estimate of the frequency of overbank flooding in the project assessment area. Site characteristics are compared to range of conditions expressed in the variable indexes.

Scaling: (Vfreq)

Indirect Measure	Direct Measure	Index
No litter to a very thin layer (< 1 cm) of non-decomposed material present on wetland surface. Presence of high water marks, silt lines, drift, seed and debris lines, and/or scattered grasses lying down as a result of overbank flows. Evidence of channel scour and sediment deposition present. Fluvial deposited logs and organic debris on channel banks with little moss, lichen, seedlings or leaf litter accumulations on these surfaces. Overall percent cover of herbaceous vegetation is low and vegetation consists of species typical of primary colonization. If trees are present they may appear stressed from frequent inundation unless established on larger nurse logs or on coarser/ better drained sediments adjacent to channel bank. Estimated flood frequency is 1-2 year return intervals.	Gauge data extrapolated to project assessment area reflects 1-2 year return interval.	**1.0**
Thin litter cover (1-3 cm) ranging from recent to partly or completely decomposed material. Fluvial deposited logs and organic debris on channel banks with moss, lichen, seedlings, or decomposing leaf litter accumulations on these surfaces. Natural levees present immediately adjacent to the channel bank. Mature trees present along banks with some species typical of primary colonization. Bark of trees may show indications of damage from floating debris, and red squirrel midden accumulations may be concentrated at base of larger trees in the wetland. Estimated flood frequency is 2-10 year return intervals.	Gauge data extrapolated to project assessment area reflects 2-10 year return interval.	**0.75**
Thick litter cover (>3 cm) with lower layer completely decomposed. No evidence of overbank deposits and fluvial transported debris not present. Dominant vegetation is mature trees (unless artificially manipulated - e.g., lawn or timber harvest). Estimated flood frequency is > 10 year return interval	Gauge data extrapolated to project assessment area reflects > 10 year return interval.	**0.5**

Indirect Measure	Direct Measure	Index
Artificial flood control features that affect assessment area present (e.g., man-made levees, flood control channels, upstream flood control impoundments, etc.).	Gauge data extrapolated to project assessment area indicates that no overbank flooding is likely.	**0.0**

7) Flood Prone Area Storage Volume (Vstore)

Definition: Ratio of flood prone area width divided by channel width at bankfull.

Use either of the methods below to determine riverine boundary.

A) Visual Estimate: Estimate the width of the flood prone area visually. A crude estimate can be made using aerial photos or topographic maps. This should be done only if you have experience in the area**.** **OR**

B) Direct Measurement: The flood prone area can be defined by the projection of a plane at twice the bankfull thalweg depth (deepest part of the stream).

1) Determine the width of the channel by using a measuring tape and measuring from the edge of bankfull on one side of the stream to the bankfull on the opposite side of the stream.
2) Determine the point on the stream channel transect at the deepest point of the stream. Measure the depth from the transect line.
3) The flood prone area is defined by the projection of a plane at twice the bankfull thalweg depth.
4) Calculate a ratio by dividing the flood prone area width by the channel width.

5) Based on the estimates above, scale the variable using the scaling index below.

6) Calculate the ratio by dividing the flood prone area width by the channel width. Report the ratio as a unit less number.

Scaling: (Vstore)

Direct measurements	Index
Ratio > 2.5	1.0
Ratio 1.3 to 2.5	.50
Ratio 1.0 to 1.3	.10

8) Land Use of the Project Assessment Area (Vwetuse)

Estimate the percent of the project assessment area covered by the following land use categories:

Category Ranking for Observed Wetland Land Uses

Undisturbed: No human induced disturbance, except for narrow footpaths, trails, and bridges that do not restrict base flow.	0
Recreation/Historic Forestry: Clearing of vegetation for low impact outdoor recreational use, clearing of woody vegetation for right of ways, logging with temporary roads (no fill), timber harvesting > 60 years.	1
Rural: Low density housing (>5 acre lots), roads with no apparent hydrologic impact.	2
Urban/Recent Forestry: Medium to high density residential (<5 acre lots), commercial/industrial, airports, gravel pits, heavy timber harvesting activity, roads with hydrologic impact with ditches, parking lots.	3

The following calculations should then be made:

Multiply the percent for each land use category by the category rank (provided in Table 10) to achieve a weighted score.

Add all weighted scores to get the total for the Project Assessment Area use impact score.

Land Use Category	% area of Disturbance	Land use Multiplier	Score
Undisturbed		0	
Recreation/Historic Forestry		1	
Rural		2	
Urban/Recent Forestry		3	
		TOTAL :	

Using the total score below scale the variable using the index below.

Scaling: (Vwetuse)

Measurement or Condition	Index
Total Assessment Area use impact score is 0 – 100	**1.0**
The Assessment Area use impact score ranges from 100- 200. An example of how this impact score can be achieved: (a) 50% of the project assessment area is urban , 50% is	**0.75**

Recreational/Historic Forestry (50 x 2) + (50 x 1) = 150).	
The Assessment Area use impact score ranges from 201 - 250. An example of how this impact score can be achieved: (a) 50% of the project assessment area is urban, 50% is rural ((50 x 3) + (50 x 2) = 250).	**0.50**
The wetland land use impact score ranges from 251 - 300.	**0.25**
Total wetland land use impact score is 301 or more. The variable is recoverable to reference standard conditions and sustainable through natural processes if the existing land use is discontinued and restoration measures are applied.	**0.10**
Total wetland land use impact score is 301 or more. The variable is neither recoverable to reference standard conditions nor sustainable through natural processes if the existing land use is discontinued and restoration measures are applied.	**0.0**

9) Adjacent Land Use (Vadjuse)

Using visual observation, aerial photography, and other office or field resources and tools, follow these steps:

Estimate an area 500 feet beyond the boundary of the upstream and downstream side of the assessment area and determine the land use categories using the table below.

Facing upslope, estimate a 90^0 arc pointed upslope of the assessment area.

Estimate the percent and type of disturbance within 1000 ft upslope staying within the 90^0 arc.

Estimate the percent of the area covered by the following land use categories below:

Category Ranking for Land Uses

Undisturbed: No significant human induced disturbance, except for bridges that do not restrict base flow.	**0**
Recreation/Historic Forestry: Clearing of vegetation, clearing for right of ways, logging with temporary roads (no fill), pasture, and croplands.	**1**
Rural: Low density housing (>5 acre lots), through-fill roads without ditches, forestry main haul roads (with through-fill and some ditches).	**2**
Urban/Recent Forestry: Medium to high-density residential (<5 acre lots), commercial/industrial, airports, gravel pits, through-fill roads with ditches and parking lots.	**3**

The following calculations should then be made:

Multiply the percent for each land use category by the category rank (provided in Table 13) to achieve a weighted score.

Land Use Category	Disturbance Arc Length / 90 X 100 = % of arc length	Land use Multiplier	Score
Undisturbed		0	=
Recreation/Historic Forestry		1	=
Rural		2	=
Urban/Recent Forestry		3	=
Total Score			

Add all weighted scores to get the total adjacent land use impact score and scale the variable using the scaling and index below and record your result in the **Variable Scoring Sheet**.

Scaling: (Vadjuse)

Measurement or Condition	Score
The adjacent land use impact score ranges from 0 – 100.	**1.0**
The adjacent land use impact score ranges from 101 - 250.	**0.75**
The adjacent land use impact score ranges from 251 - 400.	**0.50**
The adjacent land use impact score ranges from 401 - 500.	**0.25**
The adjacent land use impact score is > 500. The variable is recoverable to reference standard conditions and sustainable through natural processes, if the existing land use is discontinued and restoration measures are applied.	**0.10**
The adjacent land use impact score is > 500. The variable is neither recoverable to reference standard conditions nor sustainable through natural processes, if the existing land use is discontinued and restoration measures are applied.	**0.0**

River Proximal Slope Wetland Measurements for Microtopography

10) Microtopographic Features V(micro)

11) Presence of Surface Water Storage (Vsurwat)

For each variable:

a) Collect field measurements as directed below and record them in the field measurement column of the **Variable Scoring Sheet.**

b) Determine the variable score using the field measurements and the variable index-scoring table. Record the variable score in the Variable Index score column of the **Variable Scoring Sheet.**

c) Determine the Functional Capacity of each function by entering the appropriate score into an electronic spreadsheet shown in the Operational Draft Guidebook's Appendices. Or, manually calculate the score using the **Functional Scoring Sheet.**

Use a point-center quarter (PCQ) to measure the microtopographic and vegetation variables. Determine the fall line within the assessment area for forming the axis of a 4-quadrat PCQ sampling area. Flag 37.5 ft and 50 ft along the axes of the quadrants. One transect should be perpendicular and one parallel to the stream channel

Use the 50 ft flagging for the two 100 ft transects to measure Vmicro and Vsurwat. In a large parcel you may want to do more to repeat this procedure in another area within the assessment area.

10) Microtopographic Features V(micro)

Identify the dominant microtopographic surface at 10 ft intervals along the PCQ axes (within three feet of either side of the transect). Record the presence or evidence of ponding and/or static surface water at the same time. The table below describes the microtopographic surfaces.

Definition of Microtopographic Features

Planar Surface Feature	**Criteria**
Plane	Level or nearly level ground surface excluding level surfaces contained in channels, pits, or ponds.
Non–Planar Surface Features	
Channel	Linear feature formed by flowing water.
Pit	Depression, hole, burrow. <50 square feet.
Pond	Depression >50 square feet (e.g., flark in string bog).
Hummock	Mound or raised surface (e.g., shrub dominated strang in string bog). These features usually have different vegetation than surrounding lower areas.
Tussock	Surface formation developed from tufted plants such as cottongrass.
Coarse Wood	Woody debris >2" diameter that is lying on the surface or is <45 degrees from vertical.
Root Mass	Root system and soil uplifted from fallen trees.
Other	Describe.

PCQ Perpendicular Transect 1

Feet

Data Point	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Planar or Non-Planar (0=Planar; 1= Non-Planar)										
Presence or Evidence of Ponding (0= no; 1= yes)										

PCQ Parallel Transect 2

Feet

Data Point	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Planar or Non- Planar (0=Planar; 1= Non-Planar)										
Presence or Evidence of Ponding (0 = no; 1= yes)										

Total number of non-planar surface features recorded on the 2 transect tables: ______. Divide the above number by 20 and multiply the result by 100 to obtain percent of the observed features that are non-planar:
(____ ÷ 20) x 100 = _____ %.

Scaling: (Vmicro)

Measurement or Condition	Index
The project assessment area is characterized by complex microtopographic relief (e.g., 50->80% of observed features are non-planar) AND assessment area is predominantly undisturbed, native soils, and plant communities.	**1.0**
The project assessment area is characterized by moderately complex microtopographic relief (e.g., 25-50% of observed features are non-planar) AND assessment area is predominantly undisturbed, native soils, and plant communities.	**0.75**
The project assessment area is characterized by moderately complex microtopographic relief (e.g., 25-50% of observed features are non-planar) AND assessment area is predominantly disturbed, native soils, and/or plant communities.	**0.50**
The project assessment area is characterized by some microtopographic relief (e.g., 1-25% of observed features are non-planar) AND assessment area is predominantly disturbed or undisturbed, native soils, and/or plant communities.	**0.25**
Microtopographic features are absent.	**0.0**

11) Presence of Surface Water (Vsurwat)

Determine the percent cover of ponds and other depressions that store water in the assessment area along the 100-ft transects completed for Vmicro.

Total number of observations from the 2 transect tables where there was the presence or evidence of ponding: _____.
Divide this number by 20 and multiply the result by 100 to obtain percent of the observation points where ponding occurs:
(____ ÷ 20) x 100 = _____ %.

Scaling: (Vsurwat)

Measurement or Condition	Index
Observations or evidence of surface water or ponds in >50% or more of the assessment area, project assessment area is either predominantly undisturbed, soils, and native plant communities. OR Observations or evidence of surface water or ponds in >50% or more of the assessment area, minor anthropogenic modifications may be present but no substantial impact to site topography is apparent (e.g., vegetation clearing, footpaths, wooden walkways, etc.).	**1.0**
Observations or evidence of surface water or ponds in 10-50% of the assessment area; project assessment area is predominantly undisturbed soils and native plant communities. OR Observations or evidence of surface water or ponds in 10-50% of the assessment area, minor human disturbances or modifications may be present but no substantial impact to site topography is apparent (e.g., vegetation clearing, foot paths, wooden walkways, etc.).	**.75**
Observations or evidence of surface water or ponds in <10% of the assessment area, minor human disturbances or modifications may be present but no substantial impact to site topography is apparent (e.g., vegetation clearing, foot paths, wooden walkways, etc.).	**.50**
No observations or evidence of surface water or ponds within assessment area, project assessment area is predominantly undisturbed soils and native plant communities.	**.25**
No observations or evidence of surface water or ponds within assessment area, project assessment area is predominantly disturbed by human activities but recoverable through natural processes.	**.10**
No observations or evidence of surface water or ponds within assessment area, variable is not recoverable through natural processes.	**.00**

Slope River Proximal e Wetlands Measurements for Vegetation and Coarse Wood

12) Total Vegetative Cover (vegcov)

13) Number of Vegetative Strata (Vstrata)

14) Canopy Gaps (Vgaps)

15) Basal Area of Trees (Vtreeba)

16) Log Decomposition (Vdecomp)

17) Number of Coarse Wood (Vcwslope)

For each variable:

a) Collect field measurements as directed below and record them in the field measurement column of the **Variable Scoring Sheet.**

b) Determine the variable score using the field measurements and the variable index-scoring table. Record the variable score in the Variable Index score column of the **Variable Scoring Sheet**.

c) Determine the Functional Capacity of each function by entering the appropriate score into an electronic spreadsheet shown in the Operational Draft Guidebook's Appendices. Or, manually calculate the score using the **Functional Scoring Sheet.**

Use the point center quarter (PCQ) method for the vegetation variables: vegetative cover **(Vvegcov),** vegetative strata **(Vstrata**), gaps in the canopy **(Vgaps**), basal area of trees **(Vtreeba**), logs in decomposition **(Vdecomp)**, and number of coarse wood **(Vcwslope)**.

12) Total Vegetative Cover (Vvegcov)

1) Visually estimate the total percent canopy cover by adding each strata (forested, scrub/shrub, herbaceous, and moss and lichen). within 0.1 acre using the PCQ method. For sites dominated by herbaceous vegetation and low shrub vegetation, a line intercept method is used for cover measurements.

Cover Class Midpoints are obtained from the following table:

% Cover	Midpoint
<1	0.5
1-5	3
6-15	10.5
16-25	20.5
26-50	38
51-75	63
76-95	85.5
>95	98

Use the following tables to list the most common species and their estimated percent cover using the cover class midpoint.

Tree Species	Cover Class Midpoint
Total Cover	

Small Trees Strata (>3' & <10', single stem)	
Species	**Cover Class Midpoint**
Total Cover	

Shrubs Strata (multiple stems) and Seedlings (≤3', single stem)	
Species	Cover Class Midpoint
Total Cover	

Herbaceous Strata: Forbs, Graminoids, Ferns and Fern Allies	
Species	Cover Class Midpoint
Total Cover	

Mosses and Lichens Strata	
Species	Cover Class Midpoint
Total Cover	

1. Total percent cover of Moss / Lichen Strata	
2. Total percent cover of Herbaceous Strata	
3. Total percent cover of Shrub Strata	
4. Total percent cover of Tree Strata	
Total Percent Vegetative Cover	

Using the Total Sum vegetative Cover Scale (Vvegcov) below and record the results in the scoring sheets .

Scaling: (Vvegcov)

Condition	Index
Greater than or equal to 120% total vegetative cover and site is not appreciably altered by human activity and dominated by native plant species.	**1.0**
Greater than or equal to 120% total vegetative and site has minimal disturbance by human activity and dominated by native plant species (i.e., foot trails, selective cutting).	**.75**
> or equal to 120 % total vegetative and site significantly altered by human activity and dominated by native plant species (tree removal for ROW, heavy selective cutting).	**.50**
< or equal to 120 % total vegetative and site significantly altered by human activity. The variable is recoverable to reference standard conditions and sustainable through natural processes.	**.10**
< or equal to 120 % total vegetative and site is not recoverable to reference standard conditions nor sustainable through natural processes.	**.00**

13) Number of Vegetative Strata (Vstrata)

Determine the number of strata that have a total cover of >10 %

Scaling: (Vstrata)

Condition	Index
Three or more forest strata present and dominated by native plant species.	**1.0**
Three or more forest strata present and dominated by native plant species (i.e. foot trails, selective cutting).	**.75**
Two or three forest strata present and dominated by native plant species (tree removal for ROW).	**.50**
One forest strata present and may include native and non-native plants.	**.25**
Site historically forested but no forest strata present and site significantly altered by human activity. The variable is recoverable to reference standard conditions and sustainable through natural processes.	**.10**
Site historically forested but no forest strata present and site significantly altered by human activity. The variable is neither recoverable to reference standard conditions or sustainable through natural processes.	**.00**

14) Canopy Gaps (Vgaps)

Using a vertical sitting perspective (rather than oblique), estimate or measure the abundance of canopy gaps (percent cover as projected to the forest floor) within the forest. Gaps may be measured directly (e.g., project the openings to the forest floor, define with flagging, and measure the footprint), or estimated. If estimated rather than measured, the field assessor may find that mentally moving the openings together to determine the gap percentage within the assessment area will improve precision. For large areas, this variable may be estimated using aerial photography.

Scaling: (Vgaps)

Measurement	Index
No human disturbance evident within Project Assessment Area however site may reflect minor to severe natural disturbance. Forest canopy can intercept a large portion of snowfall; arboreal lichens typically present. Gaps comprise approximately 25-35% of the forest canopy.	1.0
Canopy gaps comprise 25-35% of the Assessment Area. Anthropogenic disturbance may be present but is minor (i.e., individual tree selection, boardwalks or limited use recreational trails, isolated recreational cabins, small communication towers, etc.). Forest canopy is dense enough to intercept a large portion of snowfall; arboreal lichens typically present.	0.75
Forest has been logged >5 years ago, but is in early successional stage. Herbaceous and shrub vegetation established, some trees reaching mid-canopy levels.	0.50
Forest has been recently (within 5 years) clearcut **or** second growth is dense with canopy closed such that gaps comprise <5% of forest within Assessment Area. Recovery is possible through forestry management activities or natural processes. Forest floor composed primarily of logging debris or leaf litter with little herbaceous or shrub growth.	0.25
Recovery is not possible due to anthropogenic disturbance (i.e., site is paved and/or all vegetation is otherwise permanently removed).	0.0

15) Basal of Area of Trees (Vtreeba)

Establish a point center quarter (PCQ) at least 30 ft. from bankfull in a representative area of the floodplain. Using a prism, angle gauge measurement or other comparable instrument, stand at the center of the PCQ and count the trees within a 1/10 acre plot. Multiply the number of trees falling within the range of the cruise angle by the Basal Area Factor (BAF) which is indicated on the prism or angle gauge value), to determine the sq ft/acre of each tree species. Repeat this procedure to take a second measurement at a location that is ecologically similar to the first. For example, if the first BAF is done in coniferous forest, the second one should also be done in coniferous forest and not in emergent vegetation or a large gap etc.

Number of trees (each species) counted ____ X _____BAF value = _____feet^2/acre.

Scaling: (Vtreeba)

Measurement or Condition for (Vtreeba)	Index
Forest not appreciably altered (i.e., not harvested with in > 80 years. Stand basal areas may vary due to natural gap processes.	1.0
Greater evidence of human disturbance (> 200 feet^2/acre).	.75
Basal areas range > 150 < 200 feet^2 /acre.	.50
Basal areas are <150 feet^2/acre. Evidence of human activity (e.g. selective logging).	.25
No trees present and riparian forest have been clearcut or modified by human disturbance. Variable is recoverable and sustainable through natural processes under current conditions.	.10
No trees present and riparian forest has been clearcut or modified by human disturbance. Variable is neither recoverable nor sustainable through natural processes under current conditions.	.00

16) Log Decomposition (Vdecomp)

Count the number of **logs** using a point center quarter (PCQ) method. The plot center should be located at least 30 ft from the bankfull width of the stream channel. Use the chart below to identify the decay class for each log.

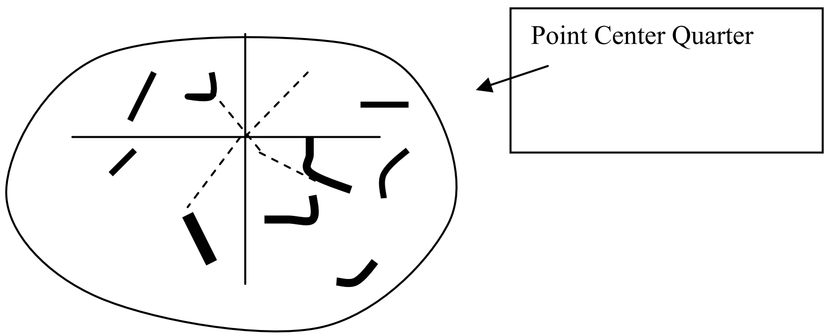
Decay Class	Coarse Wood Decay Classes	#
1	Logs recently fallen, bark attached, leaves, and fine twigs present.	
2	Logs with loose bark, no leaves, fine twigs, or fungi present.	
3	Logs w/o bark, few stubs of branches, fungi present.	
4	Logs w/o branches or bark, heartwood in advanced decay state.	
5	Logs decayed into the ground and covered.	

Scaling: (Vdecomp)

Measurement or Condition for (Vdecomp)	Index
Greater than or equal to 3 decomposition classes present within the assessment area AND assessment area is predominantly undisturbed, native soils, and plant communities.	1.0
Two decomposition classes present within the assessment area AND assessment area is predominantly undisturbed, native soils, and plant communities.	0.50
One decomposition class present within the assessment area AND assessment area is predominantly disturbed, native soils, and/or plant communities.	0.25
No logs present within assessment area and coarse woody debris sources have been altered/eliminated by human disturbance, variable is recoverable and sustainable through natural processes under current conditions.	0.10
No logs present within assessment area and coarse woody debris sources have been altered/eliminated by human disturbance, variable is NOT recoverable or sustainable through natural processes under current conditions.	0.0

17) Number of Coarse Wood (Vcwslope)

Count the number of downed coarse wood using a point center quarter (PCQ) method. The plot center should be located at least 30ft from the bankfull width of the stream channel. In each quarter, record the distance from plot center to the middle of the nearest piece of downed coarse and dead wood ≥2" diameter. If a piece spans quarter boundaries (e.g., spans the NE - SE quarter boundary), it is counted only in the quarter that contains most of the piece. If a quarter does not contain coarse woody debris, the PCQ method cannot be used. In these cases, record the number of pieces of coarse down and dead wood within a 0.1-acre (0.04-ha) plot to calculate density. This method can also be used if there are a small number of pieces that can be easily counted. Densities on a per-acre basis are calculated from the plot data.



Measure and record the distance to nearest piece of coarse woody debris in each quarter. Measure to the center of the piece.

	NE Quadrant	SE Quadrant	SW Quadrant	NW Quadrant
Distance to nearest piece (feet)				

Vcwslope Measurement

1. Total the distances recorded for the 4 quadrants.	
2. Determine the average distance (total distance/4).	
3. Square the average distance.	
4. Divide 43,560 by the square of the average distance CWD pieces/acre.	
5. Record this result in the Indicator Measurement Result column in the Summary Table.	

OR

1. If the PCQ method is not used, determine the CWD pieces/acre from the pieces counted in a 0.1 - acre plot:	
Cwslope pieces in 0.1 acre plot ______ x 10 = CWD pieces/acre	
2. Record this result in the Indicator Measurement Result column in the Variable Scoring Sheet.	

