

Stream Function Assessment Method User Manual

Version 1.1

April 2020



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Acknowledgements

This Stream Function Assessment Method (SFAM) and this User Manual was developed for use in the State of Oregon.

Many people contributed to the development of this method over a period of several years as SFAM moved from concept to reality. The authors are extremely grateful for these contributions, and wish to particularly acknowledge the following individuals for their significant technical and scientific support at various stages of SFAM development:

Peter Skidmore, *Skidmore Restoration Consulting*
Andrea Wagner, *U.S. Army Corps of Engineers, Portland District*
Melody Rudenko, *Oregon Department of State Lands*
Larissa Rohrbach, Dalton Hance, Sydney Gonsalves, Alex Caillat, Kara Hitchko, Josh Murauskas,
Anchor QEA
Gregg Lomnicki, Howard Bruner, *CSS-Dynamac*
Will Harman, *Stream Mechanics*
Polly Gibson, *Willamette Partnership*
Greg Koonce, *Inter-Fluve*

Funding

Development of the Stream Function Assessment Method has been primarily funded by the U.S. Environmental Protection Agency through cooperative agreements (Wetland Program Development Grants) and contracts.

Cover photo of the Metolius River courtesy of the Oregon Department of State Lands.

The SFAM Method (calculator workbook) and this User Manual should be cited as:

Nadeau, T-L., D. Hicks, C. Trowbridge, N. Maness, R. Coulombe, N. Czarnomski. 2020. Stream Function Assessment Method for Oregon (SFAM, Version 1.1). Oregon Dept. of State Lands, Salem, OR, EPA 910-R-20-002, U.S. Environmental Protection Agency, Region 10, Seattle, WA.

The supporting website for SFAM should be cited as:

McCune, M., M. Rempel, C. Trowbridge, T-L. Nadeau, D. Hicks, J. Kagan. 2019. Oregon Explorer-Stream Function Assessment Method (SFAM) Map Viewer: an internet tool for SFAM support. Oregon State University Library and Institute for Natural Resources, Oregon State University, Corvallis, OR. Internet: http://tools.oregonexplorer.info/OE_HtmlViewer/Index.html?viewer=orwap_sfam.

The Scientific Rationale, a separate document providing extensive information about the SFAM development process and the scientific underpinning of standard performance indices for included measures, should be cited as:

Nadeau, T-L., C. Trowbridge, D. Hicks, and R. Coulombe. 2020. A Scientific Rationale in Support of the Stream Function Assessment Method for Oregon (SFAM, Version 1.1). Oregon Department of State Lands, Salem, OR, EPA 910-R-20-003, U.S. Environmental Protection Agency, Region 10, Seattle, WA.

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1.0 Introduction

The Stream Function Assessment Method (SFAM) was developed to provide a standardized, rapid, more function-based method for assessing stream function statewide. This method is intended to further federal and state regulatory objectives by informing mitigation planning. The current document (Version 1.1) reflects edits and corrections stemming from user comments and input received since SFAM Version 1.0 was made publicly available in June 2018. A section has been added on the use of SFAM to inform restoration design and predict stream function, the SFAM Workbook has been coded to automatically link data entered into Field Forms with other Workbook tabs to reduce effort and the potential for transcription errors, and new and updated data layers were added to the SFAM Map Viewer. This User Manual also includes updates to maintain consistency with revisions made to other SFAM components (i.e., Excel Workbook, SFAM Map Viewer, Scientific Rationale) to produce SFAM Version 1.1 and replaces the Version 1.0 document.

The federal Final Compensatory Mitigation Rule (2008), under Clean Water Act¹ (CWA) Section 404, promotes the use of function assessment to determine the appropriate amount of compensatory mitigation to replace the loss of functions due to unavoidable impacts to aquatic resources. The Oregon Removal-Fill Law requires the replacement of the functions and values of water resources lost due to permitted impacts. Compensatory mitigation is commonly understood as the requirement to offset loss or impacts to functions and values associated with permitted actions; occurring only after impacts are first avoided and minimized to the extent possible. Both state (State Removal-Fill Law²) and federal (CWA) policies require mitigation for impacts to waters of the state and waters of the U.S. This includes impacts to streams. SFAM has been developed to provide a predictable, transparent, and scientifically robust approach to assessing the ecological processes affected by unavoidable impacts to streams in Oregon.

Oregon has a mature federal and state wetland mitigation process in place. However, Oregon lacked an equivalent process for stream aquatic resources. Filling this gap became increasingly important with the release of the 2008 Final Compensatory Mitigation Rule and revisions to Oregon's Removal Fill Law in 2009 to reflect applicability of mitigation requirements for all waters of the state. Staff from the Oregon Department of State Lands (ODSL), the Army Corps of Engineers (Corps), and the Environmental Protection Agency (EPA) identified the need for a stream mitigation framework that would fill this gap. The agencies also sought to satisfy the needs of key partner agencies whose regulatory programs overlap with the authorities of the ODSL, the Corps, and the EPA, such that the regulatory agencies are able to review proposed mitigation in a consistent, transparent, and coordinated manner.

Across the country, there is extensive experience with assessing impacts to wetlands to inform mitigation, but standardized frameworks to assess stream impacts and inform stream mitigation are lacking. Those that do exist generally assess structural conditions to quantify impacts and mitigation requirements. There is growing concern that this approach does not adequately mitigate for impacts to stream functions (National Research Council, 2001; Bernhardt *et al.*, 2005; Lave, Robertson and Doyle, 2008; Bronner *et al.*, 2013). Research indicates that structural condition and the type of impact (e.g. installation of rip rap) are not defensible indicators of function (NRC 2002; Sandin and Solimini, 2009). Further, the efficacy of structure and condition-based restoration practices is uncertain (Roni *et al.*, 2008; Whiteway *et al.*, 2010; Bernhardt and Palmer, 2011; Louhi *et al.*, 2011; Mecklenburg and Fay, 2011; Sundermann *et al.*, 2011; Violin *et al.*, 2011; Doyle and Shields, 2012). Thus, SFAM seeks to improve assessment and mitigation outcomes by providing a clearer link between project objectives and stream functions (Schwartz and Herricks, 2007) and supporting implementation of a function-based stream mitigation program.

While SFAM has been developed for mitigation application, it has broader application where a rapid function-based stream assessment could inform management, conservation, and restoration decision making and monitoring efforts. A Scientific Rationale documenting the development of SFAM— from conception through measure development, iterative field testing and statistical method (model) analysis— detailing standard performance index development, and providing scientific support for the development process, measure inclusion, and calculation of outputs, is also available to the user community (Nadeau *et al.*, 2020). This supports a deeper critical understanding of the method, facilitates the transfer and adaptation of SFAM, and promotes improvements as new information becomes available.

1 "Compensatory Mitigation for Losses of Aquatic Resources; Final Rule" Department of Defense 33 CFR Parts 325 and 332. Environmental Protection Agency 40 CFR Part 230 73(70) (10 April 2008), pp19594-19705.
2 ORS 196.795-990

2.0 Overview of SFAM

2.1 Limitation of Use

Oregon's extremely varied climate, hydrology, and geology results in a broad range of streams and rivers. Given this extensive variety of streams, and our aim to develop an assessment method that supports the state and federal compensatory mitigation program, our objective in developing this first version of SFAM is that it would apply to 80% of the permit applications received for impacts to streams. SFAM is primarily applicable to wadeable streams. We are exploring scientifically-supported modifications for non-wadeable streams and large rivers, and tidally- influenced streams, which may be addressed in future versions of the method.

2.2 Ecological Functions & Values

State and federal regulatory programs are responsible for maintaining the quantity, quality, and beneficial uses of streams (2008 USACE/USEPA Final Compensatory Mitigation Rule, Oregon's Removal Fill Law). Therefore, SFAM has been designed to assess both the functions and values that streams provide. Stream functions are dynamic and interrelated physical, chemical and biological processes that create and maintain the character of a stream and the associated riparian system, and determine the flux of energy, materials and organisms through or within a stream system. Stream values are the ecological and societal benefits that the stream system provides, determined by (a) the opportunity to provide a particular function and (b) the local significance of that function.

In a practical manner, a function can either be expressed or not expressed at a given site, but a value is the context of that function in the broader landscape. For example, a stream site may be effective for removing nutrients, but the value of the stream reach performing that function is higher if there is a higher concentration of nutrients entering the reach from upstream (opportunity), and there are uses downstream that would benefit from lower nutrient concentrations (significance).

Four functional groups provide the basis for a function-based assessment for streams:

1. **Hydrologic functions:** include movement of water through the watershed and the variable transfer and storage of water along the stream channel, its floodplain, and associated alluvial aquifer.
2. **Geomorphic functions:** encompass hydraulic and sediment transport processes that generate variable forces within the channel and the variable input, transfer and storage of sediment within the channel and adjacent environs that are generally responsible for channel form at multiple scales.
3. **Biological functions:** include processes that result in maintenance and change in biodiversity, trophic structure, and habitat within the stream channel.
4. **Water quality functions:** encompass processes that govern the cycling, transfer, and regulation of energy, nutrients, chemicals and temperature in surface and groundwater, and between the stream channel and associated riparian system.

Within these broad groups, a suite of 11 stream functions is identified. The 11 functions were identified through expert workshops and extensive literature review (USEPA, 2012). To ensure that functions were categorized and described sufficiently for application to mitigation, the following criteria guided the selection and definition of functions:

1. **Relevance:** function assessed is relevant to impacts resulting from proposed actions and is relevant to a broad spectrum of native species across varying stream types and spatial scales.
2. **Utility:** function assessed is practical for mitigation accounting because it is practically measurable and quantifiable, responsive to actions, and predictable.

3. **Multi-functionality:** function assessed represents the interrelated character of stream functions and is likely to contribute to positive change in other functions and influence overall stream system health.

Definitions of the 11 functions assessed by SFAM are provided in **Table 2.1**.

Table 2.1 Stream Function Categorization, Definition, and Ecosystem Services Provided

FUNCTIONAL GROUP	SPECIFIC FUNCTIONS	DEFINITION AND SERVICES/VALUES PROVIDED
Hydrologic functions	Surface water storage (SWS)	Temporary storage of surface water in relatively static state, generally during high flow, as in floodplain inundation, backwater channels, wetland depressions. Providing regulating discharge, replenishes soil moisture, provides pathways for fish and invertebrate movement, low velocity habitat and refuge, and contact time for biogeochemical processes.
	Sub/surface transfer (SST)	Transfer of water between surface and subsurface environments, often through hyporheic zone. Provides aquifer recharge, base-flow, exchange of nutrients/chemicals through hyporheic, moderates flow, and maintains soil moisture.
	Flow variation (FV)	Daily, seasonal and inter-annual variation in flow. Provides variability in stream energy driving channel dynamics, provides environmental cues for life history transitions, redistributes sediment, provides habitat variability (temporal), provides sorting of sediment and differential deposition.
Geomorphic functions	Sediment continuity (SC)	The balance between transport and deposition of sediment such that there is no net erosion or deposition (aggradation or degradation) within the channel. Maintains channel character and associated habitat diversity, provides sediment source and storage for riparian and aquatic habitat succession, maintains channel equilibrium.
	Substrate mobility (SM)	Regular movement of channel bed substrate. Provides sorting of sediments, mobilizes/flushes fine sediment, creates and maintains hydraulic diversity, creates and maintains habitat.
Biological functions	Maintain biodiversity (MB)	Maintain the variety of species, life forms of a species, community compositions, and genetics. Biodiversity provides species and community resilience in the face of disturbance and disease, full spectrum trophic resources, balance of resource use (through interspecies competition).
	Create and maintain habitat (aquatic/riparian) (CMH)	Create and maintain the suite of physical, chemical, thermal and nutritional resources necessary to sustain organisms. Habitat sustains native organisms. Habitat includes in-channel habitat, as defined largely by depth, velocity, and substrate, and riparian habitat, as defined largely by vegetative structure.
	Sustain trophic structure (STS)	Production of food resources necessary to sustain all trophic levels including primary producers, consumers, prey species and predators. Trophic structure provides basic nutritional resources for aquatic resources, regulates the diversity of species and communities.
Water Quality functions	Nutrient cycling (NC)	Transfer and storage of nutrients from environment to organisms and back to environment. Provides basic resources for primary production, regulates excess nutrients, provides sink and source for nutrients.
	Chemical regulation (CR)	Moderation of chemicals in the water. Limits the concentration of beneficial and detrimental chemicals in the water.
	Thermal regulation (TR)	Moderation of water temperature. Limits the transfer and storage of thermal energy to and from streamflow and hyporheic zone.

2.3 Measures of Function & Value

Stream functions are expressed in varied and complex ways; therefore, they are difficult, costly, and time-consuming to measure directly. To enable the assessment of functions and values within the constraints of a rapid method, measures were identified for each function.

Measures are metrics that allow a quantitative or qualitative assessment of specific characteristics that may indicate the extent to which a particular function is active. Measures can be continuous or discrete variables and may be assessed in the field (e.g., streambank incision, substrate embeddedness, bankfull width (BFW)), in the office (e.g., GIS analysis of land use or impervious areas), or collected from existing sources (e.g., 303(d) listing, EPA stream classification dataset). SFAM measures are primarily quantitative; however, where no practical quantitative approach exists to assess an attribute, measures consisting of observations and scores that represent a defined range (rather than a continuous set of measures) are used.

An initial list of measures was compiled for this project from multiple data sources, including the scientific literature, existing stream assessment protocols, spatial data sources, state-wide databases, and office-based analysis techniques. Selection criteria were then applied to assure the scientific validity of each measure and its practicality for use in a rapid assessment tool. SFAM measures (**Table 2.2**) meet the following inclusion criteria:

- **Rapid:** can be measured within the anticipated timeframe of a rapid assessment method.
- **Repeatable:** multiple trained assessment teams would likely come up with the same value for this measure for a site at a given point in time.
- **Science-based:** a panel of scientists with relevant expertise would agree that the measure is either a direct measure or highly correlated indicator of a particular stream function; it is likely that the relationship between the measure and the function(s) it assesses could be substantiated through peer-reviewed literature or through rigorous scientific evaluation.

Table 2.2 SFAM Function and Value Measures

Function Measures		Value Measures	
F1	Natural Cover	V1	Rare Species Occurrence & Special Habitat Designations
F2	Invasive Vegetation	V2	Water Quality Impairments
F3	Native Woody Vegetation	V3	Protected Areas
F4	Large Trees	V4	Impervious Area
F5	Vegetated Riparian Corridor Width	V5	Riparian Area
F6	Fish Passage Barriers	V6	Extent of Downstream Floodplain Infrastructure
F7	Floodplain Exclusion	V7	Zoning
F8	Bank Armoring	V8	Frequency of Downstream Flooding
F9	Bank Erosion	V9	Impoundments
F10	Overbank Flow	V10	Fish Passage Barriers
F11	Wetland Vegetation	V11	Water Source
F12	Side Channels	V12	Surrounding Land Cover
F13	Lateral Migration	V13	Riparian Continuity
F14	Wood	V14	Watershed Position
F15	Incision	V15	Flow Restoration Needs
F16	Embeddedness	V16	Unique Habitat Features
F17	Channel Bed Variability		

3.0 Overview of the SFAM Assessment Process

The Stream Function Assessment Method (SFAM) is a rapid, science-based approach to assessing the ecological functions and values of a stream reach. Both office work (data collection from maps, online resources and other sources) and field work (onsite measurements and observations) are required to assess measures and calculate SFAM scores.

There are several components of SFAM:

- **SFAM Workbook:** Excel spreadsheets that calculate function and value scores based on the measures assessed for a given site.
- **User Manual** (this document): step-by-step instructions and guidance on completing an SFAM Assessment.
- **SFAM Map Viewer:** online resource of stream-related datasets from state and federal agencies, local governments, and the scientific community.
- **Scientific Rationale:** document describing the development of SFAM (i.e., conception, measure development, iterative field testing, statistical analysis) and providing supporting information from the scientific literature.

It takes approximately two hours to complete the Office Component and anywhere from four to eight hours to collect the field data for the Field Component, depending on the size of the site. Once all the data is collected, it takes approximately two hours to input and review data and to evaluate the results. While one person can conduct the Office Component and data entry for SFAM, a minimum of two people is needed to collect the field data.

An SFAM Assessment may be conducted any time of the year; however, the wet season is recommended for onsite data collection, preferably after a significant flow event that will leave signs of the extent of high water across the site but not during a high flow event that could prevent data collection efforts. If possible, visit the site at least once during the driest time of the year and once during the wet season.