Scaling: (Vcwslope)

Measurement or Condition	Index
Using the PCQ method, the average distance to the first piece of coarse wood is equal to or < 20 feet.	1.0
Using the PCQ method, the average distance to the first piece of coarse wood is > 20 feet and < 30 feet.	.75
> 30 feet and < 37.5 feet	.50
No coarse wood found in the PCQ plot. The variable is recoverable to reference standard conditions and sustainable through natural processes.	.10
No coarse wood found in the PCQ plot. The variable is neither recoverable to reference standard conditions nor sustainable through natural processes.	.00

Step 5. Variable Scoring Sheet - Riverine

Variable	Units of Measurement	Field Measurement	Variable Index Score
Vpebble-D50	Median size		
Vchanrough	One Standard Deviation		
Vembedded	% Embedded Pebbles		
Vcwpot Coarse Wood Potential	# of Pieces		
Vcwin Coarse Wood in Channel	# of Pieces in Channel		
Vlogjams Number of Logjams	# of Logjams		
Vsubin Surface water into the A. Area	# of Features		
Vshade Riparian Shade	% Riparian Shade		
Valthydro Alteration of Hydroregime	Hydrologic Connections Disturbed		
Vbarrier	Downstream Barriers		
Vfreq	# of Features		
Vstore	# of Features		
Vsoilperm Soil Permeability	Soil Features		
Vtreeba Tree Basal Area	Est. of Basal Area		
Vvegcov Total Veg. Cover	Sum of % of Six (6)		
Vstrata Vegetation Strata	# of Veg. Strata		
Vwetuse Assessment Area Land use	% of Area Disturbed		
Vwatersheduse Land use in Watershed	% of Area Disturbed		

Step 5. Variable Scoring Sheet. – Slope River Proximal

Variable	Units of Measurement	Field Measurement	Variable Index Score
Vredox Redoximorphic Features	Presence or Absence		
Vacro Acrotelm Layer	Presence & Structure		
Vsoilperm Soil Permeability	Condition of Soil		
Vsource Water Source	% and Category of Observed Land Use		
Vsubout Subsurface Water Flow Out	Evidence of Subsurface Flow		
Vfreq Flood Frequency	Indicators of Frequent Flooding		
Vstore	Ratio of Flood Prone Area		
Vwetuse Assessment Area Land Use	Inches (cm)		
Vadjuse Adjacent Land use	Degree of Slope		
Vmicro Microtopography	Ratio of Observed Angle of Impacted Area		
Vsurwat Surface water	Surface Water		
Vvegcov Total Veg. Cover	# per Site		
Vstrata Vegetation Strata	% Features, Presence of Ponding		
Vgaps Canopy Gaps	Sum of % of Six (6) Vegetation Covers.		
Vtreeba Basal Tree Area	% of Hydrologic Connections Disturbed		
Vdecomp Log Decomposition	% and Category of Observed Land Use		
Vcwslope Coarse Wood	# of Pieces of Coarse Wood		

Step 6. Functional Scoring Sheets - Riverine

Function	Formulae	Functional Capacity Index (FCI)
1) Channel meander Belt Integrity	= (Vwatersheduse + Vwetuse+ Valthydro + Vfreq + Vchanrough + Vcwpot + Vlogjam + Vcwin) / 8	
2) Dynamic Flood Water Retention	= (Vstore + Vpebble-D50 + Vlogjam + Vcwin + Vvegcov) / 5 + Vwatersheduse + Vfreq) / 3	
3) Nutrient Spiraling	= (Vsubin + Vcwin + Vcwpot + Vchanrough + Vsoilperm + Vwatersheduse + Vshade) / 7	
4) Particulate Retention	= (Vcwin + Vcwpot + Vlogjams + Vtreeba + Vpebble-D50 + Vvegcov) / 6 + Vfreq) / 2	
5) Removal of Imported Elements and Compounds	= (Valthydro + Vfreq + Vsubin + (Vvegcov + Vtreeba) / 2 + Vsoilperm) / 5	
6) In-Channel Biota	= (Vshade + Vchanrough + Vembedded + Vwetuse + Vsubin) / 5	
7) Coarse Wood	= (Vcwin + Vlogjam + Vcwpot) / 3 + Vfreq) / 2	
8) Riparian Vegetation	= (Vfreq + Vwetuse + Vwatersheduse + Vshade + (Vvegcov + Vstrata) / 2 + Vtreeba) / 6	
9) Connectivity and Interspersion	= (Valthydro + Vsubin + Vwetuse + Vwatersheduse + Vbarrier) / 5	

Step 6. Functional Scoring Sheet - Slope Riverine Proximal

Function	Formulae	Functional Capacity Index (FCI)
1) Dynamic Flood Water Retention Capacity	= (Vfreq + Vcwslope + Vsoilperm + Vmicro + Vvegcov +Vstore) / 6	
2) Subsurface Water Retention Capacity	= (Vsource + (Vacro + Vsoilperm + Vdecomp)/ 3 + Vmicro + Vadjuse) / 4	
3) Nutrient Cycling	= (Vadjuse + Vsurwat + Vvegcov + (Vsource + Vsubout) / 2 + (Vacro + Vredox + Vdecomp) / 3) / 5	
4) Organic Carbon Export	= (Vsource + (Vacro + Vsoilperm + Vdecomp + Vredox + Vegcov) / 4+ Vsubout) / 3	
5) Integrity of the Root Zone	= (Vsource +Vsurwat + Vacro + (Vredox + Vsoilperm) / 2) / 4	
6) Maintenance of Wildlife Habitat Structure	= (Vvegcov + Vadjuse +Vwetuse + (Vsurwat + Vmicro) / 2 + Vstrata + (Vgaps + Vcwslope) 2) / 6	
7) Maintenance of Plants	= (Vwetuse + Vvegcov + Vsource + Vtreeba + (Vsurwat + Vacro) / 2 + (Vredox + Vsoilperm) / 2) / 6	

HGM Rapid Assessment Report Data Collection Sheets

The following list and data collection sheets are necessary for completing an HGM Rapid Assessment Report

1) Step 1. Preliminary HGM Classification (Riverine)
2) Step 1 Preliminary HGM Classification (Slope River Proxi.)
3) Step 2. Site Information (completed in the office or field)
4) Step 3. Sketch a Map of Project Assessment Area.
5) Pebble Count & Embeddedness Work Sheet
6) Variable (15) Vegetative Cover (Vvegcov) worksheets.
7) Riverine Variable Scoring Sheet
8) Slope Variable Scoring Sheet
9) Riverine Functional Scoring Sheet
10) Slope Functional Scoring Sheet

(1) Step 1. Preliminary HGM Classification

Identify, verify, and document the rationale used for recognizing HGM classes and subclasses within the project assessment area. Determine if the assessment area is a ***RIVERINE and/or SLOPE RIVER PROXIMAL Wetland Subclass by using the dominant characteristics outlined below.***

Show how the project assessment area satisfies a subclass definition provided in the guidebook by completing the form below. Specifically, include a discussion of the site characteristics and show how they are consistent with the dominant characteristics of the subclass.

Riverine Wetland Dominant Characteristics

CHARACTERISTIC	DESCRIPTION
Hydrologic Source	Unidirectional flow, higher order streams, derived from non-glacial water sources
Vegetation	Any vegetation life form (e.g., trees, shrubs, herbaceous, etc.) that are not in a marine, or estuarine system, nor directly influenced (i.e., actively flooded) by those systems.
Landforms	Occur in valley bottoms, flow predominantly on bedrock, glacial till or glacial marine deposits. Low elevation stream reaches may flow on Pleistocene or Holocene alluvial gravel deposits, or deltaic estuarine deposits raised in elevation by tectonic lift.
Slope	0.001% to ≤ 2.2%
Parent Materials	<u>Upper reaches</u>: exposed bedrock, glacial till, and colluvium over bedrock, alluvial sand, and gravel. Lower reaches: dense basal till, marine lucustrine and glacial fluvial sediments, and alluvial sand and gravel.
Soils	Sand, silt, and gravel deposits with occasional surface organic matter accumulation.

Provide the site Characteristics:

Hydrologic Source ______________________________

Vegetation ______________________________

Landform, soils ______________________________

Slope ______________________________

Slope River Proximal Wetland Dominant Characteristics

CHARACTERISTIC	DESCRIPTION
Location	Located within 200 feet of the bankfull of a river channel.
Hydrologic Source	Ground or surface water flow.
Vegetation	Any vegetation life form (e.g., trees, shrubs, herbaceous, etc.) that are not in a marine, or estuarine system nor directly influenced (i.e., actively flooded) by those systems.
Landforms	Occur adjacent to streams and valley sides. Occur in valley bottoms, flow predominantly on bedrock, glacial till or glacial marine deposits. Low elevation stream reaches may flow on Pleistocene or Holocene alluvial gravel deposits, or deltaic estuarine deposits raised in elevation by tectonic lift. **Note**: wetlands in closed depressions are out of the subclass.
Slope	0.1% to ≤25%
Parent Materials	<u>Upper reaches</u>: exposed bedrock, thin till, and colluvium over bedrock. Lower reaches: dense basal till deposited by flowing glacial ice, outwash, gravel.
Soils	Sand, silt, and gravel deposits with occasional surface organic matter accumulation.

Provide the site Characteristics:

Hydrologic Source ______________________________

Vegetation ______________________________

Landform ______________________________

Slope ______________________________

Parent Materials ______________________________

Soils ______________________________

(3) Step 2. Site Information (Completed in the Field or Office)

Dates of Site Visit ______________________

Team Members ______________________

Field Notes/Observations ______________________

Collect and review information relevant to the site. This includes, but is not limited to*:*

- *USGS, state, local, and other maps (at various scales)*
- *Geotechnical, soils, or environmental reports*
- *Correspondence, construction plans on the proposed project*
- *Published literature*

Identify the documents that were collected and reviewed. Include a detailed description of each document (e.g., citation, date, scale, quadrangle name, etc.). If possible, attach copies of each document.

- USGS, state, borough, and other maps (at various scales):
  1. ______________________
  2. ______________________
- Air photos and other imagery:
  1. ______________________
  2. ______________________
- Relevant geotechnical, soils, or environmental reports:
  1. ______________________
  2. ______________________
- Correspondence, construction plans, and specifications, etc. on the proposed project:

  ____
- Relevant published literature:

  ____
- Other documents:

- Other Questions:

  Is a cataloged anadromous fish stream adjacent to or part of the assessment area?

  Is the assessment area used by any federally listed threatened or endangered species?

  Is the assessment area adjacent to a state listed impaired waterbody?

  Is the assessment area listed as a historic or cementary?

(4) Step 3. Sketch a map of Project Assessment Area

Image source, date, and scale: ______________________________

(5) 1) Median Pebble Size D50 (Vpebble-D50):

Determine the median pebble size (D50) of the samples by using the Pebble Count Table following the procedure outline above.

Pebble Count & Embeddedness Work sheet

>2	2-4	5-8	9-16	17-32	33-64	65-128	129-256	257-512	512-1024	> 1024

Embeddness Work Sheet			
0 – 25%	26 – 50%	51 – 75%	76 – 100%

(6) 15) Total Vegetative Cover (Vvegcov)

1) Visually estimate the total percent canopy cover by adding each strata (forested, scrub/shrub, herbaceous, and moss and lichen). within 0.1 acre using the PCQ method. For sites dominated by herbaceous vegetation and low shrub vegetation, a line intercept method is used for cover measurements.

Cover Class Midpoints are obtained from the following table:

% Cover	Midpoint
<1	0.5
1-5	3
6-15	10.5
16-25	20.5
26-50	38
51-75	63
76-95	85.5
>95	98

Use the following tables to list the most common species and their estimated percent cover using the cover class midpoint.

Tree Species	Cover Class Midpoint
Total Cover	

Small Trees Strata (>3' & <10', single stem)	
Species	**Cover Class Midpoint**
Total Cover	

Shrubs Strata (multiple stems) and Seedlings (≤3', single stem)	
Species	**Cover Class Midpoint**
Total Cover	

Herbaceous Strata: Forbs, Graminoids, Ferns and Fern Allies	
Species	**Cover Class Midpoint**
Total Cover	

Mosses and Lichens Strata	
Species	**Cover Class Midpoint**
Total Cover	

1. Total percent cover of Moss / Lichen Strata	
2. Total percent cover of Herbaceous Strata	
3. Total percent cover of Shrub Strata	
4. Total percent cover of Tree Strata	
Total Percent Vegetative Cover	

(7) Riverine Variables Scoring Sheet

Variable	Units of Measurement	Field Measurement	Variable Index Score
Vpebble-D50	Median size		
Vchanrough	One Standard Deviation		
Vembedded	% Embedded Pebbles		
Vcwpot Coarse Wood Potential	# of Pieces		
Vcwin Coarse Wood in Channel	# of Pieces in Channel		
Vlogjams Number of Logjams	# of Logjams		
Vsubin Surface water into the A. Area	# of Features		
Vshade Riparian Shade	% Riparian Shade		
Valthydro Alteration of Hydroregime	Hydrologic Connections Disturbed		
Vbarrier	Downstream Barriers		
Vfreq	# of Features		
Vstore	# of Features		
Vsoilperm Soil Permeability	Soil Features		
Vtreeba Tree Basal Area	Est. of Basal Area		
Vvegcov Total Veg. Cover	Sum of % of Six (6)		
Vstrata Vegetation Strata	# of Veg. Strata		
Vwetuse Assessment Area Land use	% of Area Disturbed		
Vwatersheduse Land use in Watershed	% of Area Disturbed		

(8) Slope Riverine Proximal Variables Scoring Sheet

Variable	Units of Measurement	Field Measurement	Variable Index Score
Vredox Redoximorphic Features	Presence or Absence		
Vacro Acrotelm Layer	Presence & Structure		
Vsoilperm Soil Permeability	Condition of Soil		
Vsource Water Source	% and Category of Observed Land Use		
Vsubout Subsurface Water Flow Out	Evidence of Subsurface Flow		
Vfreq Flood Frequency	Indicators of Frequent Flooding		
Vstore	Ratio of Flood Prone Area		
Vwetuse Assessment Area Land Use	Inches (cm)		
Vadjuse Adjacent Land use	Degree of Slope		
Vmicro Microtopography	Ratio of Observed Angle of Impacted Area		
Vsurwat Surface water	Surface Water		
Vvegcov Total Veg. Cover	# per Site		
Vstrata Vegetation Strata	% Features, Presence of Ponding		
Vgaps Canopy Gaps	Sum of % of Six (6) Vegetation Covers.		
Vtreeba Basal Tree Area	% of Hydrologic Connections Disturbed		
Vdecomp Log Decomposition	% and Category of Observed Land Use		
Vcwslope Coarse Wood	# of Pieces of Coarse Wood		

(9) Riverine Functional Scoring Sheet

Function	Formulae	Functional Capacity Index (FCI)
1) Channel meander Belt Integrity	= (Vwatersheduse + Vwetuse+ Valthydro + Vfreq + Vchanrough + Vcwpot + Vlogjam + Vcwin) / 8	
2) Dynamic Flood Water Retention	= (Vstore + Vpebble-D50 + Vlogjam + Vcwin + Vvegcov) / 5 + Vwatersheduse + Vfreq) / 3	
3) Nutrient Spiraling	= (Vsubin + Vcwin + Vcwpot + Vchanrough + Vsoilperm + Vwatersheduse + Vshade) / 7	
4) Particulate Retention	= (Vcwin + Vcwpot + Vlogjams + Vtreeba + Vpebble-D50 + Vvegcov) / 6 + Vfreq) / 2	
5) Removal of Imported Elements and Compounds	= (Valthydro + Vfreq + Vsubin + (Vvegcov + Vtreeba) / 2 + Vsoilperm) / 5	
6) In-Channel Biota	= (Vshade + Vchanrough + Vembedded + Vwetuse + Vsubin) / 5	
7) Coarse Wood	= (Vcwin + Vlogjam + Vcwpot) / 3 + Vfreq) / 2	
8) Riparian Vegetation	= (Vfreq + Vwetuse + Vwatersheduse + Vshade + (Vvegcov + Vstrata) / 2 + Vtreeba) / 6	
9) Connectivity and Interspersion	= (Valthydro + Vsubin + Vwetuse + Vwatersheduse + Vbarrier) / 5	

(10) Slope Riverine Proximal Functional Scoring Sheet

Function	Formulae	Functional Capacity Index (FCI)
1) Dynamic Flood Water Retention Capacity	= (Vfreq + Vcwslope + Vsoilperm + Vmicro + Vvegcov +Vstore) / 6	
2) Subsurface Water Retention Capacity	= (Vsource + (Vacro + Vsoilperm + Vdecomp)/ 3 + Vmicro + Vadjuse) / 4	
3) Nutrient Cycling	= (Vadjuse + Vsurwat + Vvegcov + (Vsource + Vsubout) / 2 + (Vacro + Vredox + Vdecomp) / 3) / 5	
4) Organic Carbon Export	= (Vsource + (Vacro + Vsoilperm + Vdecomp + Vredox + Vegcov) / 4+ Vsubout) / 3	
5) Integrity of the Root Zone	= (Vsource +Vsurwat + Vacro + (Vredox + Vsoilperm) / 2) / 4	
6) Maintenance of Wildlife Habitat Structure	= (Vvegcov + Vadjuse +Vwetuse + (Vsurwat + Vmicro) / 2 + Vstrata + (Vgaps + Vcwslope) 2) / 6	
7) Maintenance of Plants	= (Vwetuse + Vvegcov + Vsource + Vtreeba + (Vsurwat + Vacro) / 2 + (Vredox + Vsoilperm) / 2) / 6	

APPENDIX 2 Riverine Wetlands in Coastal Southeast and Southcentral Alaska
Functions and Variable Index values

Date ______________________________
Name ______________________________
COE Waterway # ______________________
State ID Number ______________________

Two Step Procedure for Calculating the Functional Capacity Index

1. Fill in the "Index" column (column D) for all 18 variables by using the variable index values found in the completed field collection sheets from Appendix 1.
2. The Functional Capacity Index is automatically calculated for each of the 9 wetland func

Page Reference #	Variables	Index
	VpebbleD50	
	Vchanrough	
	Vembedded	
	Vcwpot	
	Vcwin	
	Vlogjams	
	Vsubin	
	Vshade	
	Valthydro	
	Vbarrier	
	Vfreq	
	Vstore	
	Vsoilperm	
	Vtreeba	
	Vvegcov	
	Vstrata	
	Vwetuse	
	Vwatersheduse	

Page Reference #	Wetland Functions				
	1 Channel Meander Belt Integrity				
	FCI: (Vwatersheduse+ Vwetuse+ Valthydro +Vfreq+ Vchanrough + Vcwpot + Vlogjam + Vcwin) / 8				
	FCI =	**0.00**	eparture =	100	
	2 Dynamic Flood Water Retention				
	FCI : (Vstore + Vpebbled50 + Vlogjam + Vcwpot + Vvegcov) / 5 +Vwatersheduse+Vfreq) /2				
	FCI =	**0.00**	eparture =	100	
	3 Nutrient Spiraling and Orgaic Carbon Export				
	FCI: (Vsubin+Vcwin+Vcwpot+Vchanrough+Vsoilperm+Vwatersheduse + Vshade)/7				
	FCI =	**0.00**	eparture =	100	
	4 Particulate Retention				
	FCI: (Vcwin+Vcwpot+Vlogjam +Vtreeba+ VpebbleD50+Vvegcov)/6+Vfreq)/2				
	FCI =	**0.00**	eparture =	100	
	5 Removal of Imported Elements and Compounds				
	FCI: (Valthydro +Vfreq + Vsubin + (vegcov +Vtreeba)/2 +Vsoilperm)/ 5				
	FCI =	**0.00**	eparture =	100	
	6 Maintenance of In-Channel Aquatic Biota				
	FCI: (Vshade + Vchanrough + Vembedded + Vwetuse + Vsubin) / 5				
	FCI =	**0.00**	eparture =	100	
	7 Presence of Coarse Wood Structure				
	FCI:(Vcwin + Vlogjam + Vcwpot)/3 + Vfreq) / 2				
	FCI =	**0.00**	eparture =	100	
	8 Maintenance of Riparian Vegetation				
	FCI: (Vfreq + Vwetuse + Vshade + Vwatersheduse + (Vvegcov +Vstrata)/2 + Vtreeba)/ 6				
	FCI =	**0.00**	eparture =	100	
	9 Maintenance of Connectivity and interspersion				
	FCI: (Valthydro + Vsubin + Vwetuse + Vwatersheduse + Vbarrier) / 5				
	FCI =	**0.00**	eparture =	100	
	Ave. % departure from Reference Stand.				0

APPENDIX 2 Slope River Proximal Wetlands in Coastal Southeast and
Functions and Variable Index values
HGM Team

Date ______________________
Name ______________________
COE Waterway # ______________________
State ID Number ______________________

Two Step Procedure for Calculating the Functional Capacity Index

1 Fill in the "Index" column (column D) for all 17 variables by using the variable index values found in the completed field collection sheets from Appendix 1.
2 The Functional Capacity Index is automatically calculated for each of the 7

Page Ref. #	Variables	Index	Page Ref. #	Wetland Functions			
	Vredox			**1 Dynamic Flood Water Retention Capacity**			
	Vacro			FCI: = (Vfreq + Vcwslope + Vsoilperm + + Vmicro + Vvegcov + Vstore)/ 6			
	Vsoilperm			**FCI =**	**0.00**	% departure =	100
	Vsource						
	Vsubout			**2 Surface Water Retention Capacity**			
	Vfreq			FCI : (Vsource + (Vacro + Vsoilperm +Vdecomp) /3 + Vmicro + Vadjuse)/ 4			
	Vstore			**FCI =**	**0.00**	% departure =	100
	Vwetuse						
	Vadjuse			**3 Nutrient Cycling**			
	Vmicro			FCI = (Vadjuse+ Vsurwat + Vvegcov + (Vsource + Vsubout)/2 + (Vacro + Vredox + Vdecomp)/3)/ 5			
	Vsurwat			**FCI =**	**0.00**	% departure =	100
	Vvegcov						
	Vstrata			**4 Organic Carbon Export**			
	Vgaps			FCI : (Vsource + (Vacro + Vsoilperm + Vdecomp +Vredox)/4 +Vsubout) /3			
	Vtreeba			**FCI =**	**0.00**	& departure =	100
	Vdecomp						
	Vcwslope			**5 Integrity of the Root Zone**			
				FCI:(Vsource + (Vsurwat + Vacro + Vredox + Vsoilperm) /4)/ 2			
				FCI =	**0.00**	% departure =	100
				6 Maintenance of Wildlife Habitat Structure			
				FCI: (Vvegcov + Vadjuse + Vwetuse + (Vsurwat + Vmicro) /2 + Vstrata + (Vgaps + Vcwdslope) /2) / 6			
				FCI =	**0.00**	% departure =	100
				7 Maintenance of Plants			
				FCI: (Vwetuse + Vvegcov + Vsource + Vtreeba + (Vsurwat + Vacro) / 2 + (Vredox + Vsoilperm) /2) / 6			
				FCI =	**0.00**	% departure =	100
				Ave. % departure from Reference Stand.			

Appendix 3 Data Analysis and Array Sheets

This Appendix includes a discussion and analysis of the data that supports the guide book. Following the discussion are several graphics and array sheets displaying the data.

Data Analysis for Riverine and Slope River Proximal Wetlands

This is a general summary of the multivariate statistics for the 33 reference sites studied for this guidebook. The 33 sites were studied in two groups at different times. The first group had 20 sites, and the second group had 13 sites. Out of the group of 20, 5 were "reference standard" (or least disturbed); out of the 13, 6 were "reference standard." The data summaries are self explanatory but the multivariate analysis may be new to some HGM users. The multivariate statistical analyses performed here, a.k.a. "ordinations", provide a method of sorting the sites based on data associated with each site such that the most important differences among the sites are apparent. To visualize this, imagine first sorting all the sites based on one value, for example, average tree age, and then plotting the sites along an axis of tree age to determine the range of tree sizes and where there are clumps of sites with similar tree sizes. Second, add in another variable by using a second axis that crosses the first and sorting the data along that axis while still maintaining each site's coordinate on the tree age axis. The result is a two-dimensional chart wherein the coordinates of each site on the chart are its values for tree age and another variable. We can continue to add axes for additional variables (most axes will NOT cross the original axis at a 90^{o} angle) and continue to spread our data out by sorting it with each additional variable. The result is a scatter plot with too many axes to meaningfully draw, so the authors instead chose to simply impose two axes that have little physical meaning and to determine how the data are distributed to find similarities and differences among the different sites.

Hydrology

The reference data set for the riverine subclass sampled in Coastal Southeast and Southcentral Alaska includes 33 sites. As mentioned above, these were studied in two groups (20 and then 13) at different times. Photos 2 and 3 illustrate typical reaches of river channel characteristic of the reference standard sites. Table 8 provides a summary of average and standard deviation data for the reference standard sites and other reference sites within the riverine subclass. Within the sites sampled, water surface slopes ranged from 0.001 to 0.045%, median bedload size, (D50) ranged from 4.76 mm to 102.88 mm, bankfull widths ranged from 10 feet to 92 feet, and average bankfull depths ranged from 0.75 feet to 5.1 feet. Width-to-depth ratios ranged from 4:1 to 98:1.