3.1 Basic Steps to Completing an SFAM Assessment

The basic steps to complete an SFAM Assessment are as follows:

1. Complete the Office Component using the ORWAP and SFAM Map Viewer and other available resources.
2. Prepare equipment and documents for your field visit.
3. Visit the site and collect data needed for the Field Component.
4. Enter data in the SFAM Workbook.
5. Review and interpret results.

The following sections of this User Manual provide detailed instructions on completing each of these steps.

3.2 Obtaining and Navigating the Workbook

Obtain SFAM documents from the Oregon Department of State Lands website or the Oregon Explorer Aquatic Mitigation Topic Page (<http://oetest.library.oregonstate.edu/topics/aquatic-mitigation?ptopic=38>). Save a copy of the SFAM Workbook with your site name and date of assessment (or using another naming protocol you have established).

The SFAM Workbook contains eight tabs, each with its own specific purpose (**Table 3.1**).

Table 3.1 Purpose and Description of SFAM Workbook Tabs

Tab	Purpose	Description
Cover Page	Data entry	Worksheet for entering information about the general characteristics of your site and assessment notes.
Values	Data entry	Worksheet for entering office-collected data about your site. Contains 16 questions/measures of stream value.
Functions	Data entry	Worksheet for entering field-collected data about your site. Contains 17 questions/measures of stream function.
Scores	Summary of scores (automatically calculated)	Worksheet with outputs of: 1. Numerical scores (between 0.0 and 10.0) of function and value for your site 2. Ratings (Higher, Moderate or Lower) for the functions and values at your site 3. Grouped function and value scores and ratings (i.e. the representative function/value for each thematic functional group)
Subscores	Summary of measure outputs (automatically populated)	Worksheet providing the measure subscores that contribute to each function and value score, and summarizes the rationale for the model.
Site Layout Field Form	Data entry	Worksheet (printable) with instructions, diagrams, and space for recording field data to guide establishment of the PAA and EAA for your site.
Proximal Assessment Area (PAA) Field Form	Data entry	Worksheet (printable) with: 1. Instructions and space for recording field data assessed in the PAA of your site 2. Automatically calculated outputs for a subset of these measurements See Appendix 4 . Sample Field Forms.
Extended Assessment Area (EAA) Field Form	Data entry	Worksheet (printable) with: 1. Instructions and space for recording field data assessed in the EAA of your site 2. Automatically calculated outputs for a subset of these measurements See Appendix 4 . Sample Field Forms.

Instructions for answering the questions on each tab are provided on that tab and in this Manual. Cells on several tabs of the SFAM Workbook (Cover Page, Values, Functions) are color coded to help guide you: yellow cells in the Values tab indicate where data is entered; orange cells in the Functions tab are linked to the PAA or EAA Field Forms; green cells indicate where automatically calculated outputs are shown.

3.3 Using the ORWAP and SFAM Map Viewer

The ORWAP and SFAM Map Viewer is hosted on Oregon Explorer’s Aquatic Mitigation topic page and can be accessed by navigating to http://oregonexplorer.info/topics/aquatic-mitigation?qt-subtopic_quicktab=0&ptopic=140 and clicking on the SFAM Map Viewer or by navigating directly to http://tools.oregonexplorer.info/OE_HtmlViewer/Index.html?viewer=orwap_sfam. The Map Viewer is an online digital library that integrates and provides access to wetland and stream-related data from state and federal agencies, local governments, and the scientific community. By default, the Map Viewer will display all available layers. To display only the layers necessary to complete an SFAM assessment, go to the Layers tab and select “SFAM” from the drop-down menu.

The Map Viewer contains several tabs, each with a set of tools designed for navigation, viewing and identifying data, and creating images and reports that will be used in the SFAM Assessment (**Figure 3.1**).

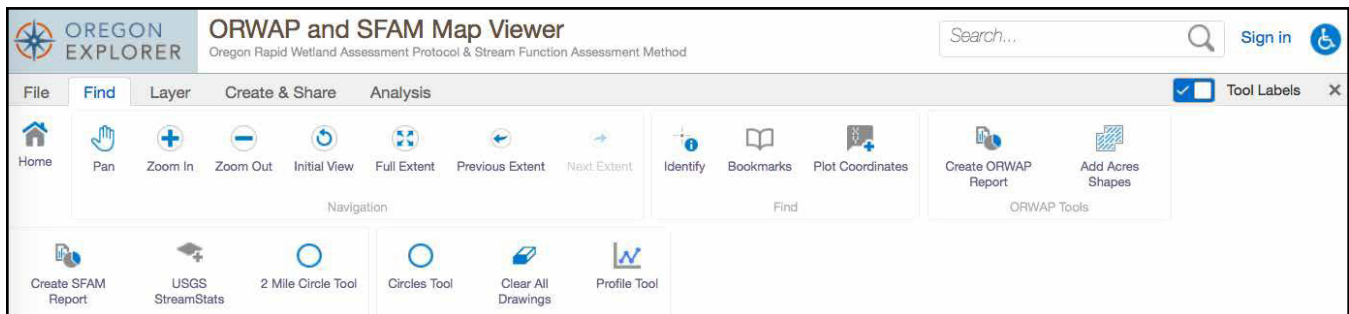


Figure 3.1 Tabs and select mapping tools in ORWAP and SFAM Map Viewer.

The purpose of each of the main ORWAP and SFAM Map Viewer tabs is described in **Table 3.2**.

Table 3.2 Description of ORWAP and SFAM Map Viewer Tabs

Tab	Purpose
File	Tool to create a printable version of the map displayed.
Find	A suite of navigation tools (Zoom, Pan, etc.) allow for manual exploration of the map. For convenience, this set of tools has been made available on all tabs in the form of a condensed drop-down menu. It is also possible to navigate to a known location by entering latitude and longitude using the Plot Coordinates tool. The Identify tool allows users to obtain information about specific features of active data layers. The USGS StreamStats tool provides a link and instructions for obtaining necessary data from the StreamStats database. The Create SFAM Report tool prompts users to outline an assessment area and then produces a data report for that area (see “Create an SFAM Report” in Section 4.2 below).
Layer	<p>Spatial data layers are grouped roughly into themes: Wetlands, Hydrology, Water Quality and Quantity, Floodplain, Soils, Land Classification, Habitat, Restoration, and Basemaps. Selecting the box next to the Layer group name and clicking the “+” button, expands the list of individual data layers within that group. Selecting an individual layer loads the data from that layer into the Map Viewer and provides the layer key.</p> <p>The Layer tab has several tools for advanced users who wish to Filter or Query information from specific data layers. The Upload Data tool allows the user to load and view data layers (.csv, .xlsx, .kml, .shp, .gpx, or a .zip containing a FileGDB or shapefiles) that are imported from other sources. Any external data uploaded to the Map Viewer will need to be reloaded each time a new session of the Map Viewer is launched.</p> <p>Information (including the metadata and web service data) is available for each layer by clicking the grey arrow to the right of the layer name. You can also download or remove layers.</p>
Create & Share	Drawing tools allow a user to add points, lines, polygons, and/or text to the map before saving or printing. Basic instructions for each tool will appear in the top of the Map Viewer once it is selected. The Edit tool allows users to make edits after a line or shape has been created. Users can then Export their drawings (without the map imagery) as a shapefile or they can export the entire map (imagery and drawings) as a PDF or image file.
Analysis	Measurement tools allow the user to calculate distance or area. Once a line or polygon is drawn, the relevant measurements appear in the Map Viewer and additional tools appear in the toolbar, allowing the user to choose the unit of measurement.

In addition to the tabs, the Map Viewer provides quick access or shortcuts to some commons tasks:



Home takes you to the introductory screen of the Map Viewer



Layers takes you to the list of SFAM data layers that can be loaded for analysis



Coordinates provides options for determining the latitude and longitude of your site



Basemaps allows you to select from different maps (e.g., aerial imagery, topographic) as the basemap



Scale allows you to select from a range of fixed map scales or to enter a specific map scale

Additional instructions and helpful hints for using the various tools in the SFAM Map Viewer are provided in **Appendix 1**.