Table 1. Riverine Hydrologic Summary and Profile Data for first Group of 20 Sites

Note: Values reported are averages unless specified One **standard deviation is reported in parentheses**	**Reference Standard Sites**		**Other Reference Sites**	
Landscape Attributes				
Drainage Basin Area Above the Project Assessment Area	11.95 mi^2 range 0.7 - 41.9 mi^2		8.72 mi^2 range 0.4 - 27.1 mi^2	
Additions or Diversions of Flow To or From the Project Assessment Area	No		Yes	
Hydrologic/Channel Characteristics				
Bankfull Width (ft)	53.93	(27.88)	44.00	(26.17)
Bankfull Depth (ft)	2.34	(1.36)	2.04	(1.52)
Bankfull Thalweg Depth (ft)	3.30	(1.82)	2.92	(2.06)
Bankfull Width: Depth Ratio	24.86	(12.92)	29.41	(27.31)
Bankfull Cross-Sectional Area (sq ft)	149.61	(155.79)	104.8	(123.63)
Range of Floodplain Widths (ft)	23.71	(4.76)	27.00	(54.10)
Flood Prone Area Width (ft)	102.86	(61.82)	70.62	(54.27)
Presence of Artificial Levees	No		Yes and No	
Water Surface Slope (%)	0.016	(0.014)	0.005	(0.004)
Channel Bed Slope (%) (Thalweg)	0.017	(0.015)	0.007	(0.005)
Channel Bedload Characteristics				
Median Bedload Particle Size (D50)	54.77 mm		24.07 mm	
Hydraulic Connections to Main Channel				
Presence of Surface Hydraulic Connections	Yes and No		Yes and No	
Presence of Sub-Surface Hydraulic Connections	Yes and No		Yes and No	

Table 2. Table 9. Riverine Hydrologic Summary and Profile Data				
Note: Values reported are averages unless specified	**Reference Standard**		**Other Reference**	
One standard deviation is reported in parentheses	**Sites**		**Sites**	
% Cover of Fine Woody Debris (<4" diameter) Below Bankfull Stage	3.89	(3.47)	3.30	(3.41)
% Deadzone Fraction at Bankfull Stage	27.70	(26.17)	24.46	(31.59)
Riparian Characteristics Above Bankfull Stage				
% Cover of Deciduous Trees Above Bankfull Stage	27.79	(26.90)	35.08	(29.62)
% Cover of Deciduous Shrubs Above Bankfull Stage	55.07	(19.82)	43.38	(29.93)
% Cover of Trees (Deciduous and Coniferous) and Shrubs Above Bankfull Stage	77	(18.37)	70.17	(24.14)
% Cover of Fine Woody Debris (<4" diameter) Above Bankfull Stage	7.64	(3.96)	13.06	(10.35)
Coarse Woody Debris (CWD) Below Bankfull Stage				
Number of Pieces of CWD in 100 ft reach Below Bankfull Stage	4.00	(4.24)	2.12	(2.44)
Diameter (Inches) – Coarse Woody Debris in 100 ft reach Below Bankfull Stage	11.63	(6.04)	9.02	(4.88)
Length (ft) - Coarse Woody Debris in 100 ft reach Below Bankfull Stage	16.82	(11.44)	8.75	(5.46)
Volume - Coarse Woody Debris (cu ft/100 ft reach Below Bankfull Stage)	2.96	(3.41)	1.25	(1.68)
Average # of Decomposition Classes Present in 100 ft reach Below Bankfull Stage	3		2	
Presence of Nurselogs in 100 ft reach Below Bankfull Stage	Yes		Yes	
Sources of Coarse Woody Debris (CWD)				
Up-Channel Source of CWD (# of Pieces / 50 ft reach up-stream of the Project Assessment Area)	4.93	(13.56)	1.42	(2.70)
Bank Source of CWD (# of Trees within 10ft of Bankfull Stage within a 100 ft reach)	8.71	(6.47)	4.92	(6.26)

The five reference standard (or least disturbed) sites in the first group of 20 studied have a greater average width, depth, thalweg depth, and cross-sectional area than the other reference sites within the group, yet the average width-to-depth ratios and the range in floodplain widths are less than the other reference sites Table 1). The reference standard sites exhibited fewer disturbances that resulted in alterations to the characteristic channel dynamics and morphology (i.e., width-to-depth ratios, entrenchment etc.). Within the first 20 reference sites sampled disturbances included: (1) increased inputs of fine particulate sediment from urbanization, forest practices, etc., (2) altered hydro-regimes in the assessment area (e.g., stormwater inputs/diversions, water harvesting, development/clear-cutting of adjacent slope wetland areas), (3) channelization and/or rip-rap stabilization, and (4) removal of coarse woody debris and/or coarse woody debris sources.

The graph below plots average particle size against cumulative percent “finer” for the reference sites versus the reference standard sites. As indicated in the graph, the cumulative frequency curve for the reference sites represents a distribution of finer bedload particle sizes than in the reference standard sites (i.e., the reference sites curve is to the left of the reference standard site curve in the graph). By definition the reference standard sites represent the least impacted/disturbed sites within the reference data set while "reference sites" represent a range of disturbance. The finer bedload particle size distribution in the reference sites is likely the result of the types of disturbance listed above.

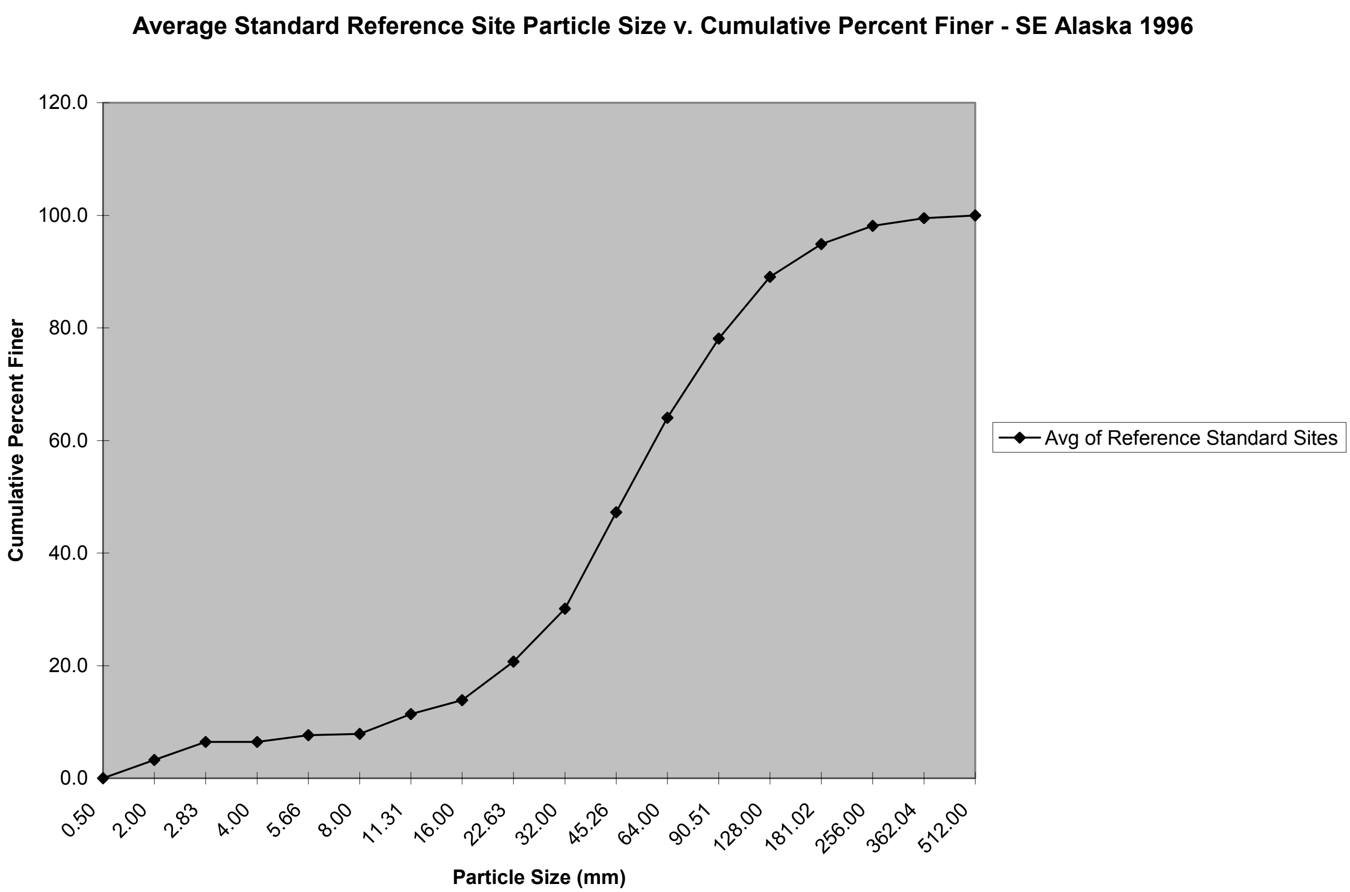


Figure 1. **Average Particle Size vs. Cumulative Percent Fines**

In Figure 2 below shows fine sediment input to the channel resulting from disturbance. In Figure 2 particle size is graphed against cumulative percent finer for the average of the reference standard sites versus Jordan Creek, a disturbed site. Jordan Creek is located within a highly urbanized watershed characterized by roads, parking lots, housing developments, playing fields, and altered hydro-regimes (stormwater management, flow additions and diversions, etc.). The cumulative frequency curve for Jordan Creek indicates a large deviation toward fine particle sizes compared to the average of the reference standard sites. Specifically, the D50 (50% of the particle sizes are smaller than the D50 value) of Jordan Creek was calculated at 4.76 mm in comparison to 54.77 mm for the reference standard sites. This deviation toward finer particle sizes is likely due to inputs of fine sediments from the disturbed portions of the watershed.

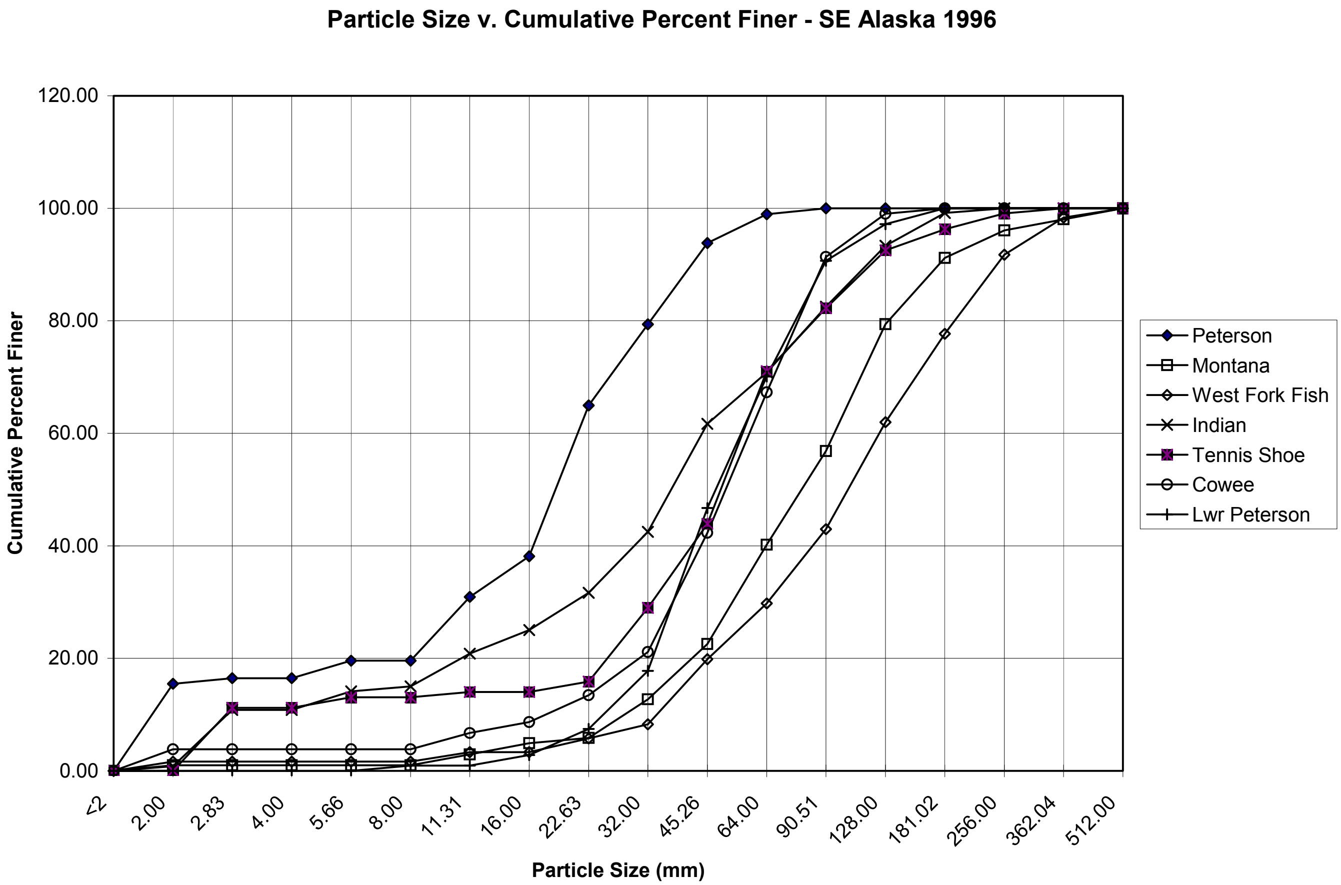


Figure 2. **Particle Sizes of Reference Standard Sites**

Characteristic of the reference standard sites is the presence of coarse woody debris and debris jams within a channel Figure 3 illustrates coarse woody debris jam data for the first 20 reference sites sampled. Of note in this graph is the lack of coarse woody debris jams within 7 of 13 sites. Coarse woody debris and debris jams play a significant role in maintaining the characteristic channel dynamics of Southeast Alaskan rivers. Coarse woody debris and debris jams alter the hydrodynamics of a river and (1) drive the course of the river (e.g., avulsions around debris jams), (2) affect the development of floodplains, (3) control the channel bed elevation, (4) retain sediments, and (5) create scour and step pools.

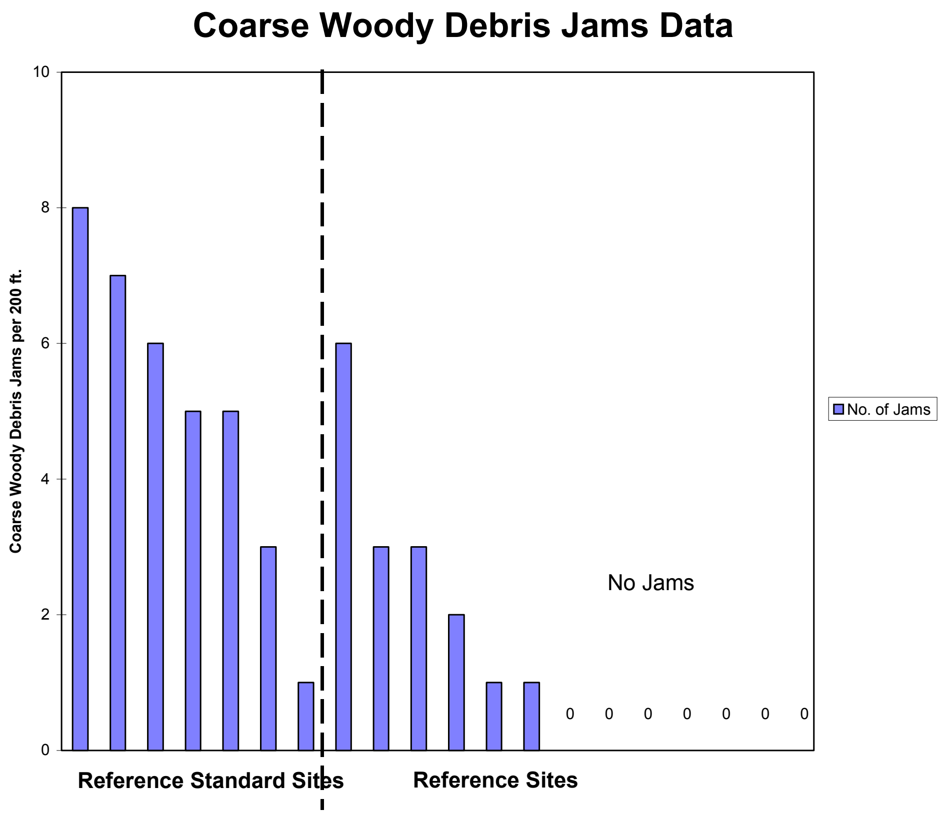


Figure 3. **Reference Standard Sites and Reference Sites vs. Log Jams**

Finally, reference standard sites in Southeast Alaska are characterized by undisturbed native vegetation communities along the channel banks and immediately proximate to the channel (i.e., off-channel slope areas) Riparian forests represent a source of coarse woody debris and nutrient input and provide regulation of the micro-climatic conditions within the channel (e.g., water temperature and light interception). Disturbance to riverine wetlands in Southeast Alaska typically resulted in an increase of emergent vegetation within the channel.

Hydrology Ordination

Figure 5 illustrates the results of the hydrology ordination (we used a detrended conical analysis or DCA). Sites are arrayed according to 48 hydrologically relevant attributes. Reference sites are designated by the open circle symbol and reference standard sites are designated by the red circle symbol. The plot shows that there was substantial overlap between standard and non-standard reference sites. The blue arrows show how the most influential parameters contributed to sorting the sites. For example, sites that are plotted low on the chart (i.e., near Axis 1), tended to have more CWD than sites that plotted higher in the plot. Axis 1 has an eigenvalue of 0.26, which means only 26% of the variability among the sites is represented by the variance along Axis 1. Axis 2 has an eigenvalue of 0.11. Both of these values are too low to make statistically significant interpretations about the hydrological differences among sites.

Figure 4 illustrates DCA ordination of 33 sites with respect to 48 hydrological variables. The blue arrows indicate how the five most influential variables correlate with distribution of the sites in the plot. The numbers indicate individual sites.

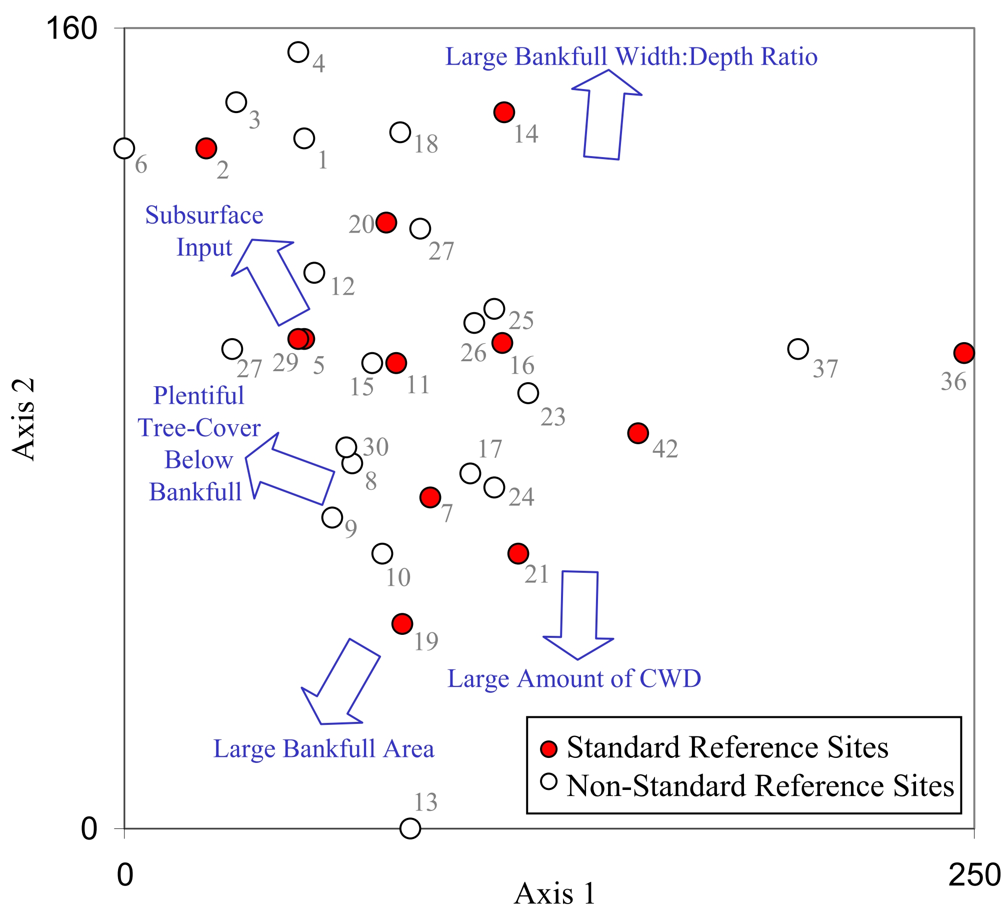


Figure 4. **Hydrologic Ordination Graph**

Soils

Coastal Southeast and Southcentral Alaska is characterized by mountainous terrain rising immediately from marine waters and extending over a relatively short distance to mountain ridges. The land area associated with fluvial processes within the context of this model tend to be narrow confined channels and valleys. Parent material for soils of the alluvial valleys consists of silts, sands, and gravels that have been deposited by Holocene fluvial processes. The typical geomorphic stratigraphy of the subclass (riverine wetlands on low permeability deposits and bedrock) has glaciofluvial and marine derived silts underlying recent fluvial silt, sand, and gravels. Tectonic activity and isostatic rebound have resulted in the formation of raised areas of marine deposited silt. The marine silts create a deep impermeable layer that causes lateral drainage through the upper hillslope deposits into downslope valley bottoms and streams. Marine silt has very low permeability, while recent deposits are highly permeable, resulting in surface expression of groundwater.

Stream meandering is limited due to channel confinement, although stream channels have cut through some of the recent glaciofluvial deposits to form present-day channels.

Holocene silts, sands and gravels form stream banks, levees, and small floodplain areas adjacent to the active channel. Soils formed in these deposits are Histosols, Entisols and Inceptisols. The typical pedon has a thin organic horizon over a series of sand, silt or gravel deposits. In many locations, the gravel lies over the glaciofluvial deposits and marine silt. Soils on the levees are fairly stable, to erosion because of plant roots, but due to the short period since deposition and slow weathering processes in Southeast Alaska, there has not been much soil formation and horizonation.

Transformations within the profile consist of weathering of parent material and organic accumulations in the upper horizons. Organic matter accumulation in the upper horizons has also led to subtle color changes. Due to higher water retention, the color changes in the upper horizons are particularly obvious in the non-weathered silt-dominated deposits.

The riverine soils are highly permeable and do not store significant amounts of water. Water flowing off slopes adjacent to the stream infiltrates vertically through the porous sand and silt deposits into the gravel where it then moves laterally to the stream. Riverine soils are not reactive and serve to move water rapidly to streams. The soils do not exhibit redoximorphic features, nor are they saturated continuously for any period of time. Water flowing off the surrounding landscape moves rapidly through the riverine soils.

Soils Ordination

Figure 5 illustrates the results of the soils ordination (we used a detrended conical analysis or DCA). Sites are arrayed according to 7 soil attributes. Again reference sites are designated by the open circle symbol and reference standard sites are designated by the red circle symbol. The blue arrows show how the most influential parameters contributed to sorting the sites. For example, sites that are plotted towards the upper left of the plot tended to have deeper litter depths and indications of saturation than sites that plotted towards the lower right. The plot shows that there was substantial overlap between standard and non-standard reference sites, however, the standard reference sites tended to have soils with better drainage and less flooding indications than the other reference sites. Axis 1 has an eigenvalue of 0.68 and Axis 2 has an eigenvalue of 0.29. This means, for example, that factors that result in the sites distributing themselves along Axis 1 (primarily the five shown in the figure) account for 68% of the variability among the sites. The soils data indicates more differences among sites than the hydrology data.

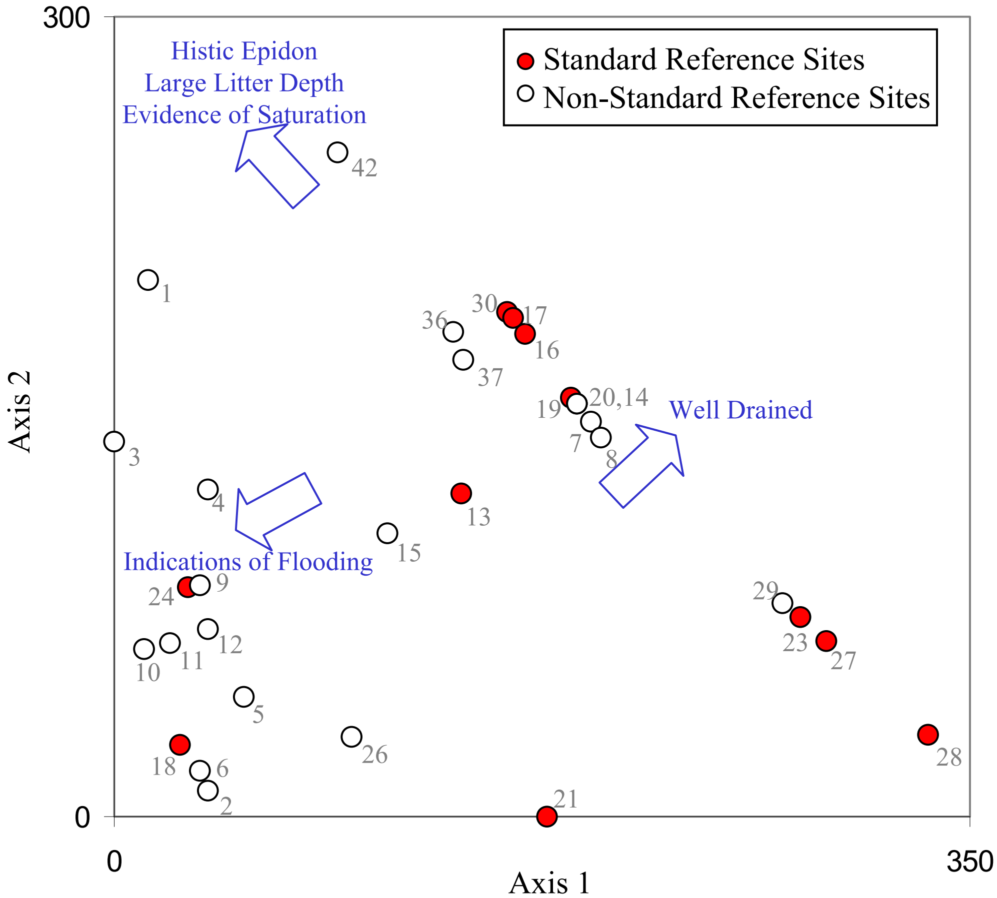


Figure 5. **Soils Ordination Graph**

Figure 5 shows DCA ordination of 33 sites with respect to 7 soils variables. The blue arrows indicate how the five most influential variables correlate with distribution of the sites in the plot. The numbers indicate individual sites.