3.4 Scales of an SFAM Assessment

Each measure in SFAM is evaluated at a scale or spatial extent applicable or relevant for the particular measure being assessed. To accomplish this, SFAM establishes three assessment area extents: Project Area, Proximal Assessment Area, and Extended Assessment Area (**Figure 3.2**).

The **Project Area (PA)** is the spatial extent of the direct impact (e.g., removal, fill, grading, planting, etc.) that a project (permitted action, mitigation, restoration) will have on a stream and surrounding area. Some projects may have multiple areas of impact but are part of a singular larger project.

The **Proximal Assessment Area (PAA)** allows for assessment of functions likely to be directly impacted by actions taken in the PA. The PAA includes the entire channel, both streambanks, and the riparian area, and upland adjacent to the impacted area on both sides of the stream.

The PAA has two sets of boundaries. The longitudinal boundaries are determined by the upstream and downstream extent of the PA, or 50 feet, whichever is greater.

The lateral boundaries extend from the channel edge a distance of two times the bankfull width ($2 \times \text{BFW}$) or 50 feet, whichever is greater. Refer to the Bankfull Width text box on the following page for a description of this measurement.

The **Extended Assessment Area (EAA)** allows for assessment of functions that may be expressed at a reach scale that is broader than the footprint of the project. The EAA has the same lateral boundaries as the PAA ($2 \times \text{BFW}$, 50 feet minimum), but the longitudinal boundaries extend a distance equal to five times BFW in each direction from the PAA. The EAA includes the entire PAA.

In addition, observations or measurements for several measures are taken along transects which run perpendicular to the stream through the riparian area, floodplain, and potentially upland adjacent to the channel.

Riparian areas are the transition zones between aquatic systems and terrestrial systems, and usually have characteristics of both. Riparian areas can store water; help protect soil and streambanks from excess erosion; absorb the water, nutrients, and energy from larger flow events; and provide organic inputs into the stream to support aquatic organisms. Riparian areas occur in a wide range of climatic, hydrologic, and ecological environments, and can naturally support a variety of plant communities. While riparian areas provide habitat for a variety of animals, SFAM does not evaluate the riparian habitat itself; but rather the contribution of the riparian area to stream functions.

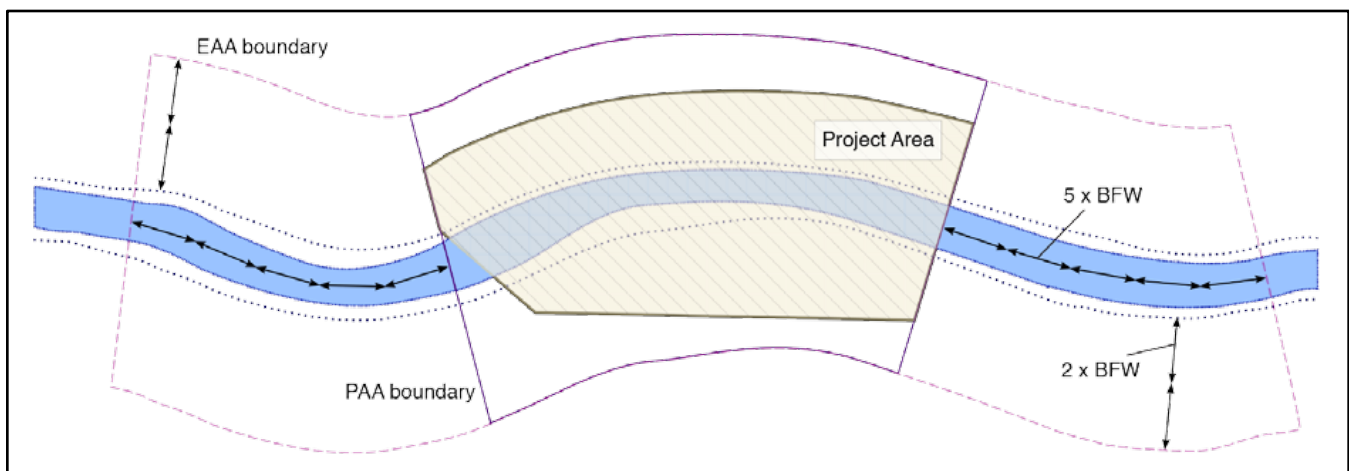


Figure 3.2 Layout of the three assessment areas in SFAM.

Bankfull Width. SFAM uses the bankfull width (BFW) to scale assessment boundaries to stream size; a larger stream size (and therefore larger BFW) will result in a larger assessment area. The bankfull width is the portion of the channel that contains the bankfull discharge, which is a flow event that occurs frequently (every 1 to 2 years), but that does not include larger flood events. The bankfull discharge has an important role in forming the physical dimensions of the channel.

For most stream channels, the BFW can be identified in the field by an obvious slope break that differentiates the channel from a relatively flat floodplain terrace higher than the channel, or a transition from exposed stream sediments or more water tolerant vegetation (e.g. willows) to terrestrial vegetation. In locations without vegetation, moss growth on rocks along the banks can be an indicator of this 'line' as can breaks in bank slope or substrate composition.

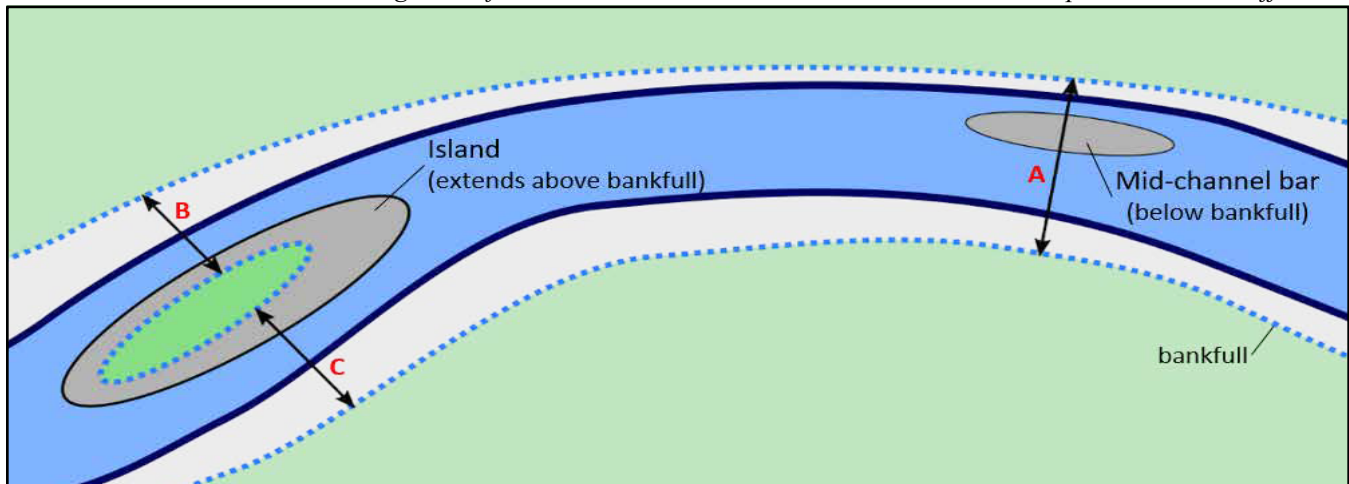
The BFW is measured by the distance across the channel (perpendicular to stream flow) between the lines on each bank demarcating the bankfull stage. In SFAM, the BFW should be measured in at least three places within the PA/PAA that are somewhat uniform (avoid taking measurements in irregular areas such as meanders or bends, road or trail crossing, or large wood jams). The average of these measures is used for establishing extent of the assessment areas.

Note that:

Mid-channel bars are included in the BFW (**Figure 3.3, Width A**). Mid-channel bars are defined as channel features lower in elevation than the line at the top of the active channel, but are frequently dry during baseflow conditions.

Islands are not included in the BFW. Islands are channel features that are dry even when the river is at bankfull stage. If a mid-channel feature is as high as the surrounding floodplain, it is considered an island. Measure and sum the multiple "bankfull widths" surrounding the island (**Figure 3.3, Widths B and C**).

Detailed instructions on delineating each of these assessment areas and transect locations are provided in the Office



Component and Field Component instructions of this Manual.

Figure 3.3 Measuring bankfull width.

Mid-channel bars are included in bankfull width (Width A). Islands are not included in bankfull width; bankfull width intersected by an island is the sum of the bankfull widths surrounding the island (Width B + Width C).

3.5 Applying SFAM Under Specific Circumstances

There are specific circumstances or conditions where the application of SFAM may need to be adjusted. Adjustments for some of those common circumstances are described below. For these, and for any circumstance that is not fully covered by SFAM, please provide a general description of adjustments that were made in the Assessment Notes box on the Cover Page of the SFAM Workbook.

Single vs Multiple SFAM Assessments

SFAM is designed to assess a single project on one stream at a time. This assures data is being collected within areas likely to change as a result of the project and makes SFAM outputs more sensitive.

Some projects may include multiple locations on a single stream, such as a series of bendway weirs or large wood placements. These locations may be combined into a single PA when the PAAs for each location would otherwise abut or overlap. Project locations where the PAAs do not abut should be split into separate PAs and two SFAM assessments performed.

When there is a series of very similar projects on one stream, then it may be sufficient to assess a subset of these and assume results will be similar. Preliminary consultation with the agencies is recommended to determine the number of assessments needed, but at least three are recommended to be representative.

Separate SFAM assessments are needed when a project spans more than one stream, such as when a project is at the junction of two streams. The PA for each stream should only include the activities that are located on that stream.

SFAM Assessment on Dry Channels



A ‘dry-channel assessment’ is one that should be conducted when ANY portion (length) of the stream is dry (i.e. having no surface water in cross-section). If any of the stream along the length of the EAA is dry, follow the ‘dry-channel’ instructions for measures that require modification of the data collection method. The measures with modified instructions for a dry channel are Cover, Embeddedness, and Channel Bed Variability. Look for this icon to indicate when to use modified instructions for a dry- channel assessment.

SFAM Assessment with Access Issues



While assessment of both sides of the streambank is optimal and expected, if it is infeasible to access one streambank/side of the channel to collect data (due to physical site conditions or legal issues), data collection for certain measures can be restricted to one side of the stream. The measures with modified instructions for sites with access issues are Invasive Weeds, Native Woody Vegetation, Large Trees, Vegetated Riparian Corridor Width, Overbank Flow, and Wetland Vegetation. Look for this icon to indicate when to use modified instructions for sites with access issues. Do not enter data for these measures for the un-accessed side of the streambank. It is important that you indicate on the PAA Field Form if data was collected on only one side by selecting “Left” or “Right” bank from the drop-down menu in cell R15 (which will modify calculations accordingly).

We do not recommend that you use other resources (e.g. aerial imagery or Google Earth) to make estimates or educated guesses about these measures.

SFAM Assessment with Partially or Fully Restricted Access to the Extended Assessment Area

Data collected in the EAA are an important component of an SFAM assessment, providing information about reach level processes and channel structure and variability that inform several of the function subscores. Standard performance indices developed for each of the measures are based on the data collection protocols that contribute to the accuracy, consistency, transparency, and repeatability of the field method. Furthermore, in assessing impacts, it is beneficial to get information beyond the PA, in the EAA, because it considers aspects of stream function that are not directly impacted which are reflected in assessment outputs. Thus, it is important to collect data as directed for each of the measures to the extent possible to assure meaningful outputs. If you must make an adjustment to the data collection protocol, we recommend solving the issue at the level of the problem (i.e. at the measure level), and clearly document those adjustments on the Cover Page.

If you are unable to secure legal access to the EAA, or encounter physical barriers that prevent you from accessing the EAA, use the following guidance to adjust the data collection method:

- If only some portion of the EAA is accessible, adjust the length of the EAA to the accessible stream area. If the length of the adjusted EAA is 10 x BFW or longer, take all EAA measurements in that reduced area (i.e. still do the 11 transects).
- If the adjusted EAA is < 10 x BFW in length, then:
 1. Collect the data as directed for Side Channels, Wood, Lateral Migration, Embeddedness and Incision in the adjusted EAA.
 2. Do not collect the component measures for Channel Bed Variability (Wetted Width and Thalweg Depth). Rather, based on the features of the reach within the adjusted EAA that you can observe upstream and downstream, indicate the category (Lower, Moderate, Higher) that best describes channel bed variability and hand enter the corresponding number from **Table 3.3** in the Functions tab of the SFAM Workbook. **Table 3.4** provides general expectations informing estimates of Wetted Width and Thalweg Depth

Table 3.3 Numerical measure data entry inputs for Wetted Width and Thalweg Depth corresponding to “lower,” “moderate,” and “higher” estimates of Channel Bed Variability.

Function Value Entry on Workbook	Category		
	Lower	Moderate	Higher
Wetted Width	.108	.300	.446
Thalweg Depth	.162	.445	.656

Table 3.4 General Wetted Width and Thalweg Depth expectations informing “lower,” “moderate,” and “higher” estimates of Channel Bed Variability.

Channel Bed Variability	Wetted Width	Thalweg Depth
Lower	Widest portions of stream <2X wider than the most narrow portions	Deepest portions (pools) <3X depth of the shallowest areas (riffles)
Moderate	Widest portions of stream 2-3X wider than the most narrow portions	Deepest portions (pools) 3-6X depth of the shallowest areas (riffles); this occurs in several locations
Higher	Widest portions of stream >3X wider than the most narrow portions	Deepest portions (pools) >6X depth of the shallowest areas (riffles); this occurs in several locations

SFAM Assessment on Multiple Channels



A stream with multiple channels is one where the flow of water splits between two or more paths separated by an ‘island’; a mid-channel feature that would still be exposed during bankfull flow (see Bankfull Width instruction box above). Most SFAM measures can be evaluated as described for multiple channel streams, recognizing that the ‘banks’ of the stream refer to the outer-most banks of the stream, not the banks of the islands. Two measures, Embeddedness and Channel Bed Variability, require modified instructions for multiple channel streams. Look for this icon to indicate when to use modified instructions for a multiple channel assessment.

SFAM Assessment with No Pre-Defined Impact

For assessments with undefined footprints (e.g. non-regulatory uses), it is not necessary to delineate a PA. However, the upstream and downstream extent of the PAA must be designated. It is recommended that the PAA be centered within the stream reach to be represented and the length of the PAA (distance between the upstream and downstream PAA boundaries) be scaled to the bankfull width of the stream. In this case, the PAA length would be at least 30x the average bankfull width, resulting in an EAA length of at least 40x bankfull width. Stream assessment lengths of 40x width are recognized as necessary to characterize the habitat and several biotic assemblages associated with a stream reach (USEPA, 2013).

SFAM Assessment for Long Project Areas (PA > 1000 feet)

When the PA is longer than 1000 feet, additional PAA transects are needed to represent the vegetation in the riparian area. The maximum distance between transects should be 250 feet. For example, a PA of 2000 feet would require eight PAA transects.

SFAM Assessments for Linear Projects Crossing Multiple Streams

For linear projects such as pipelines, roads, powerlines, etc. that will have impacts to multiple streams, preliminary work with the agencies is recommended to determine the number of assessments needed. It may be appropriate to evaluate multiple streams that are similar in nature, such as the same stream classification, flow permanence class (ephemeral, intermittent, perennial), slope, surrounding land use, structure, etc., using “representative” stream reaches for SFAM assessments. More than one SFAM Assessment will be needed to represent multiple streams.

SFAM Assessments at Crossings



It will often be the case that an SFAM Project Area is centered on a significant structure (e.g., road, culvert, bridge, diversion, etc.). It is important to capture the impact of the structure in the assessment by evaluating the Function Measures as closely as possible to the methods described in the User Manual. Measurement transects are not to be moved to ‘avoid’ the structure. Rather, the data and observations should reflect the structure(s). In some cases, it may not be physically possible to record the requested data. (e.g. measuring stream depth within a small culvert). In such cases, there are often analogous measures or assumptions that could be made that allow the practitioner to record relevant data.

The measures with modified instructions for an assessment centered on a structure are Natural Cover, Invasive Vegetation, Native Woody Vegetation, Large Trees, Incision, Embeddedness, and Channel Bed Variability. Look for this icon to indicate when to use modified instructions for an assessment centered on a crossing.

4.0 Office Component Instructions

The Office Component of an SFAM Assessment uses data and information available from online resources, reports, maps, etc., about the site and surrounding area to generate scores for the values or services provided by the site, and provides advance information on some function measures.