Vegetation

The riverine forest in Coastal Southeast and Southcentral Alaska is typically organized into zones running parallel to the stream channel. The zone closest to the stream (in the vicinity of bankfull) is often a herb/bryophyte strip. The next zone is commonly a shrub-dominated area that ends at the topographic break in slope indicating the top of the bank. The zone above this topographic break is typically where large conifers are rooted. This zone, “off-channel forest”, is an important source of large wood to the channel and, as such, is critical to the maintenance of stream morphology. In addition, vegetation in this area adds nutrients to the channel and contributes to the biodiversity of the riparian corridor by providing a source of nutrients and habitat. The off-channel forest vegetation is profiled below.

The first two zones below the top of the bank were sampled separately and then grouped as “channel bank vegetation” for analysis. Channel bank vegetation is rooted and growing in the area around bankfull and between bankfull at the top of the bank . These communities are influenced by the channel (e.g., water availability, erosional and depositional forces), soil morphology, and/or by the break in canopy above the channel. The plants growing within the channel bank zone are important in biogeochemical stream processes as well as habitat and food sources for streamside invertebrates and amphibians, and in bank stabilization.

The average cover values presented in the profiles below are averages of cover class midpoints. Since these numbers are not exact values but rather represent a range in values, they may not add to 100% (e.g., groundcovers). No trees were growing in the channel bank of reference standard sites sampled during this study. The over story of channel bank sites was composed of overhanging tree cover from off-channel zones (86% average cover). This may be due to the narrowness of the channel bank zones in reference standard sites or to the small sample size for this draft model. There were also few saplings within the channel bank; Sitka Spruce *(Picea sitchensis)* and Western Hemlock *(Tsuga heterophylla)* saplings each had an average percent cover of 3%. The shrub species with the highest average percent cover values included: Devil's Club *(Echinopanax horridum*, 16% average cover), Sitka Alder *(Alnus crispa*, 3% cover), and Huckleberries/blueberries *(Vaccinium* spp., 2% cover) The average percent cover of the herb strata was 26%. Herbs found in the channel bank zone included sedges *(Carex* spp*.)*, Goatsbeard *(Aruncus sylvester)*, Horsetails *(Equisetum spp.)*, Lace Flower *(Tiarella trifoliata)*, and Oak Fern *(Gymnocarpium dryopteris)*. The average number of taxa found within 1/10-acre plots in these areas was 18. The ground layer consisted of depositional cobbles, gravels, sands, and silts ("bare ground," 11% average cover); bryophytes (86% average cover); and litter (7% average cover).

The average overhanging tree cover in these impacted channel bank sites (26% average cover) was less than that of the reference standard channel bank sites (86% average cover). The average percent cover of saplings was similar to that of the reference standard sites; however, the composition of this stratum was very different. There were no Western Hemlock (*Tsuga heterophylla)* saplings growing at "other reference sites," and there was only a trace amount of Sitka Spruce *(Picea sitchensis)* sapling cover. The majority of the sapling cover was composed of Red Alder *(Alnus oregona,* 8% average cover) and Black Cottonwood *(Populus balsamifera,* 1% average cover).

The average percent cover of the shrub strata at these disturbed sites was one-third that of the reference standard sites. There was no Devil's Club *(Echinopanax horridum)* or Mountain Alder *(Alnus crispa)* on these sites. Sitka Willow *(Salix sitchensis)* and other willows (*Salix* spp.) made up the majority of the shrub percent cover (5% cover). Impacted sites had an average of 44% herb cover, which is almost twice that of reference standard sites. In this preliminary data set it was observed that the average impacted channel bank was wider and subject to more frequent inundation than was the average reference standard channel bank zone. This observation is consistent with the data; there were increases in percent cover for species that commonly grow in standing water, such as Skunk Cabbage *(Lysichiton americanum)*, Western Marigold *(Caltha palustris)*, and sedges *(Carex* spp.). Other herb species that were more numerous at impacted sites include Lady Fern *(Athyrium filix-femina)*, Bluejoint Reedrush *(Calamagrostis canadensis)*, Western Buttercup *(Ranunculus occidentalis)*, and Large Leafed Avens *(Geum macrophyllum)*. Certain herb species such as Goatsbeard *(Aruncus sylvester)*, Horsetails *(Equisetum* spp.), Oak Fern *(Gymnocarpium dryopteris)*, and Lace Flower *(Tiarella trifoliata),* had lower average percent cover values at impacted sites than they did at reference standard sites. There was an average of 9 taxa per 1/10 acre plots in these areas. There was a marked difference in percent cover values for the ground layers between reference standard and "other reference sites." Litter and bare groundcovers increased to average cover values of 45% and 53% respectively. Bryophyte percent cover decreased from 86% at reference standard sites to 11% at impacted sites.

At off-channel reference standard sites, the over story is typically composed of Western Hemlock *(Tsuga heterophylla,* 32% average cover) and Sitka Spruce *(Picea sitchensis,* 22% average cover) with a combined basal area of 280 ft^2/acre. Average tree density in these forests is 98 trees/acre. There was an average of 30 saplings/small trees per acre. Sitka Alder *(Alnus crispa)* had the highest percent cover (8%) of this strata; it was particularly abundant in gap areas. Wind-throw, avalanches, landslides, and disease are important sources of gaps in Southeast Alaska forests. Coniferous regeneration was represented by Western Hemlock *(Tsuga heterophylla,* 8% average cover) and Sitka Spruce *(Picea sitchensis,* 1% cover) saplings. The shrub stratum (46% average cover) was dominated by Devil's Club *(Echinopanax horridum,* 39% cover), Five-leafed Bramble *(Rubus pedatum,* 20.4% cover), Huckleberries/blueberries (*Vaccinium* spp., 8% cover), and Rusty Menzesia *(Menziesia ferruginea,* 3% cover). Huckleberry/ blueberry plants *(Vaccinium* spp.) were commonly rooted on elevated microsites, whereas Devil's Club was common in wet depressions. Prevalent herbs (total average stratum cover 42%) include Skunk Cabbage (*Lysichiton americanum*, 28%), Oak Fern (*Gymnocarpium dryopteris*, 26%), Spleenwort-leafed Goldthread *(Coptis asplenifolia*, 7%) Twisted Stalk (*Streptopus amplexifolius*, 5%), Lady Fern *(Athyrium filix-femina,* 5%), Lace Flower (*Tiarella trifoliata*, 4%), Dwarf dogwood (*Cornus canadensis*, 4%), and Enchanter's Nightshade (*Circaea alpina*, 3%). An average of 14 taxa were found within each 1/10 acre reference standard off- channel forest plots. Bryophytes were the dominant groundcover (53% average cover), followed by litter (17% cover), and bare ground (0.5%).

Trees found in these impacted off-channel forests include both deciduous and coniferous species. Sitka Spruce (*Picea sitchensis*) represented the highest average percent cover (17%), followed by Black Cottonwood (*Populus balsamifera*, 8%), Western Hemlock (*Tsuga heterophylla*, 5%), Red Alder (*Alnus oregona*, 4%), and Sitka Alder (*Alnus crispa*, 2%). The average basal area for these forests was 191 ft^2/acre and the average density was 197 trees/acre. Sapling/small tree cover is more than twice that of the reference standard condition (30% versus 12%). There was no evidence of Western Hemlock (*Tsuga heterophylla*) regeneration within these plots; however, Sitka Spruce (*Picea sitchensis*) saplings had an average percent cover of 18%. The majority of the sapling cover was provided by deciduous species; Red Alder (*Alnus oregona*) saplings had an average cover of 19% and Sitka Alder (*Alnus crispa*) sapling cover was 4%.

The composition of the shrub and herb communities in these sites was very different from that found at the reference standard sites. The Devil's Club *(Echinopanax horridum)* in these impacted off-channel forests had an average percent cover of 2%. There was also a decrease in average percent cover of Five-leafed Bramble *(Rubus pedatus)*; it was 0.2% cover. The average cover values of willows (*Salix* spp., 8%) and Salmonberry *(Rubus spectabilis,* 2%) increased in these sites. The largest drop in percent cover for herb species was Skunk Cabbage (*Lysichiton americanum,* 2% cover), followed by Oak Fern (*Gymnocarpium dryopteris*, 2% cover), and Spleenwort-leafed Goldthread (*Coptis asplenifolia*, 0% cover). Herb taxa that had higher percent covers in the impacted sites than they did at the reference standard sites include: Goatsbeard (*Aruncus sylvester*, 7% cover), Horsetails *(Equisetum* spp., 7% cover), graminoid species (6% cover), and Bluejoint Reedrush (*Calamagrostis canadensis*, 4% cover). An average of 9 taxa were found within each 1/10 acre plot in these impacted sites. Organic litter was the most common groundcover (79% cover), followed by bryophytes (19% cover), and bare ground (12%).

These data appear to indicate that upon impact, off-channel riverine forests exhibit an increase in deciduous tree species accompanied by a decrease in the percent cover supplied by coniferous species. The moisture level of the site likely decreases; Devil's Club *(Echinopanax horridum)*, Skunk Cabbage *(Lysichiton americanum)*, and bryophytes become more scarce.

1. <u>Vegetation Ordination</u>

Figure 6 illustrates the results of the vegetation ordination (Principal Component Analysis or PCA). Sites are arrayed according to their vegetative relationships. Reference sites are designated by open circle symbols and reference standard sites are designated by the red circle symbols. The numbers next to each symbol on the vegetation ordination figure represent the vegetation plot numbers; there were multiple plots per site. The numbers correspond with those on the soil and hydrology ordination figures and the letters indicate separate plots within each site. The eigenvalues for axes 1 and 2 are 0.95 and 0.60, indicating strong relationships between the variability among sites and the vegetative species. Sites that are plotted to the right of Figure 19 are characterized by a high percent cover of deciduous trees relative to conifers and shrub/forb communities found near the channel areas. Sites plotted to the left of the figure tend to have shrub/forb communities in the forest areas. Sites plotted near the top of the figure have a high percent of overhanging *Salix spp*. and of overhanging conifers. There was very little correlation between site distribution and the five environmental parameters considered; all $R^2 < 0.3$. The group of plots clustered high on the left-hand side of Figure 6are all channel bank plots. The off-channel plots are clustered in the middle and on the far right-hand side of Figure 6.

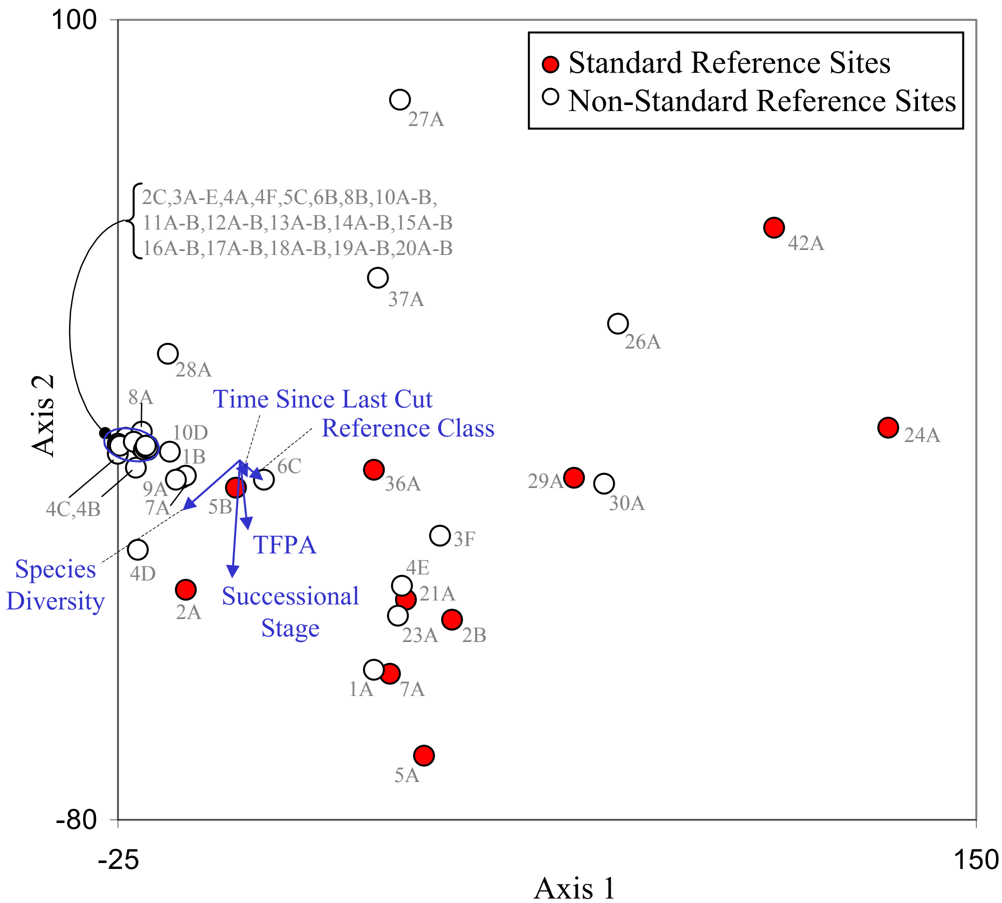


Figure 6. **Vegetation Ordination**

NOTE: This graph is a ordination (Biplot) of 61 plots (most sites had more than one plot as indicated by the A, B, etc.), 56 species, and 5 environmental variables (indicated by the arrows). TRPA = Tongass Forest Plant Association.

Fish and Wildlife Resources

The abundant fish and wildlife resources in coastal southeast and southcentral Alaska are internationally known. These abundant resources are used for sport and commercial purposes as well as help support subsistence users. Non-consumptive use of fish and wildlife is increasing dramatically because of the raise in the tourism industry. Most of the fish and wildlife species in the area are dependent on wetland habitats for some or nearly all of their life requirements.

The area streams contain important anadromous and resident fish habitats. The streams support five species of anadromous salmon (pink, chum, coho, sockeye, and chinook) as well as resident cutthroat trout, rainbow/steelhead trout, and Dolly Varden chars. These species are important to the commercial, recreational, charter boat/lodge, and subsistence fishery of the region. These fish also are a major food resource for black bears, river otters, eagles, and other wildlife. Other non-game species, including sculpin, sticklebacks, and smelt, are also present or in adjacent waters (Taylor, 1979).

Anadromous fish spend part of their life in fresh water and part in salt water. Salmon lay their eggs in stream gravels, and juvenile fish hatched from the eggs emerge from the gravels. The amount of time the juveniles spend in fish water depends on the species of salmon. Pink salmon start their downstream migration immediately after emergence, while coho salmon juveniles generally spend two years in fresh water before migrating to the ocean. Pink and chum salmon depend heavily on estuaries during their early life stages. Salmon reach maturity in the ocean, returning to their natal streams to spawn, die, and start the cycle again. Steelhead trout follow a cycle similar to coho salmon, except they often survive the spawning season, return to the ocean, and spawn again. Resident trout, and char spend all of their lives in fresh water spawning in stream gravels and growing to maturity in the streams and lakes of the region.

There are more than 200 species of birds and mammals that live in the region. A few of the management indicator species listed in United States Forest Service, Tongass National Forest EIS for several Timber Sales include: Sitka black-tailed deer, black bear, wolf, river otter, marten, Vancouver, Canada goose, bald eagle, red-breasted sapsucker, hairy woodpecker and brown creeper.

Slope River Proximal Wetlands

Development of the draft model for slope river proximal wetlands is based upon field observations and 15 river proximal slope wetlands sites located in Juneau, Port Graham and Nanwalik. The functions and variables articulated in this draft model represent the best professional judgment of the Development Team <u>without the benefit of a reasonable number of reference site data (30 or more)</u>. However, due to ecological linkages there is substantial overlap between Riverine and River Proximal wetland functions and variables.

Data Array Sheets and Data Collection Graphics

Data Array Sheets

1. Land Use (Vwetuse, Vadjuse, and Vwatersheduse
2. Hydrology (Vsubin, Vsubout, and Valthydro)
3. Vegetation (Vvegcov)
4. Vegetation (Vcwslope) and other veg. data array
5. Tree Basal (Vtreeba) and percent tree cover.
6. Potential Course Wood (Vcwpot)
7. Pebble Count Array Sheet & Graph
8. (Vpebble-D50 &Vchanrough (D84))
9. Hydrologic Data (Vfreq,Vbarriers, and associated data)
10. Hydrologic Data (Vlogjams, Vdecomp, and additional data)
11. Vegetation (Vshade data)

Sampling Location Graphics

Figure 9. Channel Transect Sampling Plots Location of Sampling Transect and Plots

Figure 10. Location of Sampling Transect and Plots

1. Land Use (Vwetuse, Vadjuse, and Vwatersheduse)

Reference Site Name and Number	Reference Standard Reference	Wetuse Assessment Area Use Score	Adjacent Land Use Score (500 ft. only)	Watershed Land use upstream % of 90^o of watershed Score
1. Switzer Creek		**100**	**200**	**200**
2. Peterson Creek Douglas Island	X	**0**	**0**	**0**
3. Duck Creek		**300**	**300**	**300**
4. Jordan Creek		**300**	**300**	**300**
5. Fish Creek		**100**	**100**	**100**
6. Vanderbilt Creek		**300**	**300**	**300**
7. Montana Creek Upper Below	X	**0**	**0**	**50**
8. Montana Creek Lower #1		**100**	**100**	**200**
9. Montana Creek Lower #2 Below		**100**	**100**	**200**
10. Gold Creek		**300**	**300**	**300**
11. Indian River Above Dam		**0**	**0**	**100**
12. Starrigavan Creek		**300**	**300**	**300**
13. White River		**300**	**250**	**225**
14. Upper White River		**300**	**300**	**300**
15. Ward Creek		**200**	**200**	**75**
16. Tennis Shoe Creek	X	**0**	**100**	**99**
17. Spasski Creek		**300**	**300**	**300**
18. Gartina Creek		**300**	**300**	**225**
19. Cowee Creek	X	**0**	**0**	**0**
20. Peterson Creek	X	**0**	**0**	**0**
21. Peterson Creek Trib. 26	X	**0**	**0**	**0**
22. Peterson Creek Trib. 53	X	**0**	**0**	**0**
23. Fish Creek Above Bridge	X	**0**	**0**	**0**
24. Lake Creek	X	**0**	**50**	**0**
25. Salmon Creek		**200**	**250**	**150**
26. South Bridget Cove	X	**0**	**100**	**0**
27. Fish Cr. Below Bridge		**100**	**200**	**200**
28. Gold Cr. Above Bridge		**100**	**100**	**100**
29. Montana Cr. Above rdg.		**100**	**100**	**100**
30. Maginnis Creek	X	**0**	**0**	**0**
31. Pt. Graham River		**0**	**100**	**100**
32. Pt. Graham Tributary		**0**	**100**	**100**
33. English Bay River		**0**	**100**	**100**

2. Hydrology (Vsubin, Vsubout, Valthydro)

Disturbance Ranking	Reference Site Number	Surface Water In	Subsurface Water Flow	Alteration of Hydrology
1 Most Disturbed.	3	0	Cont.	Y
	10	0	0	N
		0/0 = 0	0	Y = 50% N = 50%
2	12	1	2	Y
	18	0	0	Y
	27	0	0	N
	4	2		Y
	6	4		Y
	8	0	0	Y
		7/8 = 0.88	0.5	Y = 83% N = 17%
3	13	0	0	Y
	15	1	1	Y
	17	1	1	Y
	9	1	0	Y
		¾ = .75	2/4 = 0.5	Y = 100% N = 0%
4	1	1	2	Y
	11	1	2	N
	14	4	0	Y
	23	-	-	N
	36	0	0	-
	37	0	0	Y
	42	0	0	N
		6/6 = 1.0	4/6 = .67	Y = 50% N = 50%
5 Least Disturbed	16	1	3	N
	19	0	0	N
	2	0	0	n
	20	0	1	n
	21	-	-	n
	24	0	0	n
	26	3	2	y
	5	0	1	n
	7	1	0	n
		5/8 = .62	7/8 = .88	Y = 11% N = 89%

3. Vegetation (Vvegcov)

Disturb. Ranking 1=Most 5=Least	Site #	VMoss	Vshrub	Vtree Cov.	VHerb	Small Trees/ Sapling	Adj VVeg Cov.	Total VVeg Cov.
1	10	0	15	8	27	12	62	62
1	3	NA	21	30	14	48	141	113
AVERAGE							**102**	**88**
2	12	NA	20	-	16	-	90	36
2	18	10	43	-	62	-	192	115
2	25	-	-	-	-	-	-	-
2	27	48	63	85	NA	63	324	259
2	4	NA	22	21	76	16	169	135
2	6	NA	4	13	61	21	124	99
2	8	NA	20	45	62	42	211	169
AVERAGE							**185**	**136**
3	13	63	62	-	37	-	270	162
3	15	24	24	-	20	-	113	68
3	17	12	10	-	98	-	200	120
3	28	10	10	85	86	0	191	191
3	29	-	-	63	-	-	315	63
3	9	NA	63	38	60	20	226	151
AVERAGE							**219**	**126**
4	1	NA	62	63	70	12	259	207
4	11	NA	20	-	20	-	100	40
4	14	7	59	-	20	-	143	86
4	23	NA	NA	63	2	2	112	67
4	36	10	NA	63	6	20	124	99
4	37	63	20	38	24	4	149	149
4	42	98	63	85	122	10	378	378
AVERAGE							**181**	**147**
5	16	48	16	-	50	-	190	114
5	19	7	63	-	16	-	143	86
5	2	NA	42	38	114	20	268	214
5	20	24	51	-	16	-	152	91
5	21	10	10	63	10	37	130	130
5	22	86	NA	63	NA	10	265	159
5	24	48	63	63	82	-	320	256
5	26	48	63	85	16	3	215	215
5	5	NA	64	28	82	7	226	181
5	7	20	62	38	158	7	285	285
5	30	38	38	63	72	-	276	221
AVERAGE							**225**	**177**

4.Vegetation (Vcwslope) and other veg. data array.