The Office Component should be completed prior to the Field Component. To maximize efficiency, users should review this entire section before starting an SFAM Assessment. In addition, detailed instructions on completing common ORWAP and SFAM Map Viewer functions and tasks can be found in **Appendix 1**.

4.1 Create a Site Map

These instructions will guide you in developing a preliminary map of the SFAM site described in **Section 3.4**. This can be done on a digital or printed map, however the ORWAP and SFAM Map Viewer has been designed specifically for this purpose. The site map is needed for regulatory purposes to show the approximate and relative locations of the PA, PAA and EAA (**Section 6.4**), for answering Value questions in the office and for locating the approximate location of assessment area boundaries in the field. The PAA and EAA both use average BFW in determining their extent and this can only be generally estimated in the office. Once on site, users should take accurate measurements and physically lay out the PA, PAA, and EAA using measuring tapes and flags. Note that two site maps, one showing an aerial photo and a second a 7.5' topographic map, illustrating the approximate PA, PAA, and EAA boundaries are required when submitting an SFAM Assessment for regulatory purposes.

Quality maps and aerial imagery of the site are desirable for efficient work and good documentation. It is best to have a few maps of different scale in aerial imagery and topography, with streams and roads indicated. The site map will be one of the products submitted to regulatory agencies as part of an SFAM Assessment.

Step 1. Create a Digital Map of the Site

Open the ORWAP and SFAM Map Viewer in your web browser (http://tools.oregonexplorer.info/OE_HtmlViewer/Index.html?viewer=orwap_sfam) and navigate to your project site using the Zoom or Plot Coordinates tools on the Find tab, or by searching an address, place name, or latitude/longitude coordinates in the Search box on the home page.

The Map Viewer provides a wide variety of base imagery and tools that can be used to produce the site map. Two site maps, one showing an aerial photo and a second showing a 7.5' topographic map, and illustrating the approximate PA, PAA and EAA boundaries is required as part of submission of an SFAM Assessment for regulatory purposes. Maps can be printed or exported in a variety of formats.

Additional sources for aerial imagery include:

- Google Earth: <http://www.google.com/earth/index.html>
- Microsoft Imagery: <http://www.bing.com/maps/>

Aerial imagery should be centered on the project site and include the surrounding landscape. Images should be the most recent available and at a scale of 1:24,000 (1 inch = 0.5 mile) or finer.

Step 2. Draw the Project Area

Delineate the extent of your PA on the map or image by creating a polygon using drawing tools in the Create & Share tab of the SFAM Map Viewer. The PA is the spatial extent of direct impact (e.g., removal, fill, grading, planting, etc.) that a project (permitted action, mitigation,

restoration) will have on a stream and surrounding area. Some projects may have multiple areas of impact but are part of a singular larger project. If a project includes multiple but related areas of impact, the PA should encompass an area which includes all areas of impact. If the exact footprint of the PA is unknown, delineate an area that includes the maximum possible footprint of the project. Label the PA using the Text tool.



Tip: To modify a shape, select the Edit tool, drag the vertices to the desired locations, and then click again on the Edit tool to stop modifying. To erase a drawing, select the Erase tool then click on the drawing. Using the Clear tool will eliminate all drawings made on the map.

Step 3. Draw the Estimated Proximal Assessment Area Boundaries

Use a drawing tool on the Create & Share tab to draw the approximate boundaries of the PAA. The longitudinal boundaries of the PAA are at the upstream and downstream extent of the PA, or 50 feet of stream length centered on the PA, whichever is the greater stream length. Locate the approximate lateral boundaries of the PAA at a distance of $2 \times$ the average BFW or 50 feet from the stream edge (bankfull edge), whichever is greater, on each side of the stream. If the edge of the stream is visible on aerial images, estimate the average bankfull channel width (BFW) throughout the PA using the Distance tool in the Analysis tab. If BFW is not visible, use an estimate based on visible reaches upstream and downstream, or use 50 feet. Label the PAA using the Text tool. Note – the PAA lateral boundaries can be smaller than the PA.



Tip: To use the Distance tool, select it and then click on the map in the location you want to start your measurement. Use your computer mouse to extend the line out, pausing to display the distance of the line or clicking once to create a new segment of the line. To end the line, double click and the total distance will be displayed. To delete the line and the distance display from the map, select the Erase tool from the Analysis tab and click on the line.

Step 4. Draw the estimated Extended Assessment Area boundaries

Use a drawing tool on the Create & Share tab to draw the approximate boundaries of the EAA. The upstream and downstream EAA boundaries are identified by multiplying the average BFW by 5 and measuring that distance upstream and downstream from the PAA upper and lower boundaries respectively. The lateral boundaries of the EAA are the same distance from the stream edge (bankfull) as for the PAA above (i.e. $2 \times$ BFW or 50 feet, whichever is greater). Note that the EAA contains the entire PAA (i.e. the PAA is part of the EAA). Label the EAA using the Text tool.

Figure 4.1 shows an example of a site map with PA, PAA, and EAA boundaries drawn and labeled using SFAM Map Viewer tools



Tip: To draw the PAA and EAA shapes, it is helpful to use the Distance tool to draw two lines of the necessary lengths ($2 \times$ average BFW and $5 \times$ average BFW, respectively, or 50 feet) near but slightly away from the PA for reference. To change the color of a shape, select the Edit tool from the Create & Share tab, click on the shape, and select Styles in the resulting display box. Choose from an existing style, or create your own style following the prompts provided.

Step 5. Save A Copy of the Site Map

Save a copy of the site map using the Print or Export tools on the Create and Share tab. Instructions on how to do this can be found in **Appendix 1**.

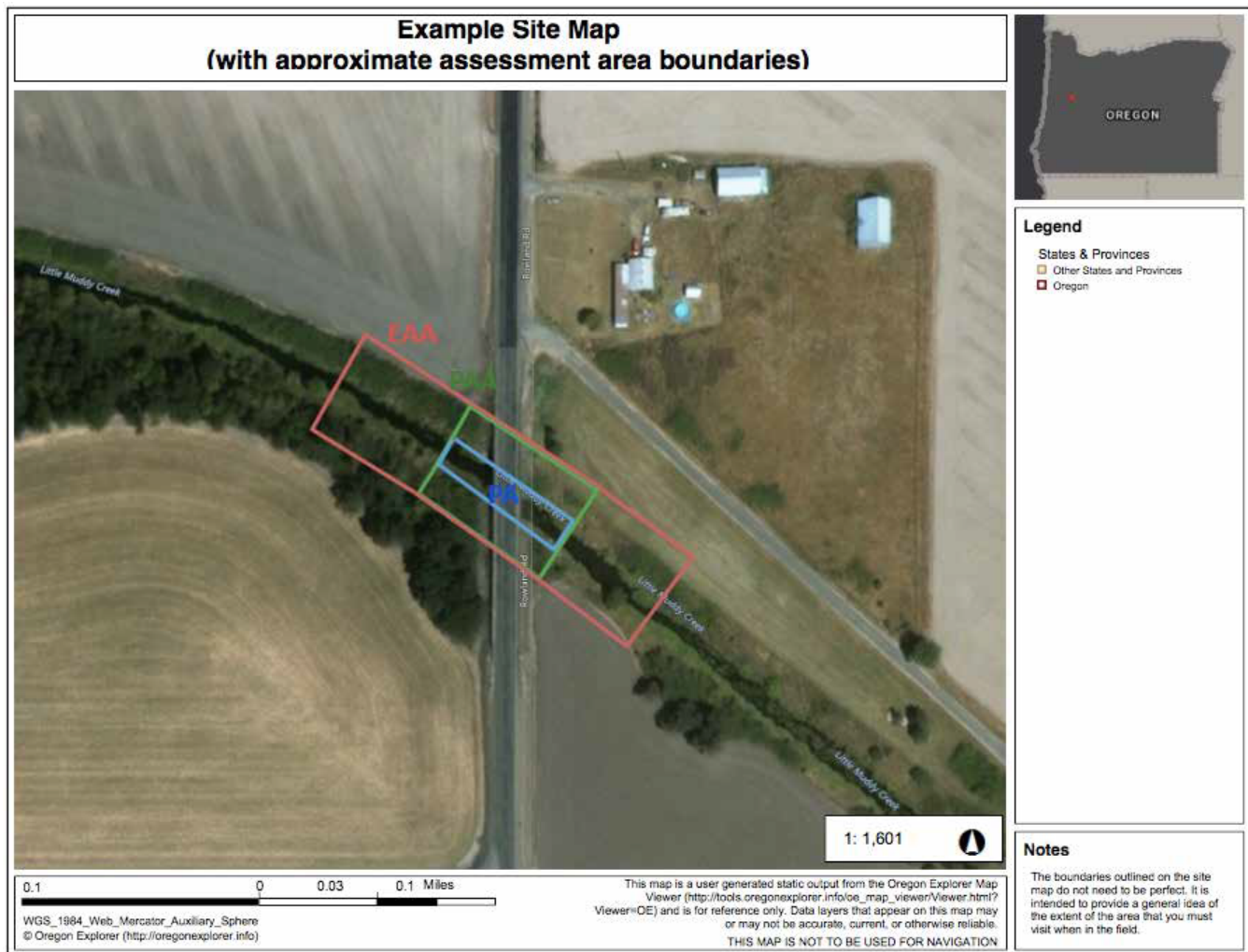


Figure 4.1 Example of a site map with Project Area, Proximal Assessment Area, and Extended Assessment Area in the ORWAP and SFAM Map Viewer.

4.2 Generate an SFAM Report and StreamStats Report

The Office Component of an SFAM Assessment can be completed using information from the ORWAP and SFAM Map Viewer and other online resources. The SFAM Report, generated in the SFAM Map Viewer, provides the information needed for many of the Workbook measures, and data layers in the Map Viewer can be visually analyzed to obtain responses to several others.

Create an SFAM Report

Open the ORWAP and SFAM Map Viewer in your web browser (http://tools.oregonexplorer.info/OE_HtmlViewer/Index.html?viewer=orwap_sfam) and navigate to your site using the Zoom or Plot Coordinates tools on the Find tab. You can also search an address, place name, or latitude/ longitude coordinates in the Search box on the home page.



Click the Create SFAM Report icon on the Find tab and follow the instructions provided in the sidebar of the Map Viewer. You will be prompted to delineate the PA boundary using drawing tools (click Draw Area) or by uploading a shapefile (click Upload Shapefile). The boundary should include the upstream and downstream boundaries of the project and capture some of the riparian areas on both sides of the stream.



Tip: While the SFAM Report cannot be generated directly from the polygon previously drawn for the site map, during the report generation process you can simply trace over the PA polygon using the drawing tools provided.

When prompted, download the SFAM Report and save the PDF file to your computer. An example SFAM Report is shown in **Figure 4.2**.

Create a StreamStats Report

A StreamStats Report is created using data from the U.S. Geological Survey (USGS) StreamStats database. The StreamStats Report provides information about the drainage area of your PA. An example StreamStats Report (partial) is shown in **Figure 4.3**.



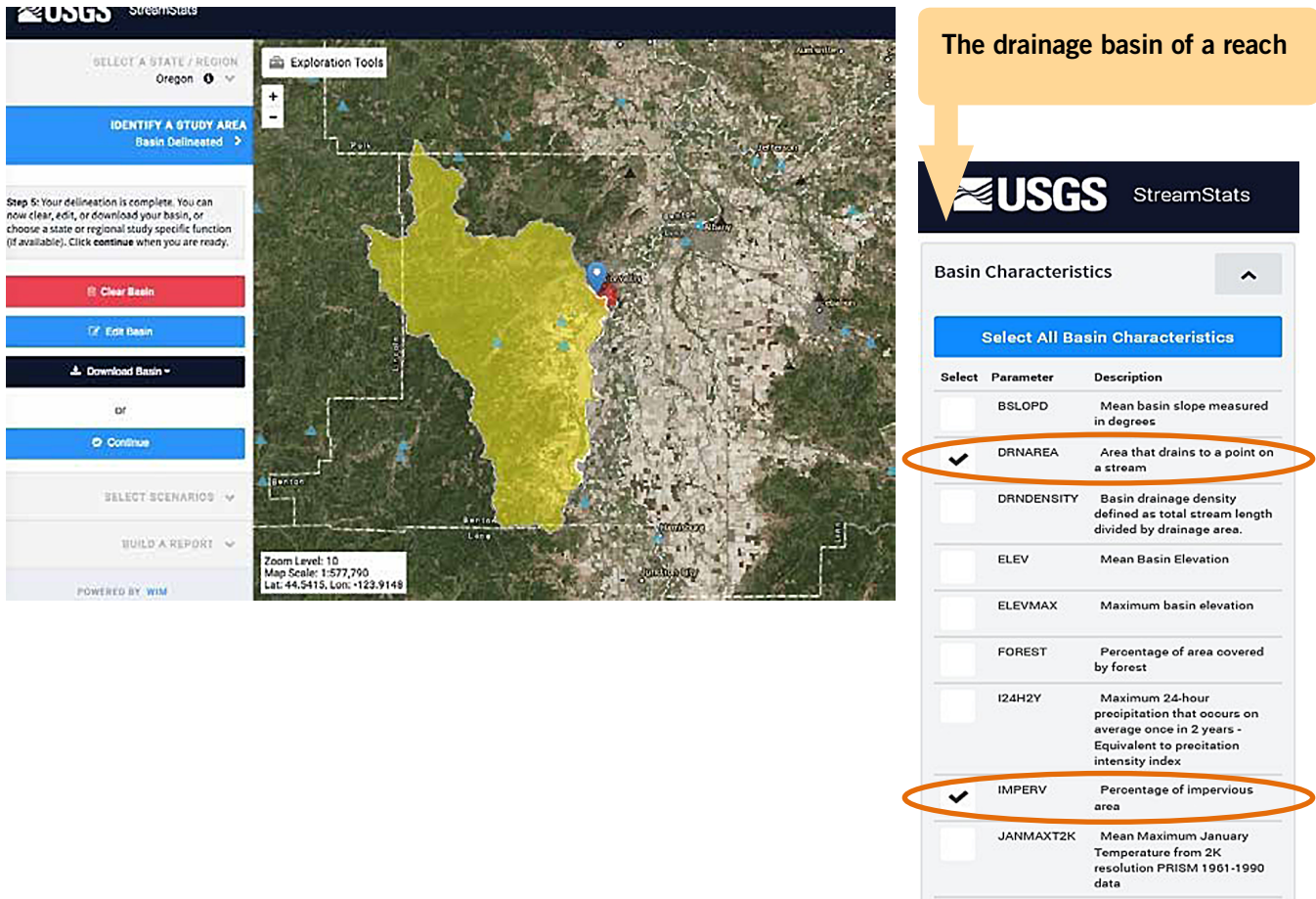
To create a StreamStats Report, click the USGS StreamStats icon on the Find tab. This will open a sidebar with the link to an external USGS webpage: [USGS StreamStats 4.0](https://www.streamstats.org/) with detailed instructions on how to create a report. These steps are also summarized below.

Zoom or use the search feature to locate the project site. Select Oregon as the State Study Area. The basin delineation tool will be enabled once you have zoomed in to level 15 or greater. Click Delineate and then click on a blue stream cell on the map that corresponds with the downstream end of the PA.

Tap or click on one of the blue cells/pixels to indicate the reach for which you are creating the basin report.



Once the basin is delineated, click Download Basin and save the polygon as a shapefile to your computer.



The drainage basin of a reach

Basin Characteristics

Select All Basin Characteristics

Select	Parameter	Description
<input type="checkbox"/>	BSLOPD	Mean basin slope measured in degrees
<input checked="" type="checkbox"/>	DRNAREA	Area that drains to a point on a stream
<input type="checkbox"/>	DRNDENSITY	Basin drainage density defined as total stream length divided by drainage area.
<input type="checkbox"/>	ELEV	Mean Basin Elevation
<input type="checkbox"/>	ELEVMAX	Maximum basin elevation
<input type="checkbox"/>	FOREST	Percentage of area covered by forest
<input type="checkbox"/>	I24H2Y	Maximum 24-hour precipitation that occurs on average once in 2 years - Equivalent to precipitation intensity index
<input checked="" type="checkbox"/>	IMPERV	Percentage of impervious area
<input type="checkbox"/>	JANMAXT2K	Mean Maximum January Temperature from 2K resolution PRISM 1961-1990 data

Click Continue to generate a report of basin statistics. Select Peak-Flow Statistics under the Scenarios menu (this will provide the 2-year peak flood data). Then, scroll down the side bar, expand the Basin Characteristics menu and select the DRNAREA (drainage area) and IMPERV (percentage of impervious area) parameters, along with any others that are of interest. Click Continue on the following screens until a Report is provided. Record the values for 2 Year Peak Flood (Q2), DRNAREA and IMPERV for entry into the SFAM Workbook.