Reference Site Number	Disturb. Ranking 1=most 2=least	Shrubs & Deciduous	Ground Cover (Forbs, ferns, Mosses, Lichens)	Trees Conifer	Slope Coarse Wood	% Shrub Cover
10	1	0	3.0		0	15
3	1	NA	5		0	21
Average		0	**4.**			18
12	2	NA	25		0	20.5
18	2		38	10	0	43
25	2	-	10		32	-
27	2		95	48	34	63
4	2	NA	20.5		0	22
6	2	NA	10.5		0	4.5
8	2	NA	10.5	29	0	20.5
Average			**29.9**			28.9
13	3		85	63	0	62
15	3		72	24	0	24
17	3		118	12		10.5
28	3	10.5	30			10.5
29	3		58		20	
9	3	NA	30			63
Average		10.5	**45 (w/o #17)**	33		34.0
1	4	NA	38		10.5	62
11	4	NA	25		0	205
14	4		48	7	0	59.2
23	4	NA	96		12	NA
36	4		38	10.5		NA
37	4		60	63		20.5
42	4		50	98		63
Average		44.6	**60.0**			45
16	5		96	48		15.5
19	5		30	7		63
2	5	NA	85		-	425
20	5		58	24		51
21	5	10.5	10.5		20	10.5
22	5	85.5	85			NA
24	5	48	110.5		12	63
26	5	48	110.5		16	63
5	5	NA	85.5		-	64
7	5		85.5	20	8	62
30	5	38	110.5		19	38
Average		45.9	**78.5**	24.8		47.2

5. Tree Basal (Vtreeba) and percent tree cover.

Reference Site Numbers	Disturb. Ranking	% Tree Cover	Tree Basal Area (Treeba)
Gold Creek 10	1	8	20
Duck Creek 3	1	30	87
Average		19	54
12	2	-	110
18	2	-	56
25	2	-	-
27	2	85	-
Jordan Creek 4	2	21	128
Vanderbilt Creek 6	2	13	107
8	2	45	150
Average		41	110
13	3	-	502
Ward Creek 15	3	-	166
17	3	-	2
28	3	85	-
29	3	63	-
9	3	38	10
Average		41	110
1	4	63	120
Indian River 11	4	-	725
14	4	-	458
23	4	63	-
36	4	63	165
37	4	38	120
42	4	85	75
Average		62	277
16	5	-	62
19	5	-	116
2	5	38	130
20	5	-	244
21	5	63	-
22	5	63	-
24	5	63	-
26	5	85	
Fish Creek 5	5	28	277
Upper Montana 7	5	38	173
30	5	63	-
Average		55	179

6. Potential Course Wood (Vcwpot)

Site Name and Number	Disturb. Ranking 1=most 5=least	Bank Source of Coarse Woody Debris Section 1	Bank Source of Coarse Woody Debris Section 2	Total Coarse Woody Debris Bank Source Sec. 1& 2.
Gold Creek - 10	1	0	0	0
Duck Creek - 3	1	23	4	27
Average		**11.5**	**2.0**	**13.5**
Starrigavan Creek - 12	2	18	19	37
Gartina Creek - 18	2	3	2	5
Salmon Creek - 25	2	13	7	20
Fish Cr. Below Bridge - 27	2	6	8	14
Jordan Creek - 4	2	1	2	3
Vanderbilt Creek - 6	2	10	5	16
Montana Creek Lower #1 - 8	2	1	5	6
Average		**7.4**	**6.9**	**14.4**
White River - 13	3	0	1	1
Ward Creek - 15	3	4	7	11
Spasski Creek - 17	3	1	2	3
Gold Creek Above Bridge - 28	3			
Montana Creek Above Bridge - 29	3	9	12	21
Montana Creek Lower #2 - 9	3	3	1	4
Average		**3.4**	**4.6**	**8.0**
Switzer Creek - 1	4	1	2	3
Indian River Above Dam - 11	4	14	19	33
Upper White River - 14	4	11	2	13
Fish Creek Above Bridge - 23	4	10	12	22
Port Graham River - 36	4	7	4	11
Port Graham River Trib. - 37	4		6	6
English Bay River - 42	4			
Average		**8.6**	**7.5**	**14.7**
Tennis Shoe Creek - 16	5	1	4	5
Cowee Creek - 19	5	18	16	32
Peterson Cr., Douglas Island - 2	5	8	0	8
Peterson Creek - 20	5	6	14	20
Peterson Creek Trib. (# 26) - 21	5	6	13	19
Peterson Creek Trib. (# 53) - 22	5	7	15	22
Lake Creek - 24	5	13	14	28
South Bridget Cove - 26	5	6	5	11
Fish Creek - 5	5	9	3	12
Montana Cr.Up.Below Ft. Bridge - 7	5	8	2	10
Maginnis Creek - 30	5	15	18	33
Average		**8.8**	**9.5**	**18.2**

7. Pebble Count Array Sheet and Graph (Vpebble-D50 &Vchanrough (D84))

SITE #	Dist.Rank.	D50	D84
3	1	49.83	106.63
10	1		
4	2	4.76	17.63
6	2	8.96	26.67
8	2	21.71	44.63
12	2	30.5	56.28
18	2	23.48	76.29
25	2	50.11	101.73
27	2	38.74	88.59
		25.46571	58.83143
		15.95883	31.54565
9	3	16.56	29.7
13	3	9.85	36.62
15	3	46.13	83.43
17	3	30.5	59.98
28	3	38.24	72.39
29	3	24.37	61.24
		27.60833	57.22667
		13.5082	20.60379

8. Hydrologic Data (Vfreq,Vbarriers, and associated data)

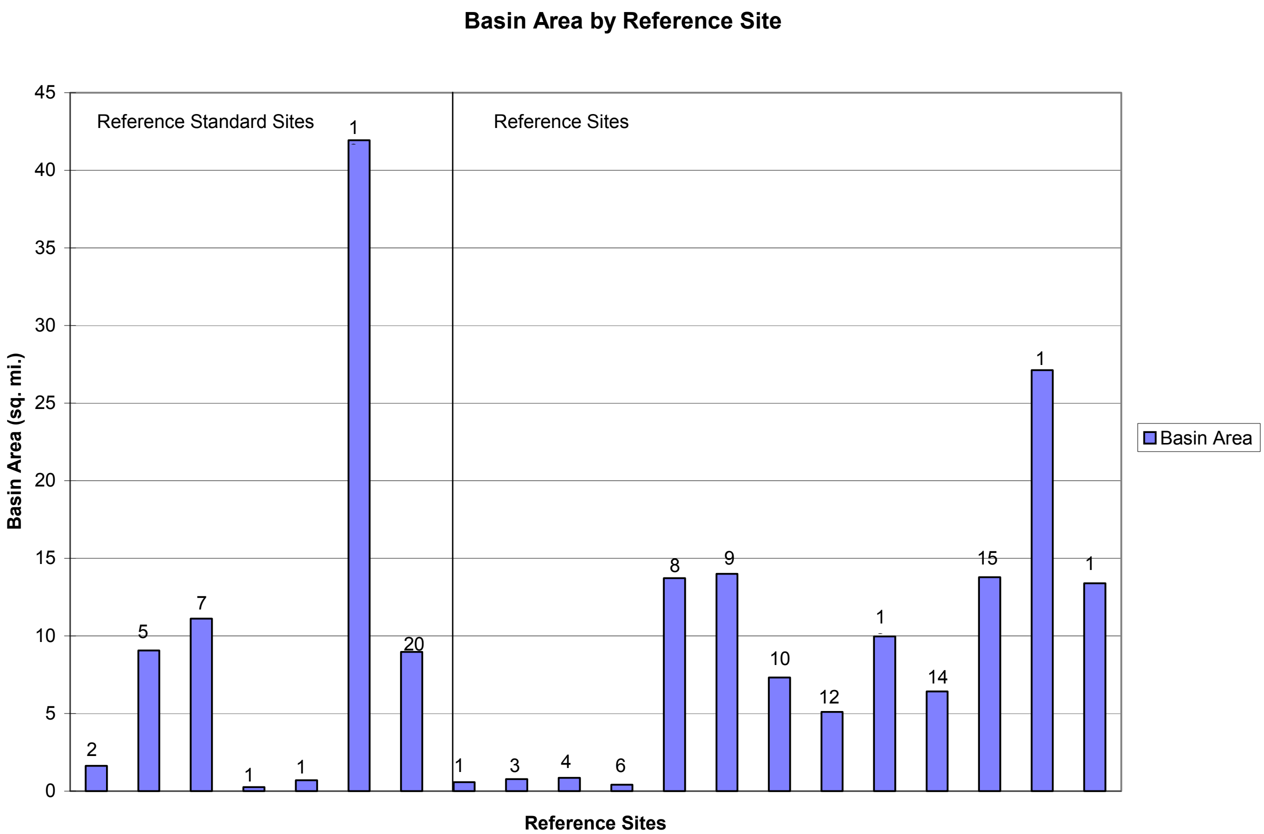
Site #	Ranking	Additions or Diversions of Flow to Assessment Area	Bankfull Width to Depth Ratio	Bankfull Cross-Sectional Area	Flood Prone Area Width	Presence of Artificial Levees	Ave. Water Surface Slope
10	1	1	7	63.0	21	1	0.010
3	1	1	24	13.0	45	1	0.009
Average			**15.5**	**38.0**	**33.0**		**0.010**
12	2	1	25.3	57.0	47	0	0.009
18	2	1	98	62.4	95	1	0.001
25	2	1		111.7	139	1	0.050
27	2	0				0	
4	2	1	22	26.5	59	1	0.002
6	2	1	4	6.3	5	1	0.001
8	2	1	25	166.0	68	1	0.001
Average			**34.9**	**71.6**	**68.8**		**0.0**
13	3	1	13	462.0	85	0	0.011
15	3	1	32	114.0	74	0	0.003
17	3	1	33	161.0	150	0	0.003
28	3		31.67	45.6	72	0	0.280
29	3						
9	3	1	13	180.0	54	0	0.005
Average			**24.5**	**192.5**	**87.0**		**0.1**
1	4	1	11	9.3	15	0	0.004
11	4	0	24	213.0	150	0	0.008
14	4	1	75	42.0	200	0	0.002
23	4	0	20.9	61.4	55	0	1.800
36	4				1059	1	
37	4	1			333		
42	4	0			96	0	2.200
Average			**32.7**	**81.4**	**272.6**		**0.8**
16	5	0	47	92.0	150	0	0.017
19	5	0	18	469.0	150	0	0.002
2	5	0	9	33.3	18	0	0.009
20	5	0	34	67.0	150	0	0.009
21	5	0	3.5	6.3	7	0	2.500
22	5	0	16.7	4.7	12.5	0	1.900
24	5	0	14.06	112.5	69.6	0	1.800
26	5	1	5.86	32.5	85	0	1.050
5	5	0	14	23.5	24	0	0.045
7	5	0	28	149.5	78	0	0.022
30	5						
Average			**19.0**	**99.0**	**74.4**		**0.7**

9. Hydrologic Data (Vlogjams, Vdecomp, and additional data)

Site Number	Disturb. Ranking	Average Water Surface Slope	Ave. Channel Bed Slope (Thalweg)	Maximum Bedload Size	# ofCWD Jams per Site	# of CWD Decomp. Classes Downstream
10	1	0.010	0.010	6		0
3	1	0.009	0.011	2		2
Average		**0.010**	**0.010**			**1.00**
12	2	0.009	0.012	1		2
18	2	0.001	0.001	1		0
25	2	0.050	1.050	0	0	
27	2				0	
4	2	0.002	0.004	2		4
6	2	0.001	0.001	2		0
8	2	0.001	0.001	2		2
Average		**0.0**	**0.2**		**0.0**	**1.5**
13	3	0.011	0.013	1		0
15	3	0.003	0.001	1		1
17	3	0.003	0.005	1		0
28	3	0.280	1.540	0	0	
29	3				2	1
9	3	0.005	0.008	2		3
Average		**0.1**	**0.3**		**1.0**	**1.0**
1	4	0.004	0.014	2		4
11	4	0.008	0.010	0		4
14	4	0.002	0.004	1		0
23	4	1.800	2.300	1	0	
36	4			1	0	2
37	4			1	3	
42	4	2.200	1.500	0	1	
Average		**0.8**	**0.8**		**1.0**	**2.5**
16	5	0.017	0.021	0		2
19	5	0.002	0.003	0		0
2	5	0.009	0.005	2		3
20	5	0.009	0.011	1		2
21	5	2.500	2.500	2	0	3
22	5	1.900	2.000	1		2
24	5	1.800	1.800	0	4	2
26	5	1.050	1.100		0	2
5	5	0.045	0.043	0		2
7	5	0.022	0.029	0		4
30	5				2	1
Average		**0.7**	**0.8**		**1.5**	**2.1**

10. Vegetation (Vshade data)

Site Number	Disturb. Ranking	Ave. % of Deciduous Tree Cover Above Bankfull	Ave. % of Deciduous Shrub Cover Above Bankfull	Ave. Dist. of Overhanging Vegetation Above Bankfull	Ave. % Tree and Shrub Cover Below Bankfull	Ave. % of Deciduous Tree Cover Below Bankfull	Ave. % of Deciduous Shrub Cover Below Bankfull
10	1	13	7	17.0	17	4	13
3	1	97	3	94.3	91	87	10
Average		**54.6**	**5.0**	**55.6**	**53.6**	**45.6**	**11.6**
12	2	83	44	69.3	60	45	24
18	2	36	20	57.5	25	8	2
25	2	16	16	63.0		38	38
27	2	16	1	85.5		16	1
4	2	41	40	52.8	72	29	9
6	2	30	4	63.5	76	61	11
8	2	56	44	86.0	65	25	27
Average		**39.4**	**23.8**	**68.2**	**59.4**	**31.4**	**15.8**
13	3	1	48	36.0	25	1	7
15	3	9	54	86.0	68	16	7
17	3	17	97	96.8	12	8	2
28	3	63	16	63.0		38	16
29	3	63	63	38.0		1	3
9	3	46	44	82.3	60	22	15
Average		**33.1**	**53.7**	**67.0**	**41.1**	**14.3**	**8.1**
1	4	2	79	92.0	91	1	81
11	4	13	54	95.5	90	30	35
14	4	28	81	79.0	47	13	15
23	4	3	86			16	3
36	4	1	38	0.5		1	86
37	4	38	63	0.5		16	68
42	4	0	38	15.5	38	1	38
Average		**12.0**	**62.6**	**47.2**	**66.3**	**10.8**	**46.5**
16	5	32	46	43.0	37	10	12
19	5	55	74	81.3	55	45	22
2	5	19	16	93.0	84	21	10
20	5	72	72	85.8	73	69	3
21	5						
22	5	79	16		44	41	
24	5	16	63			16	3
26	5	16	38	85.5		3	38
5	5	1	62	76.8	60	1	4
7	5	4	62	63.8	25	2	15
30	5	16	38	38.0		1	3
Average		**30.7**	**48.6**	**70.9**	**53.8**	**20.7**	**12.1**



Hydrologic Graphics - Basin Area by Reference Site

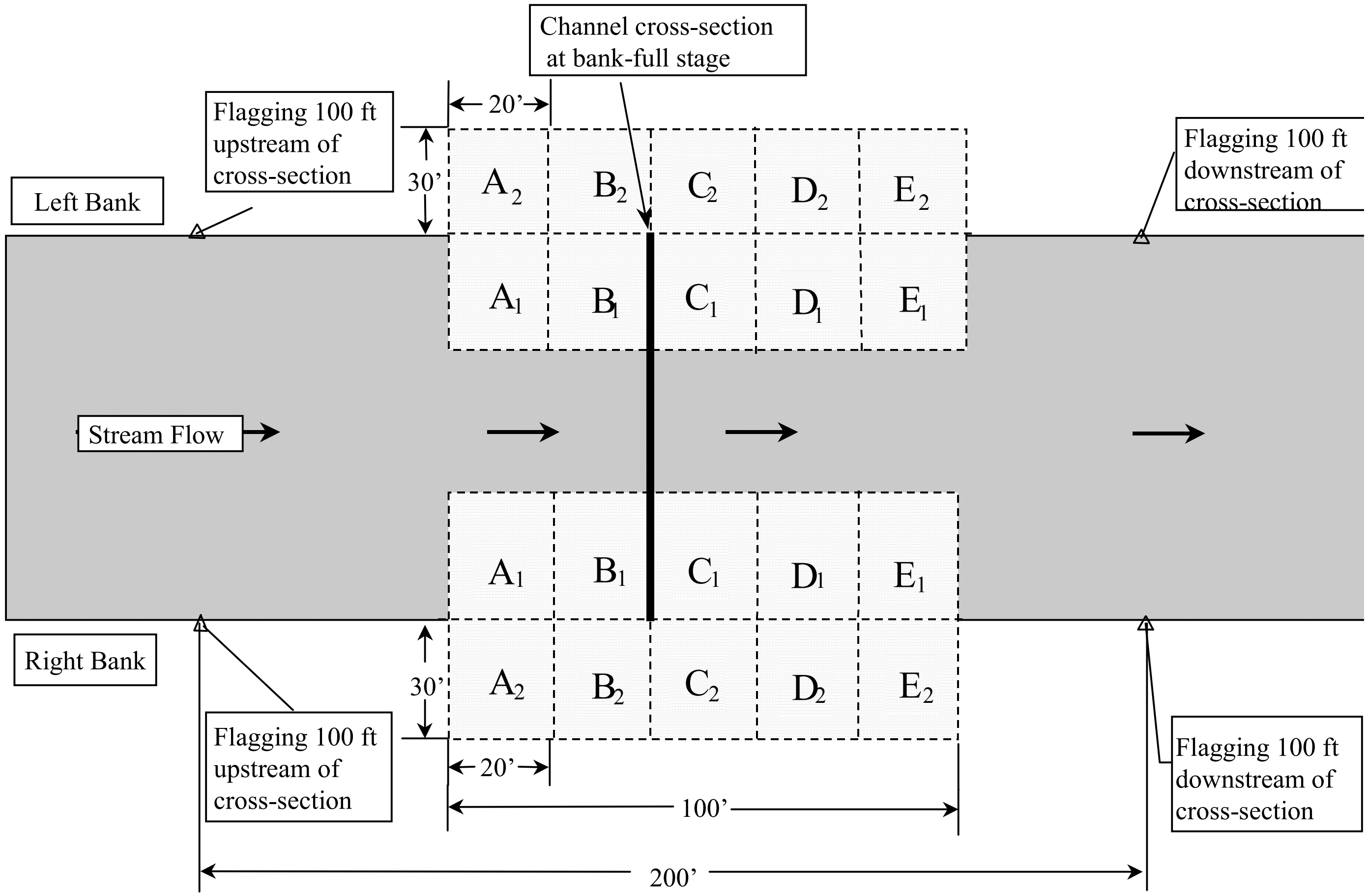


*Figure Not to Scale

Figure 9. **Channel Transect Sampling Plots**

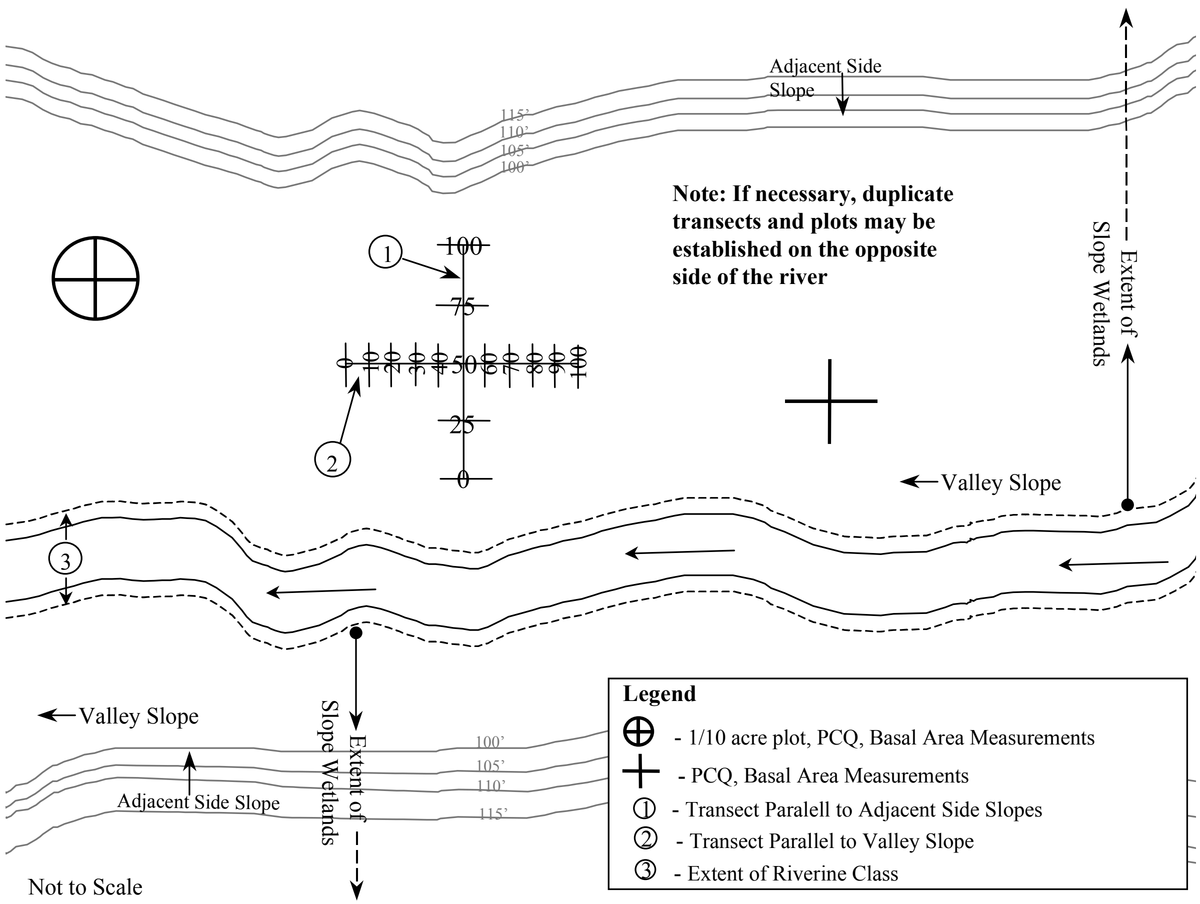


Figure 10. **Location of Sampling Transect and Plots**

Appendix 4 Guidebook Development

A group of local and national experts are collectively referred to in this guidebook as the "Development Team." The Development Team prepared this guidebook in accordance with COE guidelines as outlined at the end of this Appendix. The members of the Development Team are listed below and the steps that were followed to prepare the guidebook.

Development Team Members

Group	Group Members and Affiliation	
Field Assessment Group	Jim Powell, Team Leader (ADEC) Terry Brock (Formally USDA/U. S. Forest Service) Bruce Bigelow (USGS) Peter Huberth (Forestry Consulting) Mark Anderson (Formally ADEC) Rick Noll (Formally, ADNR)	Ralph Thompson (Formally COE) Dave D'Amore (USFS/PNW) Janet Schempf (ADF&G) Anne Leggett, (HDR Alaska) Beth Potter (formally ADEC)
NWSTC "National Group"	Mark Brinson Lyndon Lee	Wade Nutter Dennis Whigham, Garry Hollands
NWSTC "Technical Group"	Kevin Featherston Mark Rains	Jeff Mason Bill Kleindl

Personnel who contributed to the development of the Guidebook

Agency Personnel	Carl Schrader (Formally ADEC) K. Koski (NMFS)	Kevin Brownlee (ADF&G) Steve Wright (ADEC)
Clerical Assistance	Amanda Thompson (ADEC)	Tina St. Clair (ADEC) Leslie Floresca (ADEC)
Technical Assistance	Chris Kent (ADEC)	

Steps Completed by Development Team. The Development Team has completed Steps 1 - 10. Within the next year, the Development Team plans to complete Step 11. These Steps are outlined at the end of this Appendix.

Step 1. Organize Development Team

In the spring of 1996 DEC, the Development Team Leader, and NWSTC held organizational meetings to identify local wetland experts, organize HGM training and began gathering wetland information on southeast and Southcentral Alaska. The Development Team consisted of 20 national and local experts, representing agencies, non-governmental organizations, and the private sector. The training was held in May 1996 for Development Team members and was offered by the NWSTC.

Step 2. Select and Characterize Wetland Subclasses

With assistance from the NWSTC and after extensive among the development team members the Riverine subclass was identified and slope subclass was selected for coastal southeast and Southcentral Alaska. Prior to initiating fieldwork, the Development Team assembled information about the landscape within the reference domain. Topographic and geologic maps, soil surveys, National Wetland Inventory (NWI) maps, aerial photographs, species lists, climatic data, and historical information were analyzed. Members of the Development Team also identified potential reference sites and reference standard sites and developed initial

Step 3. Field Verify Subclasses and Develop First Approximation Assessment Models

The Development Team, with assistance from NWSTC, developed an initial subclass definition for the Riverine subclass and Slope River Proximal and first approximation models and functions. These initial definitions and approximations were based on national guidebook information and local expert best professional judgement.

Step 4. Collect Field Data and Information for Reference System.

The data collection effort in the HGM process is designed to include quantitative and qualitative measurements that will enable the Development Team to develop a reproducible description of a HGM subclass. Field and office data collected in the HGM process are used for (1) subclass profile descriptions, (2) model development and calibration, and (3) restoration design criteria. For example, riverine forest structure and composition is measured in the field using a number of different techniques (e.g., point center quarter method). Species composition, stem density and basal area data are then used (1) as descriptors of forest structure in the riverine subclass forest profile, (2) to scale variables in the HGM model (e.g., Vcwin, and Vtreeba), and (3) as data that is available for restoration design targets (e.g., number of stems per acre of hemlock and spruce at forest age 2, 5, and 10 years). Initial design of the data collection should include techniques for collecting data for all subclass profile descriptions, model development, and specific criteria for restoration design.

<u>Riverine Site Data and Information</u> (Task 1 and 2) Data and information were collected for a total of 33 sites for the riverine wetland subclass in coastal southeast and Southcentral Alaska. Site investigation for the first 20 riverine wetland sites were conducted during the summer and fall of 1996. Data and information was collected from an additional 13 sites during 1997 and 1998. Three of the 13 sites were located on the Kenai Peninsula, near the communities of Port Graham and Nanwalik. The sites near Port Graham and Nanwalik represent the northern most bounds of the reference domain.

The sites represented the range in variation of wetland functions from undisturbed to highly degraded. Of the 33 riverine sites sampled, 10 were considered “reference standard” sites by the Development Team.

Slope River Proximal Site Data and Information (Task 1) During 1997 and 1998 data and information was collected on 15 sites for the slope river proximal wetland subclass. Twelve of these sites are located in and around Juneau. The other three sites are located near the communities of Port Graham and Nanwalik. The authors intend to collect data from 15 additional sites before developing final conclusions regarding the slope river proximal subclass model. However, considering that wetland functions for the riverine and slope river proximal subclasses are highly interrelated, the authors offer a preliminary model for the slope river proximal wetland subclass. For the purposes of this Peer Review Draft the preliminary models and determinations are offered in an effort to obtain comments and review.

Copies of the completed field data sheets are on file at ADEC/Division of Air and Water Quality/Wetlands Program.

Step 5. Analysis Reference Site Data

Analysis of reference site data was conducted during three different time frames. The first analysis was conducted in the fall of 1996 for the information and data from the initial 20 sites. This analysis is contained in Chapter 3. Second, during the 1997 and 1998 field seasons additional site information and data was collected and array sheets were developed based on the total number (33) sites. Thirdly, the Alaska Natural Heritage Program conducts an ordination and analysis on the 33 sites. This analysis was conducted for data collected for riverine and slope river proximal reference sites. The final analysis presented in this document was conducted by the University of Alaska Southeast. Below is a summary of the steps that were taken to do the analysis.

Following standard quality assurance and quality control steps, the Development Team analyzed field data from the reference sites. The team first sorted all sampled sites into "reference standard" and "non reference standard" categories. Following this initial split, sites were grouped into five groups according to overall degradation.

Sorting of sites as described above allowed relatively fast characterizations of the reference system data. When possible, and to facilitate the variable scaling effort, qualitative data were converted to numeric values. Other qualitative data were used to classify reference sites by reference class (*i.e.,* reference site or reference standard site), land use, and other appropriate characteristics.

An analysis of the riverine data was conducted by NWSTC in September 1996. This analysis included a multivariate analyses of some of the reference system data. Using vegetation data, detrended correspondence analysis (DCA) was used to ordinate sampled sites (Hill 1979; Hill and Gauch 1980; ter Braak 1987; Jongman *et al.* 1987). The authors emphasize that DCA was not necessarily used to scale vegetation variables. Rather, the NWSTC found ordination approaches to be useful tools that facilitated our understanding of how altered sites and reference standard sites differed in terms of measured (e.g., vegetation community) traits.

Additionally the Development Team used several approaches to examine quantitative data in an attempt to determine trends. Standard statistical analyses were used to find ranges of values, means and standard deviations. (Zar 1984). Variable scaling based on quantitative field data included in the reference system generally used data ranges, means, and standard deviations as the "statistical" inputs. More advanced parametric or non-parametric methods were usually not needed or were not practicable, given low sample sizes for each community type.

The riverine model provided in this document is based on the analysis of the initial 20 sites and data array sheets developed for the additional 13 sites. The authors used these graphical and tabular summaries in their attempts to understand trends in the data and to offer assistance to users of the guidebook. Some of these graphic summaries can provide a basis for development of restoration project targets and standards for wetlands within the subclass.

Step 6. Scale HGM Model Variables

After field sampling, analysis of the initial 20 sites and data array sheets and reference system information the Development Team reviewed and attempted to refine aspects of the first draft guidebook published in September 1996. Following analyses of the reference system data as described above and in Chapter 3, the team verified that certain variables in the first approximation models could be scaled using reference system data and used successfully to develop models of ecosystem functions. During this process, some variables contained in the September 1996 Draft guidebook were discarded because they were no longer applicable.

The additional 13 riverine sites and 15 slope river proximal sites were analyzed in 2002 and 2003. New variables were added as necessary. Often, new variables were either (a) variables published in other HGM guidebooks, or (b) chosen because of particular patterns observed in reference system data gathered for the subclass. Following the model refinement efforts explained above, all variables were scaled by members of the team using reference system data combined with best scientific judgment.

Step 7. Field Test Draft Models, Functions and Variables.

Riverine: After the Development Team finished collecting data from 33 riverine sites the models contained in the September 1996 Draft Guidebook was field tested during the 1999 field season. During 1999, the authors of this document field-tested the model several times. The model was also field tested during April and May of 2000. The most recent revisions to the Draft Model were conducted on June 19, 2000 and 2001 by the Development Team. The most recent revisions are contained in Chapter 4 of this document.

Slope River Proximal**:** During 1998 and 1999 the Development Team conducted fieldwork testing on the slope river proximal wetland draft model contained in the

September 1996 Draft Guidebook. In June 19 and 20, 2000 the Development Team field-tested and decided on a preliminary draft model and functions for Slope River Proximal.

Step 8. Revised Draft Model and Guidebook. During 2000 – 2002 the development team revised the second draft and agreed to the final models, which are included in this guidebook.

Step 9. Peer Review of Draft Guidebook The models in this guidebook have been peer reviewed by local wetland experts and are expected to be further refined after the publication of this guidebook.

Additional, on June 25, 2003 three of the authors and other local experts conducted training on the Field Guide portion of the Operational Draft Guidebook. The authors received several suggestions that were incorporated into the Operational Draft Guidebook and Field Guide.

Steps Used by the Development Team to Develop this Guidebook

Steps	Date Completed
Step 1. Organize Development Team Task 1. Identify Development Team Members Task 2. Train Development Team Members in HGM classification & Assessment Techniques	June 1996
Step 2. Selected and Characterize Wetland Subclasses	June 1996
Step 3. Field Verify Subclasses & Develop the Initial Assessment Models Task 1. Field Verify Riverine Slope River Proximal Subclasses Task 2. Define Riverine Initial Functions, Variables, & Field Indicators Task 3. Development of the Reference System Task 4. Refine Riverine Model Task 5. Develop Initial Slope River Proximal Model	June 1996
Step 4. Collect Field Data and Information for Reference System Riverine Subclass Task 1. Collect Data in Juneau and Southeast AK. (20 sites) Task 2. Collect Data: Juneau (10 sites), Pt. Graham & Nanwalik (3) Slope River Proximal Subclass Task 1. Collect Data in Juneau (15 sites)	 October 1996 Nov. 1997 Nov. 1998
Step 5. Analyze Reference Site Data Riverine Subclass Task 1. First Analysis of initial Riverine Data (20 sites) Task 2. Array sheets developed from second analysis based on (33 sites) Slope River Proximal Subclass Task 1. First Analysis of initial Slope River Proximal (15 sites) Task 2. Array Sheets developed from initial 15 sites	 October 1996 Nov. 1999 Oct. 2000 Oct. 2000
Step 6. Scale HGM Model Variables Riverine Subclass Task 1. Initial Scaling of 20 sites Task 2. Revise scaling to include an additional 13 sites Slope River Proximal Subclass Task 1. Initial scaling Task 2. Revisions	 Oct. 1996 Nov. 1999 Oct. 2000 Oct. 2001
Step 7. Field Test Draft Model, Functions, and Variables	Nov. 2002
Step 8. Revised Draft Model and Guidebook	Dec. 2002
Step 9. Peer Review of Draft Guidebook	May 2003
Step 10. Publish Draft Operational Guidebook	June 2003
Step 11. Implement Draft Operational Guidebook Task 1. Distribute to users Task 2. Train users Task 3. Provide assistance to users	June 2003
Step 12. Review and Revise Draft Model Guidebook	To be Initiated

COE Steps for Developing HGM Models and HGM Guidebooks (Federal Register, August 16, 1997)

STEP			STATUS*
Phase I.	**Organization of Regional or (Development) Assessment Team**		
	A.	Identify Development Team Members	C
	B.	Train Member in HGM Classification and Assessment	C
Phase II.	**Identification of Wetland Assessment Needs**		
	A.	Identify Wetland Subclasses	C
	B.	Prioritize Wetland Subclasses	C
	C.	Define Reference Domains	C
	D.	Initiate Literature Review	C
Phase III.	**Draft Model Development**		
	A.	Review Existing Models of Wetland Functions	C
	B.	Identify Reference Wetland Sites	C
	C.	Identify Functions for each Subclass	C
	D.	Identify Variables and Measures	C
	E.	Develop Functional Indices	C
Phase IV.	**Draft Regional Wetland Model Review**		
	A.	Obtain Peer-Review of Draft Model	C
	B.	Conduct Interagency and Interdisciplinary workshop to critique model	I
	C.	Revise Model to Reflect Recommendations From Peer-Review and Workshop	C
	D.	Obtain Second Peer-Review of Draft Model	C
Phase V.	**Model Calibration**		
	A.	Collect Data From Reference Wetland Sites	C
	B.	Calibrate Functional Indices Using Reference Wetland Data	C
	C.	Field Test Accuracy and Sensitivity of Functional Indices	C
Phase VI.	**Draft Model Guidebook Publication**		
	A.	Develop Draft Model Guidebook	C
	B.	Obtain Peer-Review of Guidebook	C
	C.	Publish as Operational Draft Regional Wetland HGM Functional Assessment Guidebook to be Used in the Field	C
Phase VII.	**Implement Draft Model Guidebook**		
	A.	Identify Users of HGM Functional Assessment	On-going
	B.	Train Users in HGM Classification and Evaluation	On-going
	C.	Provide Assistance to Users	On-going
Phase VIII.	**Review and Revise Draft Model Guidebook**		TBI

Key (Status): C = Completed; I = In process; TBI = To Be Initiated

APPENDIX 5 HGM Interagency MOU

HGM INTERAGENCY MOU
State and Federal Interagency
MEMORANDUM OF UNDERSTANDING
MARCH, 2000

BETWEEN THE

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION (ADEC)

ALASKA DEPARTMENT OF FISH AND GAME (ADF&G)

ALASKA DEPARTMENT OF NATURAL RESOURCES (ADNR)

ALASKA DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES (ADT&PF)

U.S. DEPARTMENT OF INTERIOR; U.S. FISH AND WILDLIFE SERVICE (USFWS)
AND
U.S. GEOLOGICAL SURVEY (USGS)

U.S. ARMY CORPS OF ENGINEERS, ALASKA DISTRICT (COE)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

U.S. DEPARTMENT OF AGRICULTURE; NATURAL RESOURCE CONSERVATION SERVICE (NRCS),
U.S. FOREST SERVICE, ALASKA REGIONAL OFFICE (USFS)
AND

U.S. DEPARTMENT OF TRANSPORTATION; FEDERAL HIGHWAY ADMINSTRATION (FHWA)

CONCERNING

THE DEVELOPMENT OF A WETLAND FUNCTIONAL ASSESSMENT METHOD AND GUIDEBOOKS:
The Hydrogeomorphic Approach (HGM)

A. PURPOSE:

This Memorandum of Understanding (MOU) establishes a cooperative approach among federal and state agencies to improve wetland management and regulatory decision-making in Alaska. Each signatory agency desires to cooperate and develop a scientifically based wetland functional assessment method. To accomplish this task the signatory agencies have initiated an interagency effort to develop hydrogeomorphic methodology (hereafter "HGM"), a functional assessment tool for wetlands. HGM is a rapid assessment tool that is tailored to specific geographic regions and classes of wetlands (See *Smith, D. R., Ammann, A., Bartoldus, C. and Brinson, M. An Approach for Assessing Wetland Functions using Hydrogeomorphic Classification, Reference Wetlands, and Functional Indices," Technical Report WRP-DE-9, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. NTIS No. AD A307 121. (1995).*

The Alaska HGM Management Team, Statewide Technical Oversight Team, and Guidebook Development Teams, as explained by this MOU are currently developing HGM Guidebooks (hereafter "Guidebook") for areas of the state where resource development activities are planned or under way. Through these efforts the state will improve the understanding of Alaska's wetland functions and have an assessment tool for improving our management of wetlands.

The signatory agencies intend to use each Guidebook after each has been reviewed by the signatory agencies and the U.S. Army Corps of Engineers, Waterways Experiment Station. (COE/WES). It is understood that when a functional assessment is being performed in support of wetland permitting, planning, and management the Guidebook appropriate to the subject wetland system will be used.

B. AUTHORITY:

This Memorandum of Understanding is entered into under the following laws and agency authorities:

Agency Authorities	
ADNR:	AS 38.05.020
ADEC:	AS 46.03.020
ADF&G:	AS 16.05.050, AS 16.05, AS 16.20, 16 U.S.C. 661 et. seq.
ADT&PF:	AS 44.42.020
COE & EPA:	Clean Water Act (33 USC 1251), Executive Order 11990
NRCS:	Food, Agriculture, Conservation and Trade Act of 1990 Public Law 101-624 (104 Stat. 3584; 16 U.S.C. 3837)
USFWS:	Fish and Wildlife Coordination Act (P.L. 85-624; 72 Stat. 563)
USFS:	Economy Act of June 30, 1932, as amended (31 U.S.C) Fish and Wildlife Coordination Act of March 10, 1934, as amded, 16 U.S.C. 661 Executive Order 11990, (42 Fed. Reg. 26961 1977)
USGS:	Economy Act of June 30, 1932, as amended, Section 601, (31 U.S.C 1535) Public Law 99-591

FHWA: Executive Order 11990

General Authorities
Intergovernmental Cooperation Act of 1968 (P.L. 90-577; 82 Stat. 1102)

C. BENEFITS TO EACH PARTICIPANT:

This agreement commits the signatory agencies to cooperatively develop a common scientific platform using the HGM Approach and HGM Guidebooks to assess wetland functions. The HGM Approach provides agencies, private sector, and the public with a way to classify wetlands and to assess wetlands based on local characteristics. The HGM Guidebooks provide a rapid assessment tool that uses local site data and information to determine how wetlands function. This site data and information is intended to improve decisions made about wetlands.

The HGM Approach was designed to be used by federal resource and regulatory agencies, and the public when appropriate in the Clean Water Act Section 404 permitting and Section 401 Water Quality Standards Certifications. Wetland functional assessment procedures are required by the Natural Resource Conservation Service to conduct wetland minimal effect determinations in accordance with the 1985 Food Security Act, as amended. The Guidebooks are expected to be useful to local, state and federal agencies in watershed management and planning.

D. THREE INTERAGENCY/STAKEHOLDER TEAMS ESTABLISHED TO DEVELOP HGM APPROACH AND GUIDEBOOKS:

The Alaska Department of Environmental Conservation (ADEC) has initiated an interagency /stakeholder effort to develop the HGM Approach. Three teams: (1) The Alaska HGM Management Team, (2) HGM Statewide Technical Oversight Team, and (3) HGM Guidebook Development Teams have been established to develop the HGM Approach and HGM Guidebooks in Alaska.

HGM Management Team

This agreement establishes ADEC as the lead agency for coordinating the Alaska HGM Management Team. This team will provide overall policy and management direction and coordinate the development of the HGM Approach in Alaska. Specifically, this team will meet as necessary to review progress on providing training, data management, guidebook development and use. The members of the HGM Management Team are ADEC, ADF&G, ADNR, ADT&PF, EPA, NRCS, USFWS, COE, FHWA, USGS, USFS, and other agencies and stakeholders, as they become signatories to this MOU.

HGM Statewide Technical Oversight Team

This agreement establishes ADEC as the lead agency for coordinating this team. This team is to provide primarily technical advice and direction to the HGM Management Team on the HGM Approach and HGM Guidebook development. Specifically, this team will review HGM guidebooks for compliance and statewide consistency as well as organize, develop, and participate in HGM Training. The Statewide Technical Oversight Team (STOT) is also responsible for providing guidance and direction to both users of existing guidebooks and Guidebook Development Teams. The members of the HGM Statewide Technical Oversight Team are ADEC, ADF&G, NRCS, USFWS, COE, and EPA.

HGM Guidebook Development Teams

The purpose of each Guidebook Development Team is to develop guidebook(s) for HGM wetland classes or subclasses for a specific area. Each Guidebook Development Team is trained in the HGM Approach and is responsible for collecting field data, developing models, and authoring Guidebook(s). The teams will be open to broad representation consisting of public, private, and academic experts in disciplines such as hydrology, botany, soils, and habitat. The membership of each Guidebook Development Team will be unique for each Guidebook being developed.

E. DATA AND INFORMATION MANAGEMENT:

Data generated to support the development of Guidebooks will be stored at ADEC and will be accessible to agencies and the public. The Guidebooks will be available to the public at the ADEC and the COE/WES Internet web sites as they are developed. Hard copies will be made available by ADEC.

F. GUIDEBOOK DEVELOPMENT:

Alaska and a few other states are pioneering the development of HGM Guidebooks. ADEC, ADF&G, ADNR, ADOT&PF, EPA, NRCS, COE, USFS, USGS, USFWS and other interested organizations are participating in the development of Guidebooks in three regions in Alaska. The Guidebook Development Teams are developing the Guidebooks consistent with the procedures identified by the U.S. Corps of Engineers in the *National Action Plan to Develop the Hydrogeomorphic Approach for Assessing Wetlands Functions* (Federal Register: August 16, 1996 (Vol. 61, No. 160, Pages 42593-42603); Federal Register: June 20, 1997 (Vol. 62, No. 119, pages 33607-33620). Also, the Guidebooks are consistent with national guidance from the NRCS Director of Watersheds and Wetlands Division (August 21, 1996). Guidebooks contain the assessment model, supporting data sets, and assessment protocol for the user. The final product of the development phase is entitled: “Operational Draft Guidebook” (ODG).

In Alaska, Guidebooks are currently being developed where the majority of wetland permitting and planning activity occurs. A total of nine Guidebooks, within five areas, are anticipated through 2003. The list of areas, Guidebooks and anticipated completion dates for the Operational Draft Guidebooks follows:

Areas	Guidebooks (by wetland class)	Operational Draft Guidebook Estimated Completion
Currently being developed		
1. Interior	Flats	May 1999 (Completed)
2. Kenai River Watershed	Riverine	Spring 2001
	Slope	Spring 2002
3. Coastal Southeast and Southcentral	Riverine/River Proximal	Spring 2001
	Slope	Spring 2002
Anticipated		
4. Upper Cook Inlet	Riverine	2003
	Slope or Depression	2003
5. Arctic Coastal Plain	Flats	2003
	Slope or Depression	2003
	Total 9 Guidebooks	

G.Implementation:

The HGM Guidebooks are not intended to replace other analysis such as jurisdictional delineation, the Habitat Evaluation Procedure (HEP), threatened and endangered species database and/or field reviews, and others. Rather, HGM is a tool that can be used in conjunction with other data and/or assessment methodologies.

1) Operational Draft Guidebook Use

Consistent with the COE, EPA, NRCS, FHWA, FWS, and NMF Final National Action Plan (Federal Register Vol. 61, No. 160/Friday, August 16, 1996) each ODG will be distributed for a two-year period to be used by regulatory and resource agencies. The ODGs will be published by the ADEC. After each of the ODGs are published they will be submitted to the COE/WES for their approval and made available on Internet web sites. After COE/WES approves each ODG, will be used by all the signatory agencies including use by the NRCS for Minimal Effect Determinations, the Alaska Corps of Alaska District Regulatory Branch in the 404 permitting, EPA Region 10, and ADEC in 401Water Quality Certifications as appropriate. Other agencies with interest or responsibility for wetland regulation and management, non-governmental organizations, and other parties will have an opportunity to use the ODGs during this two-year period and provide recommendations for improvements.

After the Operational Draft Guidebook has been used in the field for two years it may be revised incorporating comments and any corrections identified by the specific Guidebook Development Team. The revised Operational Draft Guidebook will be reviewed and approved by the COE/WES as a Final Guidebook.

2) Final Guidebooks

The Final Guidebooks will be used by all the signatory agencies including use by the NRCS for Minimal Effect Determinations, the Alaska Corps of Alaska District Regulatory Branch in the 404 permitting, EPA Region 10, and ADEC in 401Water Quality Certifications as appropriate. Specifically, the Guidebooks can be used as an impact assessment and predictive tool that can help permit specialists suggest, and/or examine, alternatives for projects involving waters/wetlands.

H.GUIDEBOOK USER TRAINING:

The Alaska HGM Statewide Oversight Technical Team established by this MOU will be responsible for organizing and conducting training in the HGM Approach and use of specific HGM Guidebooks. Training is necessary and will be contingent upon available funding.

I. FUNDING AND SUPPORT:

This MOU does not require the signatory agencies to commit funding to carry out the purposes of the agreement. This MOU expresses agency commitment and support to develop the HGM functional assessment method and enables the agencies to provide financial assistance and support if and when funds become available to the participating agencies.

J. REVIEW, CHANGES, OR TERMINATION TO THIS AGREEMENT:

This MOU will be reviewed as required, with at least one review to occur after three years. Revisions may be brought forward by any of the signatory parties when changing conditions or circumstances warrant. Revisions may require convening the HGM Management Team or may be such that they can be made through an exchange of correspondence and upon full agreement of all signatory agencies. Revisions will be in an appropriate form and may be an addendum to the MOU.

The MOU will remain in effect for a period of six years, at which time it will be reaffirmed, if appropriate.

Other agencies may enter into this MOU following their review and acceptance of the MOU as written.

Each party, upon thirty (30) days written notice to the other parties, may amend or terminate their participation in this agreement.

K.NONDISCRIMINATION STATEMENT:

The program or activities conducted under this agreement will be in compliance with the nondiscrimination provisions contained in the Titles VI and VII of the Civil Rights Act of 1964, as amended; the Civil Rights Restoration Act of 1987 (public law 100-259); and other nondiscrimination statutes: namely, section 504 of the Rehabilitation Act of 1973, Title IX of the Education Amendments of 1972, the Age Discrimination Act of 1975, and American's With Disabilities Act of 1990. They will also be in accordance with regulations of the Secretary of Agriculture (7 CFR 15, Subparts A & B), which provide that no person in the United States shall on the grounds of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or family status, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity receiving federal financial assistance from any agency of the U.S. Government.

K. SIGNATORY AGENCIES:

This agreement is entered into upon the date of the last signature by and between the federal and state agencies listed under this section.

Federal Agencies

U.S. Department of Interior

U.S. Fish and Wildlife Service

4/13/00
David B. Allen — Date
Regional Director

U.S. Geological Survey
Water Resources Division

8/23/00
Gordon Nelson — Date
District Chief

U.S. Army Corps of Engineers
Alaska District

13 July '00
Sheldon L. Jahn — Date
Colonel, Corps of Engineers, District Engineer

U.S. Environmental Protection Agency
Region 10 Alaska Operations Office Anchorage

4/21/00
Marcia Combes — Date
Director, Alaska Operations

U.S. Department of Transportation

Federal Highway Administration

1/2/01
David C. Miller — Date
Division Administrator

U.S. Department of Agriculture
Natural Resource Conservation Service

4/6/00
Charles Bell — Date
State Conservationist

U.S. Forest Service Region 10

9/14/00
James A. Caplan — Date
~~Acting~~ Deputy Regional Forester

00MOU-11101-027

State of Alaska Agencies

Department of Environmental Conservation

Michele Brown — 3/25/00
Michele Brown   Date
Commissioner

Department of Fish and Game

Frank Rue — 10.30.00
Frank Rue   Date
Commissioner

Department of Natural Resources

Pat Pourchot — 12/05/00
Pat Pourchot   Date
Commissioner

Department of Transportation & Public Facilities

Joseph L. Perkins — 12-14-00
Joseph L. Perkins, P.E.   Date
Commissioner

Appendix 6 Literature

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Appendix 7 Glossary

abiotic Non-living processes in contrast to biotic or living processes. For example, the deposition of suspended sediments on a floodplain is an abiotic process.

accretion Vertical accumulation of inorganic or organic material.

adjacent "…bordering, contiguous, or neighboring" (33 CFR Part 328, Section 328.3 (a)(7)(c)).

aerobic Conditions in which free molecular oxygen is present. In contrast, see anaerobic.

alkalinity The capacity of water to buffer changes in pH through reaction in the carbon dioxide-bicarbonate buffering complex and others.

alluvial Refers to the transport of material by flowing water normally in a river or stream.

alluvium Sediments transported by the flowing water of a river or stream.

anaerobic Conditions in which free molecular oxygen is absent. In contrast, see aerobic.

aquic A moisture regime in a soil that is a reducing regime, virtually free of dissolved oxygen due to saturation.

aquifer A rock or sediment formation, group of formations, or part of a formation which is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

artesian aquifer An aquifer that is under hydrostatic pressure which is significantly greater than atmospheric. The upper limit of the aquifer is defined by a confining bed that limits upward movement of water.

artesian well A well that penetrates a confined aquifer in which the potentiometric surface is above the surface of the ground.

assessment area The wetland area, or portion of the wetland, which will be assessed with HGM models. There has to be at least one assessment area per assessment.

assessment model A simple model that defines the relationship between ecosystem and landscape scale variables and functional capacity of a wetland. The model is developed and calibrated using Reference Wetlands from a Reference Domain.

assessment objective The reason why an assessment of wetland functions is being conducted. Assessment objectives normally fall into one of three categories. These include: documenting existing conditions, comparing different wetlands at the same point in time *(e.g.,* alternatives analysis, and comparing the same wetland at different points in time (*e.g.,* impact analysis or mitigation success).

assessment The objective task of identifying actions, taking measurements of baseline condition, and predicting changes to the baseline conditions as a result of the actions that occur.

available water capacity (available moisture capacity) The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very Low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very High	more than 12

bank storage The temporary increase in groundwater levels near stream channel during a period of flooding. As stage decreases, the groundwater levels return to pre-flood levels.

best professional judgement The process of making decisions based on personal experience and knowledge when better information is not available. Best professional judgement is often used in day-to-day management decisions related to wetlands.

bidirectional flow Horizontal flow occurring in opposite directions as a result of tides or seiche.

biochemical oxygen demand (bod) The measure of the quantity of dissolved oxygen, in milligrams per liter, necessary for the decomposition of organic matter by microorganisms such as bacteria.

biodiversity The total species composition of an area.

biogeochemical The interaction and integration of biological and geochemical cycles.

biogeochemistry The term referring to the interaction between biological and geochemical processes or cycles.

biomass The amount of living matter present at a specified time and expressed as the mass per unit area or volume.

biotic Term applied to living entities or processes

black spruce forest and woodland Sparse to dense plant community dominated by *Picea mariana* (black spruce) with tree crown coverage $\geq$10%. Frequently has an ericaceous shrub understory and moss-covered forest floor.

bog A peatland where the primary source of water is direct precipitation, and consequently is nutrient poor.

bog, ombrotrophic See ombrotrophic bog.

brackish See mixohaline.

buffered water Water that is resistant to changes in pH. See alkalinity and hardness.

capacity See functional capacity.

capillary forces The forces acting on soil moisture in the unsaturated zone attributable to molecular attraction between soil particles and water.

capillary fringe The zone immediately above the water table, where water is drawn up by capillary forces.

cation exchange capacity The ability of a particular soil to adsorb predominantly charged cations, such as ammonium, calcium, etc. and sometimes negatively charged ions (anions).

centroid The point in character space the coordinates of which are the mean values of each character over a given cluster of OTUs (operational taxonomic unit).

channel bank The sloping land at the edge of a channel. The bank has a steeper slope than the channel bottom, and is usually steeper than the floodplain.

channel An open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water.

chemical oxygen demand (cod) A measure of the chemically oxidizable material in the water. COD furnishes an approximation of the amount of organic and reducing material present.

circumneutral Term applied to water, or soil, with a pH between 5.5 and 7.4.

clay As a soil separate, the mineral soil particles less than 0.002 mm in diameter. As a soil textural class, soil material that is 40% or more clay, less than 45% sand, and less than 40% silt.

Clean Water Act of 1977 (33 U.S. C. 1344) Section 404 of this law that directs the Secretary of the Army, acting through the Chief of Engineers to issue permits, after notice and opportunity for public hearing, for the discharge of dredge or fill material into waters of the United States at specified locations. The object of the Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (33 U.S. C.1344, Section 101(a).

coarse textured soil Loamy fine sand to coarse sand.

collector channels The small channels that collect overland flow and carry it to larger channels.

colloidal material Sediments held in suspension in water as a result of molecular motion (generally defined as <0.00024mm particle size)

colluvium Loose and incoherent deposits, usually at the foot of a slope or a cliff and brought there chiefly by gravity. Talus and cliff debris are included in such deposits.

compaction Increasing the bulk density of soils through compression, trampling, machinery, etc. Results in altered activity by microbes and soil fungus, interferes with nutrient availability, and alters wetland hydrology.

condensation The process that occurs when an air mass is saturated and water droplets form around nuclei or on surfaces.

conductivity See specific conductance and hydraulic conductivity.

confining bed A body of material of low hydraulic conductivity that is stratigraphically above, below or adjacent to one or more aquifers.

connectivity The degree of connection between two entities. In an HGM context, it is a measure of physical connection within wetlands and between wetland and nearby ecosystems.

continuity Continuous effective contact between all components of a wetland system to give it high conductance by providing low resistance (*i.e.*, the flow of water, the movement of organisms.

conversion Causing a total loss of functional capacity by transforming one kind of ecosystem into another kind of ecosystem. For example, converting a bottomland hardwood forest to a soybean field.

cumulative effects The sum of all environmental effects resulting from cumulative impacts.

cumulative impact 1) The impact on the environment which results from the incremental impact of an action when added to the other past, present, and reasonable foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. 2) The sum of all individual impacts occurring over time and space, including those of the foreseeable future.

cumulative impacts The sum of all direct and indirect impacts that have occurred spatially and temporally in a given landscape.

decomposition The alteration (breakdown) of a molecule into simpler molecules or atoms. In wetlands, organic matter is broken down by physical, biological, and chemical process.

degradation Causing a partial loss of functional capability in an ecosystem. See conversion.

denitrification The microbially mediated heterotrophic process of converting (reducing) nitrate or nitrite to either nitrous oxide or dinitrogen gas.

depressional wetland A wetland geomorphic setting which occurs in depressions, but usually at the headwaters of a local drainage. Consequently, surface flows are restricted.

detrital pool Organic matter produced on site as a result of photosynthesis.

detritus Organic matter undergoing decomposition, with the attendant protists, fungi, and other organisms that serve as food for detritus feeders.

direct impact Project impacts that result from direct physical alteration of a wetland such as the placement of dredge or fill material.

direct measure A quantitative measure of an assessment model variable.

direct precipitation Water that falls directly into a lake or stream without passing through any land phase portion of the runoff cycle.

discharge area An area in which there are upward components of hydraulic head in the aquifer. Groundwater is flowing toward the surface in a discharge area and may escape as a spring, seep, or baseflow, or by evaporation and transpiration.

discharge wetlands Wetlands that receive groundwater that is discharged into the wetland basin.

discharge, mean The arithmetic mean of individual daily mean discharges during a specified period.

discharge 1) The volume of water flowing in a stream or through an aquifer past a specific point in a given period of time. 2) The volume of water (or more broadly, a volume of liquid plus suspended sediment) passing a given point within a given period of time.

dissolved organic carbon (doc) The fraction of total organic carbon that passes through a 0.45 micron pore diameter filter.

dissolved The material in a water sample that will pass through a 0.45 um filter.

dominant a. For plant species in a strata: species with the highest canopy coverage that either alone or, added in sequence, comprise ≥ 50% of the total canopy coverage for the strata. In addition, any species which, after identification of the leading dominant species as described above, comprise ≥20% of the total canopy cover for the strata. (see US Army Corps Of Engineers 1987 delineation manual)b. For land uses, etc.: the land use that is ≥ 50% areal coverage

drainage The process of removing water from a wetland; construction of structures that remove surface and/or subsurface water as a rate that is more rapid than occurs under natural conditions. Usually reverses biogeochemical functions from a net import to net export.

drainage area The area above a specified point on a stream, measured in a horizontal plane, enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into the stream.

drainage basin The land area from which surface runoff drains into a stream system.

drainage divide A boundary line along a topographically high area that separates two adjacent drainage basins.

dry biomass The amount of biomass remaining after it is dried completely in an oven at 105^{o}C.

duration See persistence.

ecotone A zone of transition between two ecosystems normally characterized by organisms that occur in the two adjacent ecosystems, or alternatively, a zone between two ecosystems where processes occur at a rate higher than in the adjacent ecosystems.

edaphic (control) The control of the distribution or function of plant species as a result of soil conditions in contrast to atmospheric conditions.

eigenvalue Estimate of degree of association of sample point in a multivariate data array.

elevation head The energy of water at a specific elevation (due to gravity) with respect to a reference elevation.

emergent hydrophyte Erect, rooted, herbaceous vegetation that may be temporarily to permanently flooded at the base, but does not tolerate prolonged inundation of the entire plant.

endosaturation Saturation in all soil layers to 200cm (80in) or bedrock.

energy dissipation A decrease in the velocity of movement of water within a stream corridor or over the surface of a wetland. A decrease in velocity occurs when water from a confined area spreads out over a larger surface area and/or when flowing water meets obstruction to flow *(e.g.,* tree stems, fallen logs).

enhancement Increasing the number of different functions performed by a wetland, or increasing the ability of an existing wetland to perform specific functions.

eolian processes The atmospheric deposition of solids - usually mineral soil material (*e.g.*, silt) - after transport by wind.

ephemeral Overland flow/surface water is present for hours to days after a precipitation event. See intermittently flooded as defined by Cowardin *et al.* 1979.

epibenthic algae Algae that live on the bottom or benthos of an aquatic or wetland ecosystem.

epipedon A soil layer that forms at the surface.

episaturation Saturated layers that overly unsaturated layers in the upper 2m (80in) of the soil profile.

equipotential line A line in a two dimensional groundwater flow field such that the total hydraulic head is the same for all points along the line.

equipotential surface A surface in a three dimensional groundwater flow field such that the total hydraulic head is the same everywhere on the surface.

estuarine fringe Estuarine fringe wetlands are located in estuaries that maintain the high water table. They typically receive their source of water by twice daily flooding, at least at the lower elevations of the wetland. Salt marches and mangroves are abundant examples.

eutrophication The process of accelerated aging of a surface water body caused by excess nutrients and sediments being carried to the water body.

evaluation The subjective application of human values to determine the significance of the effects of actions on the affected parties.

evaporation The process by which water passes from the liquid to the vapor state.

evaporative discharge Upward capillary flow of water from a near-surface water table in response to hydraulic gradients set up by higher evapo-transpiration rates at the soil surface.

evapotranspiration The loss of water from vegetation as a result of evaporation and transpiration expressed in the same units as precipitation, or the sum of evaporation and transpiration.

extensive peatlands Peat accumulation creates "biogenic" landscape elements These areas, if they did not have accumulations of peat, would be considered depressional if they were quite small, or flats if they were mostly mineral soil.

fen A peatland receiving ground water.

fibric soil material (peat) The least decomposed of all organic soil material. Peat contains a large amount of well-preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

field capacity The maximum amount of water that the unsaturated zone of a soil can hold against the pull of gravity. Field capacity is dependent on the length of time the soil has been undergoing gravity drainage. Usually considered to be the water content of a soil at 1/3-bar suction or negative pressure.

flats Flats are broad areas of mineral soils that have seasonally high water tables. Pine savannas of the Southeast are common examples. (Some argue that flats are slope wetlands with zero gradient).

floodplain The land adjacent to a stream that is inundated when stream discharge exceeds channel capacity.

flow duration The amount of time that streamflow equals or exceeds a specific stream discharge value.

flow reversal A change in the direction of groundwater flow, common in Prairie Pothole Region. For example a change from groundwater discharge or recharge or the reversal. They occur with changes in the hydraulic gradient.

flow, channel Surface water flow occurring between the banks of a stream.

flow, floodplain Flow of water on floodplain that occurs when stream discharge exceeds bankfull and water flows across the floodplain.

flow, near surface Lateral flow that occurs just below the surface of a wetland in a layer that is often more permeable than the more consolidated sediments just below. Synonymous with subsurface flow, and interflow.

flow, non-channelized See overland flow

flow, overland The irregular, downslope flow of surface water that occurs after the infiltration capacity of the soil and depression storage capacity of the land surface has been exceeded.

flow, subsurface See interflow.

flow, surface Non-channelized flow occurring above the land surface. Synonymous with overland flow.

flowthrough wetlands Wetlands that recharge the groundwater system and receive groundwater as discharge.

fragmentation The breakup of an extensive ecosystem into a number of smaller patches.

fresh Term applied to water with less than 0.5 ppt dissolved salts.

fringe wetland 1) A wetland adjacent to a large body of water (*i.e.*, the ocean or a large lake) in which frequent and regular bidirectional exchanges of water occur as a result of astronomic tides or seiche. 2) Fringe wetlands occur at the margins of large bodies of water, and thus have a virtual unlimited source of water. They are flooded from the larger body of water at a frequency that is dictated by astronomic tides in marine coastal areas and by seiches in lacustrine settings. Examples are tidal salt marshes and lakeside marshes in the Great Lakes.

function (ecosystem) Processes that are necessary for the self-maintenance of an ecosystem such as primary production, nutrient cycling, decomposition, etc. The term is used primarily as a distinction from values. The term values are associated with society's perception of ecosystem functions. Functions occur in ecosystems regardless of whether or not they have values.

function context area (fca) The area that influences, or is influenced by, a wetland function. The Function Context Area can include aquatic and upland systems adjacent to the wetland.

functional assessment The process by which the capacity of a wetland to perform a function is measured. This approach measures capacity using an assessment model to determine a functional capacity index.

functional capacity index (fci) An index of the capacity of wetland to perform a function relative to other wetlands from a regional wetland subclass in a reference domain. Functional capacity indices are by definition scaled from 0.0 to 1.0. An index of 1.0 indicates that the wetland performs a function at the highest sustainable functional capacity, the level equivalent to a wetland under reference standard conditions in a reference domain. An index of 0.0 indicates the wetland does not perform the function at a measurable level, and will not recover the capacity to perform the function through natural processes.

functional capacity unit (fcu) Calculation reached by multiplying the functional capacity index for a wetland area by the size of the wetland area.

functional capacity The rate or magnitude at which a wetland ecosystem performs a function. Functional capacity is dictated by characteristics of the wetland ecosystem and the surrounding landscape, and interaction between the two.

functional profile 1) Qualitative and quantitative descriptive depictions of wetlands that, in the case of the hydrogeomorphic classification, emphasizes the physical characteristics such as geomorphic setting, water source, and hydrodynamics. Profiles also may include the biotic components. 2) Narrative or quantitative description of significant factors such as water source, hydrodynamics, vegetation, and soils that affect how a wetland functions.

geomorphic setting The location of a landscape with respect to landforms, such as stream headwater locations, valley bottom depression, and coastal position.

geomorphic A term that refers to the shape of the land surface.

geomorphology The study of the classification, description, origin, nature, and development of present landforms and their relationship to underlying structures and geologic history.

glacial drift (geology) Mineral material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

glacial outwash (geology) Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

glacial outwash Well sorted sand, or sand gravel, deposited by meltwater from a glacier.

glacial till A glacial deposit composed of mostly unsorted sand, silt, clay, and coarse fragments (rocks of various sizes) laid down directly by melting ice.

glaciofluvial deposits (geology) Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

glaciolacustrine deposits Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

graminoid: Grasses, sedges, or rushes.

gravity flow Flow of water controlled by gravity instead of strictly piezometric head differences.

ground water aquifer See aquifer

ground water discharge The movement of groundwater from an aquifer to the surface of the earth.

ground water flow The movement of water through openings in sediment and rock in the zone of saturation. Flow of water in a porous medium, under saturated conditions, below the surface of the land.

ground water perched See *perched* ground water.

ground water recharge The movement of water from the surface of the earth to an aquifer.

ground water, confined See confined ground water.

ground water, unconfined See unconfined ground water.

ground water Water occurring in the subsurface voids, pore spaces, or fissures of the earth, as opposed to water occurring above the surface of the earth in streams, ponds, lakes, and in the ocean. The water contained in the interconnected pores located below the water table in an unconfined aquifer or located in a confined aquifer.

haline Term applied to water containing greater than 0.5 ppt ocean derived salts.

halophyte Plants adapted to grow and reproduce where the salt concentration in water or soil is high.

hardness 1) A measure of the amount of calcium, magnesium, and iron dissolved in the water. 2) A property of water that is roughly proportional to the ion concentration. Water from a calcareous aquifer is often hard due to calcium carbonate content. Such waters are very resistant to fluctuations in pH. Alternative: The sum of equivalents of polyvalent cations expressed as the equivalent concentration of calcium carbonate ($CaCO_3$).

head, total The sum of the elevation head, the pressure head, and the velocity head at a given point in an aquifer.

headwaters Streams with average annual discharge less than 5 cfs (US Army Corps of Engineers 404 Regulatory Program definition).

herb Forbs, ferns, fern allies, and graminoids.

high water table (seasonal) The highest level of a saturated zone in the soil in most years. Location based mainly on evidence of a saturated zone; gleyed colors (redoximorphic depletions) in the soil.

highest sustainable functional capacity The level of functional capacity achieved across the suite of functions by a wetland under reference standard conditions in a reference domain. This approach assumes that the highest sustainable functional capacity is achieved when a wetland ecosystem and the surrounding landscape are undisturbed.

hilltop A topographically high area lower in elevation than a mountain. Areas usually less than 300 meters in elevation.

Histosol Organic soils -- *i.e.*, soils that are dominated by organic material to specific depths and thickness requirements.

Histic epipedon A soil horizon formed at the surface and dominated by organic material and is 20-40cm (8-16in) thick.

horizon, soil A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the master diagnostic horizons. Lower case subscripts represent subordinate designations *(i.e.*, additional definition or subdivision of the master horizons).

humus The amorphous, ordinarily dark-colored, colloidal matter in soil; a complex of the fractions of organic matter of plant, animal, and microbial origin that are most resistant to decomposition.

hydraulic conductivity A coefficient of proportionality describing the rate at which water can move through a permeable medium. The density and kinematic viscosity of the water must be considered in determining hydraulic conductivity.

hydraulic diffusivity A property of an aquifer or confining bed defined as the ratio of the transmissivity to the storativity.

hydraulic gradient The change in total head over a change in distance in a specified direction.

hydraulic head See total head.

hydric soil Soil that is wet long enough to periodically produce an anaerobic condition, thereby influencing the growth and reproduction of plants.

hydrodynamics: The capacity of water to do work such as transport sediments, erode soils, and flush pore waters in sediments as a result of its vertical, or unidirectional and horizontal, or bidirectional and horizontal motion. Vertical motion results from evapotranspiration and precipitation, bidirectional flows result from astronomic tides and seiches, and unidirectional flows result from the pull of gravity on surface water in streams and on the surface of the earth.

hydrogeologic unit A portion of the landscape that has a distinct surface and ground water composition.

hydrogeology The study of the interrelationships of geologic materials and processes with water, particularly ground water.

hydrogeomorphic class0 A class of wetlands in the classification scheme developed for use with HGM procedures. Each class has similar hydrogeomorphic characteristics.

hydrogeomorphic unit Hydrogeomorphic units are areas within a wetland assessment area that are relatively homogenous with respect to ecosystem scale characteristics such as microtopography, soil type, vegetative communities, or other factors that influence function. Hydrogeomorphic units may be the result of natural or anthropogenic processes. See Partial Wetland Assessment Area.

hydrogeomorphic wetland class The highest level in the hydrogeomorphic wetland classification. There are five basic hydrogeomorphic wetland classes including depression, fringe, slope, riverine, and flat.

hydrogeomorphic wetland type Wetlands with a similar geomorphic setting, source of water, and hydrodynamics.

hydrograph 1) A graphic description of hydrologic stage discharge or storage over time. 2) A graph that shows some property of ground water or surface water as a function of time.

hydrologic unit A distinct hydrologic feature delineated by the Office of Water Data Coordination on the State Hydrologic Unit Maps. Each hydrological unit is identified by a unique eight-digit number.

hydrology The study of the occurrence, distribution, and movement of all waters of the earth.

hydroperiod The depth, duration, seasonality, and frequency of flooding. In its simplest form, it refers to the time period of inundation of the land surface.

hydrophilic Adapted to and tolerant of water.

hydrophyte 1) A plant adapted to grow and reproduce in standing water or on saturated soils characterized by a periodic oxygen deficit as a result of excessive water. 2) A type of plant that grows with the root system submerged in standing water.

hydroscopic water Water that clings to the surface of mineral particles in the zone of aeration.

hyperhaline The term used to describe water with a salinity greater than 40 ppt due to ocean derived salts.

hypersaline The term used to describe water with a salinity greater than 40 ppt due to land derived salts.

impact assessment The determination or assessment of activities on the functioning of a particular system.

impact A human action that either by design or oversight alters the characteristics of an ecosystem.

indicator Indicators are observable characteristics that correspond to identifiable variable conditions in a wetland or the surrounding landscape.

indirect impact Impacts resulting from project activities that indirectly affect the physical, chemical, or biological integrity of a wetland. Indirect impacts typically occur in association with direct impacts, but are usually separated from them in time and space. An example would be the impacts of increased human activity on wildlife habitat in a wetland proximate to the activity.

infiltration capacity The maximum rate at which infiltration can occur under specific conditions of soil moisture. For a given soil, the infiltration capacity is a function of the water content, texture, and structure.

infiltration The movement of water from the surface into the soil. Infiltrated water permeates vertically through the unsaturated zone, or moves horizontally as throughflow.

influent stream See losing stream.

in-kind mitigation Mitigation in which lost functional capacity is replaced in a wetland of the same regional wetland subclass.

interception The interception of precipitation by vegetation before it reaches the ground surface. The process by which precipitation is captured on the surface of vegetation before it reaches the ground surface.

interflow The later movement of water in the unsaturated zone during or immediately after a precipitation event. The water moving as interflow discharges directly into a stream or lake. See throughflow.

interfluve The relatively flat and undissected upland between adjacent streams flowing in the same general direction.

intermediate zone That part of the unsaturated zone between the root zone and the capillary fringe.

intermittent or "intermittently flooded" "The substrate is usually exposed, but surface water is present for variable periods without detectable seasonal periodicity. Weeks, months, or even years may intervene between periods of inundation. The dominant plant communities under this regime may change as soil moisture conditions change. Some areas exhibiting this regime do not fall within our [the] definition of wetland because they do not have hydric soils or support hydrophytes" (Cowardin *et al.,* 1979).

inundation The condition where water occurs above the surface (*i.e*., flooding).

invert The bottom of a channel, pipe, or culvert.

ion exchange A process by which an ion in a mineral lattice is replaced by another ion that was present in an aqueous solution.

irregularly flooded tidal wetland Wetlands located in a tidal region, but too isolated to be inundated by astronomic tides.

isolated wetland Wetland isolated from the surrounding landscape with respect to the exchange of surface water.

jurisdictional wetland Wetlands which meet the soil, vegetation, and hydrologic criteria defined in the 'Corps of Engineers Wetlands Delineation Manual', or its successor.

kettles Depressional areas in glaciated landscapes that resulted from the melting of ice blocks buried by glacial outwash and recession.

lacustrine Related to lake or pond environments.

lacustrine fringe Fringe wetlands occur at the margins of large bodies of water, and thus virtually have an unlimited source of water. Lake fluctuations, such as seiches, are normally the source of water in lacustrine fringe wetlands. Examples are unimpounded lakeside marshes of the Great Lakes.

lag time The time from the center of mass of rainfall to the peak of a hydrograph.

land dominated hydrograph The dominant influence on the timing, duration, and amount of water delivered to a channel or swale is the land use and/or condition of the watershed/contributing area.

landform Large-scale, distinctive landscape features, such as mountains, plains, and plateaus.

landscape 1) A heterogeneous land area composed of a cluster of interacting ecosystems that is repeated in a similar form through. 2) All distinct spatial units of an area, usually at the watershed level or larger. Its gross features of the land surface include, but are not limited to slope, aspect, topographic variation, and position relative to other landforms.

lichen A symbiotic association derived from members of two different kingdoms Algae (Kingdom Protista) and a fungus (most of which are Ascomycota).

life form, plant The general morphologic category of plants, such as tree, shrub, herbaceous, etc.

lithology Term referring to the composition of the earth's crust. Soils develop as a consequence of weathering of the parent material.

litter Recently fallen plant material which is only partially decomposed and in which the organs of the plant are still discernible; forming a surface layer on some soils.

loading Process of adding excess amounts of material, nutrients, toxins, etc. to wetlands. Loading can result in the loss of, or significant reduction in, some ecological functions.

loam Soil material that is 7 to 27% clay.

macrophytes A common term for wetland vascular plants. Includes submersed species, semi-aquatic (leaves beneath water with different morphology than aerial leaves) and emergent (rooted in soil but most aerial biomass above the water) species.

maintenance The upkeep of functions and processes in wetlands.

marsh A wetland normally characterized by the presence of shallow surface water, and dominated by emergent vegetation.

mean high tide The average elevation of all daily high tides over a specified period.

mean high water The average elevation of the high water over a specified period.

mean low tide The average elevation of all daily low tides over a specified period.

mean low water The average elevation of low water over a specified period.

mean sea level See *National Geodetic Vertical Datum of 1929.*

mean tide The elevation midway between mean high tide and mean low tide.

meander swales Linear depressions that form on floodplains as a result of stream meandering.

mesohaline The term used to describe water with a salinity of 5-18 ppt due to ocean derived salts.

mesosaline The term used to describe water with a salinity of 5-18 ppt due to land derived salts.

metabolic transformation Chemical changes associated with biological processes.

microtopographic variation Small scale variations in surface elevation/relief (*e.g.*, pit-and-mound or hummock-and-hollow topography, coarse woody debris, root masses etc.) that provide roughness (*i.e.*, friction or resistance to flow) which reduces or transforms the velocity/kinetic energy associated with flowing water.

milligrams per liter (mg/l) A unit for expressing the concentration of chemical constituents in solution. It represents the mass of solute per unit volume (liter) of water. Concentration of suspended sediment is also expressed in mg/l, and is based on the mass of dry sediment per liter of water-sediment mixture.

mineral soil flats Mineral soil flats occur on broad interfluves that have seasonally high water tables. Precipitation is the only water source. Pine flatwoods of the Southeast are common examples.

mineral soil Soil composed of primarily mineral materials as opposed to organic materials.

mineraltrophic wetlands Fens with hydrophytic vegetation but with species that are calciphilous and specific for fens. The wetlands form in areas where groundwater carries dissolved constituents that precipitate in the soil zone.

minimal effect exemption A decision to allow an action to occur even through it would result in more than a minimal impact on a wetland.

mitigation plan A plan for replacing lost functional capacity resulting from project impacts.

mitigation ratio The ratio of the Functional Capacity Units (FCUs) lost in a Wetland Assessment Area (WAA) to the FCUs gained in a mitigation wetland.

mitigation wetland A restored or created wetland that serves to replace functional capacity lost as a result of project impacts.

mitigation, in-kind See in-kind mitigation.

mitigation, out-of-kind See out-of-kind mitigation.

mixohaline The term used to describe water with a salinity of .5-30 ppt due to ocean derived salts. Roughly synonymous with the term brackish.

mixosaline The term used to describe water with a salinity of 0.5-30 ppt due to land derived salts.

modal soil profile A soil profile that represents the average or general soil type that is typical for the area or system of interest.

model calibration The process of parameter estimation based on known data.

model variable See assessment model.

model verification The process of comparing parameter estimates against a new set of data after model has been calibrated.

moss Non-vascular, non-flowering plant species that are members of the phylum Bryophyta.

mottling, soil Outdated terminology that refers to irregular spots of different colors that vary in area and size within the soils profile. Mottling generally indicates alternating conditions of oxidation and reduction, poor aeration and impeded drainage and is currently defined as redoximorphic features (*i.e.*, depletions and concentrations).

mucky surface texture 1) A surface texture of highly decomposed organic material. 2) A mineral horizon that has a significant amount of decomposed organic material within.

National Wetland Inventory (NWI) A Fish and Wildlife Service program designed to map and inventory wetlands of the United States.

natural levee Levees that form at the edge of stream channels as a result of sediment deposition that occurs as the velocity of floodwater is reduced after it leaves the stream channel.

navigable waters See waters of the United States.

nitrate The most oxidized form of nitrogen which can be used as an alternate terminal electron acceptor in anaerobic respiration.

nitrification The microbial transformation from ammonium to nitrite and from nitrite to nitrate. It is an energy-yielding aerobic process.

non-planar In the context of microtopography, land surfaces that are convex, concave, jagged or otherwise not flat and alone or in a complex with other non-planer features, are capable of ponding and/or impeding the flow of surface and shallow subsurface water.

nonpoint source Nutrients or contaminants that enter wetland and aquatic ecosystems from diffuse, unconfined sources over a greater areal extent, in contrast to a point source from a defined, discrete location. Common non-point sources are agricultural and urban landscapes.

nutrient uptake The incorporation, absorption, or adsorption of nutrients by vegetation, soil, and detritus.

off-site mitigation Mitigation that is done at a location physically separated from the site at which the original impacts occurred, possibly in another watershed.

oligohaline The term used to describe water with a salinity of 0.5-5 ppt due to ocean derived salts.

oligosaline The term used to describe water with a salinity of 0.5-5 ppt due to land derived salts.

ombrotrophic bog A peatland that receives precipitation as the sole source of water. Generally, peat has accumulated enough to isolate the plants from acquiring nutrients from the underlying mineral strata.

ombrotrophic Term referring to low nutrient conditions which usually implies that the dominant source of water to the wetland is direct precipitation.

ordinary high water mark "**. . .** that line on the shore established by the fluctuation of water and indicated by physical characteristics such as clear natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding area" (33 CFR Part 328, Section 328.3 (a)(7)(e)).

organic biomass The difference between ash biomass and dry biomass.

organic soil flats Organic soil flats are similar to mineral soil flats except for organic matter accretion. They receive precipitation as the only source of water. Northern Minnesota peatlands are a common example.

organic matter Plant and animal residue in the soil in various stages of decomposition.

organic soil Soil composed of primarily organic materials as opposed to mineral materials.

out-of-kind mitigation Mitigation in which lost function capacity is replaced in a wetland of a different regional wetland subclass.

outwash plain fen Fens that occur in low areas in coarse-textured sediments such as glacial outwash. Water flows into these fens from the surrounding landscape and then through the fen.

overbank flooding The movement of water onto the floodplain that occurs after stream discharge exceeds channel capacity.

overbank transport Movement of water from the stream channel onto the adjacent floodplain. Synonymous with overbank flooding.

overland flow The flow of water over a land surface due to direct precipitation. Overland flow generally occurs when the precipitation rate exceeds the infiltration capacity of the soil and depression storage is full.

oxidation-reduction See reduction-oxidation.

paleochannels Relict channel systems that no longer function to carry water, but, have obviously done so in the past.

paludification The landscape phenomenon in which increasing surface moisture augments the accumulation of organic matter and the formation of a Histosol.

palustrine Non-tidal wetlands that are not part of the lacustrine or riverine systems in the U. S. Fish and Wildlife Service National wetland classification system.

partial wetland assessment area (pwaa) A portion of a WAA that is identified a priori, or while applying the assessment procedure, because it is relatively homogeneous, and different from the rest of the WAA with respect to one or more model variables. The difference may occur naturally, or as a result of anthropogenic disturbance. See hydrogeomorphic unit.

particle size classification Classification of particles into size classes according to the United States Department of Agriculture - Natural Resources Conservation Service.

Clay	<0.002mm
Silt	0.002 - 0.05mm
Sand	0.05 - 2.0mm
Gravel	2.0 - 75mm

particle size The diameter, in millimeters, of a particle determined by either sieve or sedimentation methods.

particulate organic carbon (poc) The fraction of total organic carbon that is retained by a 0.45 micron filter.

parts per thousand (ppt) Units used to express salinity or halinity. One part solute per one part solvent.

passerine A member of one of the largest order of birds (Passeriformes); mostly altrical songbirds with perching habits; includes the migratory songbirds such as warblers, flycatchers, vireos, larks, wrens, gnatcatchers, sparrows, finches and thrushes.

peat Unconsolidated material, primarily comprised of undecomposed organic matter, that has accumulated under excess moisture.

pedogenic Chemical, physical, and biological processes over time that result in changes to soils, usually color, structural, and/or textural changes.

pedon A three-dimensional sample of soil large enough (1 to 10 sq. meters) that the horizons within the soil are adequately expressed.

peraquic A soil moisture regime in which groundwater is <u>always</u> at or very close to the surface.

perched Water that overlies an unsaturated, impermeable layer.

perched aquifer A region in the unsaturated zone where soil may be locally saturated because it overlies a low permeability unit.

perched ground water The water in an isolated, saturated zone located in the zone of aeration. It is the result of the presence of a layer of material of low hydraulic conductivity called a perching bed. Perched ground water will have a perched water table.

perched water table Water standing above an unsaturated zone in the soil.

percolation The vertical movement of water through the unsaturated zone subsequent to infiltration.

perennial or "permanently flooded" "Water covers the land surface throughout the year in all years. Vegetation is composed of obligate hydrophytes" (Cowardin *et al.* 1979).

permafrost A thermal condition in which a material, including soil, remains below $0^{o}C$ for 2 or more years in succession. <u>Permafrost may be cemented by ice or, may be dry.</u>

permanent wetland Pond and lake that has a central open-water zone that is typically surrounded by deep marsh, shallow marsh, wet meadow and low prairie zones. These wetlands contain water year round except during extensive droughts.

permeability The capacity of a porous medium to transmit fluids.

persistence (duration) The length of time that something (*e.g.* water) is present, or the time period over which it occurs.

pH The negative log of the hydrogen (hydronium) ion activity.

phreatic water Water in the saturated zone.

phreatophyte A plant capable of maintaining a high rate of transpiration by virtue of a taproot that extends to the water table.

physiognomy The gross structure of a plant community resulting from the dominance of life forms such as trees, shrubs, or graminoids.

phytoplankton Plant forms of plankton *(e.g.,* algae) that exist in the water column in contrast to attached epiphytic or epibenthic algae.

piedmont A steep, rolling physiographic province formed at the base of mountains. For example, the Piedmont west of the Atlantic coastal plain and to the east of the Appalachian Mountains.

piezometer A non-pumping well, generally of smaller diameter, that is used to observe and measure the elevation of the water table or potentiometric surface.

pipe flow Subsurface flow of groundwater that occurs through soil macropores often formed by decayed root channels or animal burrows.

planar In the context of microtopography, land surfaces that are flat and generally incapable of ponding or impeding the flow of surface and shallow subsurface water.

plant life form The general morphologic category of plants, such as tree, shrub, herbaceous, etc.

pluvial Pertaining to, or resulting from, the action of rain or precipitation.

point bar The deposit formed by the accumulation of suspended and bed load sediments around and against the convex bank in a stream channel bend.

polyhaline The term used to describe water with a salinity of 18-30 ppt due to ocean derived salts.

polysaline The term used to describe water with a salinity of 18-30 ppt due to land derived salts.

poor fen A fen with productivity levels between a rich fen and an ombrotrophic bog.

pore space The volume between mineral grains (voids) in a porous medium.

pore water pressure The pressure (stress) transmitted by the fluid that fills the voids between particles of soil or rock.

porewater Water that fills the voids and interstices of soil or rock.

porosity The ratio of the volume of void spaces in a rock or soil to the total volume of the rock or soil.

potential evapotranspiratio (pet) The amount of water that would be lost by evapotranspiration by the natural vegetation of an area if water were never limiting during the year.

potential evapotranspiration ratio (pet ratio) The ratio between the potential evapotranspiration and actual precipitation. Ratios greater than 1.0 indicate a water deficit.

precipitation Any form of water originating in atmosphere that falls onto the surface of the earth.

precipitation, direct Precipitation, throughfall, or stemflow that falls directly, or indirectly onto a specified portion of the landscape.

predominant >50% of area, total number, etc.

pressure head The pressure from a column of water above a specific reference point - usually in units of cm (water), bars, or Pascals.

primary production The conversion of solar energy into chemical energy by plant photosynthesis.

profile An exposed vertical section of the soil that allows it to be adequately described (*i.e.*, profile descriptions).

project alternative(s) Different ways in which a given project can be done. Alternatives may vary in terms of project location, design, method of construction, amount of fill required, and other ways.

project area The area that encompasses all activities related to an ongoing or proposed project.

project assessment area (PAA) The waters/wetland area within the geographic extent of the reference domain to be assessed for impacts.

project standards Performance criteria and/or specifications used to guide the restoration or creation activities towards the project target. Project standards should include and specify reasonable contingency measures if the project target is not being achieved.

project target The level of functioning identified or negotiated for a restoration or creation project. The targets must be based on reference standards and/or site potential and consistent with restoration or creation goals. They are used to evaluate whether a project is developing toward reference standards and/or site potential.

propagule Reproductive structures such as the seeds or vegetative cuttings from plants.

rating curve A graph of the discharge of a river or stream at a particular point as a function of the elevation of the water surface.

recharge area An area in which there are components of hydraulic head that allow water to move downward into the deeper parts of a soil or aquifer.

recharge wetland Wetland that recharges groundwater within its basin (*e.g.* watershed).

recharge Water that infiltrates to an aquifer, usually by gravity.

recycle The movement of nutrients and/or water from biota to the physical environment and back to the biota.

red flag features Features of a wetland or the surrounding landscape to which special recognition or protection is assigned on the basis or objective criteria. The recognition or protection may occur at a federal, state, regional, or local level, and may be official or unofficial.

redox See reduction-oxidation.

redox concentration A segregation and concentration of iron (Fe) and/or manganese (Mn) into visible features within a soil horizon, denoting alternating conditions of oxidation and reduction.

redox depletion Visible features within the soil where clay and/or iron (Fe) and/or manganese (Mn) have been removed due to reducing conditions.

reduction-oxidation The potential difference, usually expressed in millivolts, between a platinum electrode and a reference electrode in a solution. Chemically, it is the loss (oxidation) or gain (reduction) of an electron by an element or compound.

reference The term reference in the context of functional assessment is used as a basis for comparing two or more wetlands of the same subclass. The principle of reference is useful because (1) everyone uses the same standard of comparison, and (2) relative rather than absolute measures allow better resolution, efficiency in time, and consistency in measurements.

reference domain All wetlands within a defined geographic region that belong to a single hydrogeomorphic subclass.

reference standard Conditions exhibited by a group of reference wetlands that correspond to the highest level of functioning (highest sustainable capacity) across the suite of functions of the subclass. By definition, reference standard functions are assigned an index of "1.0".

reference wetland Wetland sites within the reference domain that encompass the known variation of the subclass. They are used to establish the range of functioning within the subclass. Reference wetlands may include (1) former wetland sites for which restoration to wetland is possible, and (2) characteristics of sites derived from historic records or published data.

region A geographic area that is relatively homogenous with respect to large scale factors such as climate and geology that may influence how wetlands function.

regional wetland subclass Wetlands within a region that are similar based on hydrogeomorphic classification factors. There may be more than one regional wetland subclass identified within each hydrogeomorphic wetland class depending on the diversity of wetlands in a region, and assessment objectives.

regolith The upper part of the earth's surface that has been altered by weathering processes. It includes both soil and weathered bedrock.

removal mechanisms Physical, chemical, and biological processes that place material *(e.g.,* nutrients) into a form that are not readily available.

residence time The time it takes a component to break down or otherwise be lost from the system (*i.e.* residence time in the soil).

restoration 1) Returning a modified ecosystem to its pre-modified condition. For example, restoring a tidal connection to a saltmarsh isolated by road construction. 2) Taking a former wetland area that had performed wetland functions or is now performing diminished functions, and altering conditions such that the wetland now performs most of its natural (pre-disturbance) functions.

return flow Refers to water that is not used by plants or stored in wetland soils. This water usually returns to streams by overland flow.

return interval Interval of time corresponding to the return of water to the wetland surface.

return period The average time interval between hydrologic events of a certain magnitude or greater. Usually expressed in years (*e.g.,* 2-year flood event).

rhizomes A horizontal stem, usually underground, that often sends out roots and shoots.

rich fen A fen with a high level of productivity that is often dominated by grasses or trees in contrast to the shrubs and mosses often associated with poor fens.

ridge A linear elevation of the earth's surface. It may or may not be associated with mountains.

riparian Pertaining to the boundary between water and land. Normally it represents streamside areas and the zone of influence of the stream to the upland boundary.

riparian transport Movement of water from uplands to floodplains by overland flow, or subsurface flow.

riverine wetland Riverine wetlands are long linear features that contain a riverbed and bank, and functionally cover the area of the 100-year floodplain.

root zone The zone from the land surface to the depth penetrated by plant roots.

roughness Macro/microtopographic features, vegetative characteristics (*i.e.,* stem densities, basal area, percent cover etc.), and soil/bedload attributes of the channel banks, channel bed, and floodplain surface which exert resistance or drag on flowing water. Mannings equation and the Chezy formula are engineering equations that attempt to express or quantify the resistance factor(s) encountered by flowing water.

runoff The amount of water that flows from an area of land after evapotranspiration, storage, and subsurface flow have been accounted for. This term is synonymous with overland flow.

saddle Topographically low area between two hilltops.

saline Term applied to water containing greater than 0.5 ppt of land derived salts.

saline soil A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

saline wetlands Wetlands with soils that have a total dissolved soils or water column concentration of >0.5 ppt. Wetlands typically fall into five salinity classes (oligohaline, mesosaline, polysaline, eusaline, and hypersaline.

saturated soil A soil that has all <u>available</u> pore space filled with water. Some clayey soils with numerous very small (micropores) pores may not have all pore space occupied with water, but can still be considered saturated.

saturated zone 1) The zone in which the voids in the rock or soil are filled with water at a pressure greater than atmospheric. The *water table* is the top of the saturated zone in an unconfined aquifer. 2) Regions below the land surface in which all pore space is filled with water.

scrub-shrub Wetland vegetation dominated by shrubs or low trees.

seasonal or "seasonally flooded" "Surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years. When surface water is absent, the water table is often near the land surface" (Cowardin *et al.* 1979).

seasonal frost Portions of the soil profile that freeze and thaw annually or are not frozen for a duration sufficient to meet the definition for permafrost (*i.e.*, 2 years).

sedge wetland See fen; fen, poor; and fen, rich.

sediment, suspended Sediments held in suspension by fluid turbulence or Brownian (molecular) motion (colloidal material).

sediment The solid material transported by, suspended in, or deposited from water. It includes chemical and biochemical precipitates and decomposed organic material such as humus*,* or alternatively, an assemblage of individual mineral grains that were deposited by water, wind, ice, or gravity.

seepage A site where ground water discharges to the surface, as often happens at the toe of a slope.

semiconfined aquifer An aquifer confined by a low permeability layer that permits water to slowly flow through it.

sequester The retention of nutrients, sediments, etc., in compartmental surface features, and biomass within the wetland.

sheetflow See overland flow.

shrub Multi-stemmed woody species.

silt As a soil separate, individual mineral particles that range in diameter from the clay boundary (0.002 mm) to the very fine sand boundary (0.05 mm). As a soil textural class, soil that is 80% or more silt and less than 12% clay.

site potential The highest level of functioning possible given local constraints of disturbance history, land use, or other factors. Site potential may be equal to or less than levels of functioning established by Reference Standards.

site specific Refers to a location associated with a specific wetland function, structural attribute, etc.

slope The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20% is a drop of 20 feet in 100 feet of horizontal distance.

slope wetland Slope wetlands grade into the flat below where the slope becomes negligible. Hillside seeps or springs are good examples of slope wetlands.

small tree Single-stem, woody vegetation >3 to <10 ft (0.9 to 3 m) tall.

soil Freely divided rock-derived material containing an admixture of organic matter and capable of supporting vegetation.

soil depth The distance from the top of the soil to the underlying bedrock.

soil horizon A layer of soil that is distinguishable from adjacent layers by characteristic physical properties such as structure, color, or texture, or by chemical composition, including content of organic matter or degree of acidity or alkalinity. Master soil horizons are designated by a capital letter, subordinate soil horizons are denoted by lowercase letters (*e.g*., Bg; Cfm).

soil series The basic unit of soil classification; it is a subdivision of the family level. It is a group of soils having soil horizons similar in differentiating characteristics and arrangement in the soil profile and developed from a particular type of parent material.

source The place of origin of material such as water, and nutrients. In a wetland context, the wetland can be the source of materials to adjacent ecosystems or materials can move into the wetland from other areas (*i.e.*, sources).

strata The distinct vertical layers of vegetation that can be identified in a given plant community or at a given site. Layers typically include: moss or Bryophyte; herbaceous or ground layer; shrub, sapling/tall shrub; and tree.

stream A body of running water moving under the influence of gravity down gradient in a narrow, clearly defined, natural channel.

streamflow A type of channel flow, applied to surface runoff moving in a stream. Units of measurement are volume over time interval.

stress 1) The condition of diverting potentially useful energy from an ecosystem or an organism, or alternatively, the response of an organism or community to abnormal conditions (*e.g.*, change in water supply, change in nutrient input, introduction of contaminants). 2) The immediate physical, chemical, and biological changes resulting from a disturbance. 3) Force applied to a material.

structure, soil The aggregation of individual soil particles into larger units with planes of weakness between them.

subclass profile The highest organizational element of an HGM reference system and is defined as a narrative and quantitative description of, at least, the subclass geomorphic setting, climate, hydrology, geology, soils, and biotic communities.

subsoil Technically, the B-horizon; roughly, the part of the solum below plow depth.

subsurface drainage See subsurface flow. The movement of subsurface water can be natural or influenced by human activity (*i.e.*, drain tiles).

subsurface flow See throughflow and interflow.

subsurface storage The storage of water below the soil surface.

succession The predictable and orderly change in biotic and abiotic characteristics of a community or ecosystem in a particular location over time.

surface water Water above the surface of the land, in contrast to ground water that is below the surface of the land.

thermal regime Characteristic temperature(s) within a soil profile.

throughfall The portion of intercepted precipitation that ultimately drips from vegetation surfaces onto the ground.

throughflow 1) The lateral movement of water in an unsaturated zone during and immediately after a precipitation event. The water from throughflow seeps out at the base of slopes and then flows across the ground surface as return flow ultimately reaching a stream of lake. See interflow. 2) Water that infiltrates into the soil on a slope and subsequently emerges as seepage at the foot of the slope, as opposed to interflow which enters directly into a stream.

tidal wetland A wetland influenced by astronomic tides.

topographic A term referring to the slope and elevation of land.

transformation The process of converting a material (nutrient, etc.) from one form to another. Examples would be particulate organic carbon to dissolved organic nitrogen, organic nitrogen to ammonia.

transpiration The process by which plants give off water vapor through their leaves.

transport mechanism Physical processes that move materials from one location to another.

transport, riparian Movement of water from upland regions to the floodplain either by overland flow and/or subsurface flow.

tree Single-stem, woody vegetation ≥10 ft (3 m) tall.

turbidity Cloudiness in water due to suspended and colloidal organic and inorganic material.

tussock A plant form that is tufted, bearing many stems arising as a large dense cluster from the crown.

unchannelized flow Normally reserved for surface flow that is diffuse and thus not confined to a channel. Also non-channelized flow.

unconfined aquifer A permeable body of rock/soil in which groundwater moves freely.

unconfined ground water The water in an aquifer where there is a water table.

unidirectional flow Horizontal flow that occurs in one direction in contrast to bidirectional flow associated with astronomic tides or seiche.

unsaturated zone 1) The zone between the land surface and the water table that includes the root zone, intermediate zone and capillary fringe. The pore spaces contain water at less than atmospheric pressure, as well as air and other gases. Saturated bodies, such as perched ground water, may exist in the unsaturated zone.

upland Non-wetland

upland related Processes, structures, etc. associated with topographically higher areas adjacent to wetlands.

value of wetland function(s) The relative importance of wetland function, or functions, to an individual or group.

values Generally, what people consider to be important. It can be measured, relatively, by what motivates people into activity.

variable An attribute or characteristic of a wetland ecosystem or the surrounding landscape that influences the capacity of wetland to perform a function.

variable condition The condition of a variable as determined through quantitative or qualitative measures.

variable index A measure of how an assessment model variable in a wetland compares to the reference standards of a regional wetland subclass in a reference domain.

vertical fluctuations The movement of water upward and downward in the soil profile.

viscosity The property of a fluid describing its resistance to flow. Units of viscosity are force-time per area (Newton-seconds per meter squared ($N{\cdot}s{\cdot}m^{-2}$) or Pascal-seconds ($Pa{\cdot}s$)).

water budget An evaluation of all sources of input and corresponding discharge (output) with respect to an aquifer or a drainage basin.

water quality Qualitative and quantitative conditions of water, usually in reference to physical, chemical, and biological properties, and usually from the perspective of use and benefits to society.

water source The place of origin of water that enters a wetland or system. Examples would be rainfall (precipitation), streams, lakes, ground water, and oceans.

water table The surface in an unconfined aquifer or confining bed at which the pore water pressure is atmospheric. It can be measured by installing shallow wells extending a few feet into the zone of saturation and then measuring the water level in those wells.

water year The twelve month period from October 1 through September 30. Water year is designated by the calendar year in which the water year ends, and which includes 9 of the 12 months. For example, the water year ending September 30, 1980 is called "1980 water year."

waters of the United States "....(a)(1) All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide; (2) all interstate waters including interstate wetlands; (3) all other waters such as intrastate lakes, rivers, streams, (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate , or foreign commerce including such waters: (i) Which are or could be used by interstate or foreign travelers for recreational or other purposes; or (ii) From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or (iii) Which are used or could be used for industrial purposes by industries in interstate commerce; (4) All impoundments of waters otherwise defined as waters of the United States under this definition. (5) Tributaries of waters identified in paragraphs 1-4 above; (6) The territorial sea: (7) Wetlands adjacent to waters (0ther than waters that are themselves wetlands) identified in paragraphs (a) (1)-(6) of this section; waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of the Clean Water Act (other than cooling ponds defined in 40 CFR Section 423.11(m) which meet the criteria of this definition) are not waters of the United states (404(b)(1) Guidelines - 40 CFR Section 230.3(s))" (33CFR Part 328, Section 328.3 (a)(1)-(6)).

watershed The area of land from which surface water drains to a single outlet.

wetland
1) "... Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal conditions do support, a prevalence of vegetation, typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (Corps Regulation 33 CFR 328.3 and EPA Regulations 40 CFR 230.3).
2) "... lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface of the land is covered by shallow water"

wetland assessment area(WAA) The wetland area to which results of an assessment are applied.

wetland ecosystem In 404 "...areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (Corps Regulation 33 CFR 328.3 and EPA Regulations 40 CFR 230.0). In a more general sense, wetland ecosystems are three dimensional segments of the natural world where the presence of water, at or near the surface, creates conditions leading to the development of redoximorphic soil conditions, and the presence of a flora and fauna adapted to the permanently or periodically flooded or saturated conditions.

wetland enhancement The process of increasing the capacity of a wetland to perform on, or more functions. Wetland enhancement can increase functional capacity to levels greater than the highest sustainable functional capacity achieved under reference standard conditions, but usually at the expense of sustainability, or a reduction of functional capacity of other functions. Wetland enhancement is typically done for mitigation.

wetland function The normal activities or actions that occur in wetland ecosystems, or simple, the things that wetlands do. Wetland functions result directly from the characteristics of a wetland ecosystem and the surrounding landscape, and their interaction.

wetland restoration The process of restoring wetland function in a degraded wetland. Restoration is typically done as mitigation.