Return to the ORWAP and SFAM Map Viewer and click Upload Data (Layers tab). Upload the shape file from its saved location, change symbolization if desired (it is recommended that you use a “diagonal fill style” to allow for transparency), and click Proceed to load the drainage basin polygon into the Map Viewer. The polygon delineating the drainage basin for your PA will now be visible onscreen.

4.3 Complete the Cover Page of the SFAM Workbook

Use information about your site as well as data from the SFAM Report to answer questions on the Cover Page, as described below. Data is entered either by typing a number into the appropriate Workbook cell or by selecting options from the drop-down menu.

General Site Information

Record information about the name of the project, date of assessment, name of data collectors, a project number (if known), the site latitude and longitude (the center of the PA), the assessment timing (current conditions or predicted conditions), and the PA length and area into the appropriate Workbook cells. This information will automatically populate in the header of all other Workbook tabs.

Elevation

Refer to the SFAM Report to determine the elevation for your site and enter it into the appropriate Workbook cell.

Oregon Stream Classification

Refer to the SFAM Report to identify the Stream Classification for your site and select the appropriate answers for Aquifer Permeability, Soil Permeability, Erodibility, and Gradient from the drop-down menus in the Workbook. If there is more than one Stream Class reported, enter the one that occupies the greatest percent Area reported and note any additional stream classes in the Assessment Notes section of the Cover Page.

If you would like to explore this data layer further, load the Oregon Stream Classification layer (under the Hydrology group). Seventeen stream types have been identified based on the EPA Stream Classification System (GIS-based) for Oregon.

Flow Duration or Permanence Class

Load the Flowline layer within the National Hydrography Database (NHD) in the ORWAP and SFAM Map Viewer (under the Hydrology group) to determine whether the channel is perennial, intermittent, or ephemeral. If there is no NHD information about the subject stream reach, or you do not agree with the NHD designation, and other information is available to support a designation, provide that information on the Cover Page notes.

If there is no additional information available, then apply the Streamflow Duration Assessment Method for the Pacific Northwest (SDAM; <https://www.epa.gov/measurements/streamflow-duration-assessment-method-pacific-northwest>) in the field to distinguish between perennial, intermittent, and ephemeral streamflow of the subject reach.

Level III EPA Ecoregion

Refer to the SFAM Report to identify the Level III EPA Ecoregion for your site. Select the appropriate ecoregion from the drop-down menu. Once an ecoregion is selected, the adjacent cell will auto-populate to show whether the site is located within the “Western Mountains” or “Xeric” ecoregion of the state.

Ecoregions are geographic areas that exhibit generally similar ecosystem characteristics, specifically the type, quality, and quantity of environmental resources. This information is used to set performance expectations for several function measures.

Average Stream Width


Estimate whether the average width of the stream throughout the PA is >50 feet or < 50 feet using an aerial image of the site (see **Section 4.1**). If you are able to see the edges of the stream on your image, you may be able to use the Distance tool on the Analysis tab to estimate stream width. Once bankfull width measurements have been taken in the field, update this cell, if needed.

2-Year Peak Flood



Refer to the StreamStats Report to identify the 2-Year Peak Flood. The 2-Year Peak Flood is flow at or near bankfull discharge or effective discharge, at the point where water begins to overtop banks and inundate the floodplain. It is also an indicator of when channel forming or maintaining processes are occurring.

Size of Drainage Area

Refer to the StreamStats Report to identify the size of the drainage area or DRNAREA (i.e. the total basin area flowing into the PA) of your site. This information does not directly inform function or value measures, but rather is used to provide site context to users and reviewers. Note that the StreamStats method is based upon a natural landscape and if the stream is primarily fed by piped streams and waterways, modeled data will not necessarily be accurate.


OREGON EXPLORER

**Stream Function Assessment Method (SFAM)
Report**

Report Generated: May 28, 2018 05:16 PM

Location Information			
Latitude	44.9302 N	Longitude	-123.0336 W
Elevation	148 ft	Level III Ecoregion	Willamette Valley
HUC8	17090007 Middle Willamette		
HUC10	1709000703 Chehalem Creek-Willamette River		
HUC12	170900070301 Croisan Creek-Willamette River		
Linear ft of stream in HUC8	141,076	Annual precipitation	40 in

Stream Type and Classifications			
Stream Classification	Mountain Wet Rain / Valley Wet	Percent of project area	100.00 %
Aquifer permeability	High	Soil permeability	High
Gradient	2-6%	Erodibility	Difficult_to_Erode

Stream classifications and associated attributes are derived from a U.S. Environmental Protection Agency stream classification geospatial data layer developed for Oregon (2015). This layer provides a statewide stream/watershed classification system for streams and rivers of various sizes, based in part on a hydrologic landscape classification system.

Rare Species Scores and Special Habitat Designations			
Rare Species Type	Maximum score	Sum Score	Rating
Non-anadromous Fish Species	0	0	None
Amphibian & Reptile Species	0	0	None
Feeding Waterbirds	0	0	None
Songbirds, Raptors, and Mammals	0	0	None
Invertebrate Species	0	0	None
Plant Species	0	0	None

Scores have taken into account several factors for each rare species record contained in the official database of the Oregon Biodiversity Information Center (ORBIC): (a) the regional rarity of the species, (b) their proximity to the point of interest, and (c) the "certainty" that ORBIC assigns to each of those records.

Within 300 ft of a Special Protected Area?	No
Within a HUC12 that has designated Essential Salmonid Habitat?	Yes
Within 2 miles of an Important Bird Area?	No

Water Quality Impairments	
Pringle Creek	
Status	Impairment
Cat 3B: Insufficient data, potential concern	Heptachlor

Stream Type and
Classification of
Stream Reach

Rare Species Scores

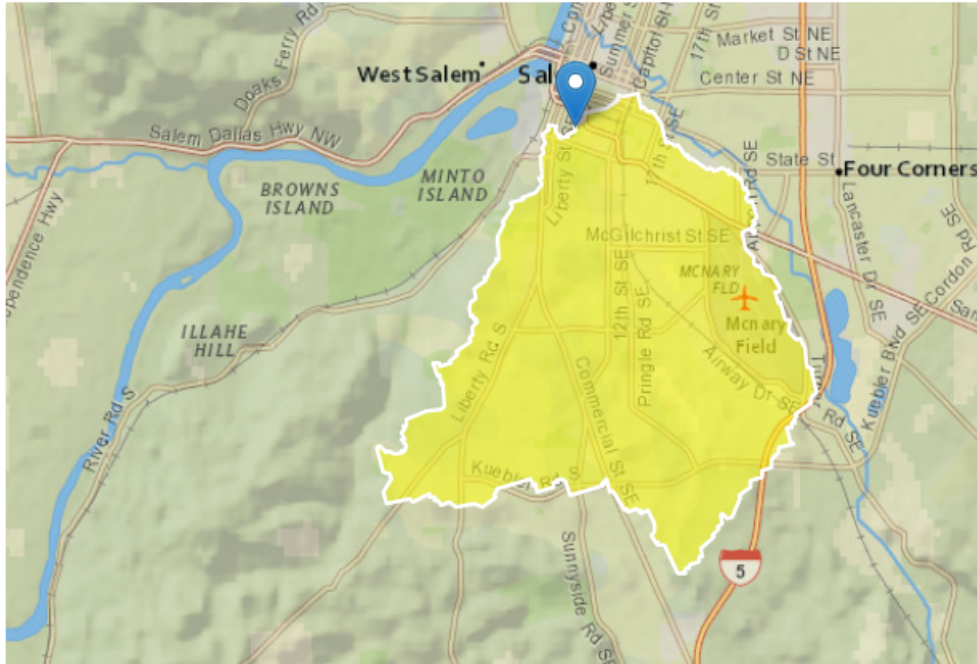
Protected Area Status

Special Habitat
Designation

Figure 4.2 Example of an SFAM Report.

StreamStats Report for Pringle Creek

Region ID: OR
 Workspace ID: OR2019121817395553000
 Clicked Point (Latitude, Longitude): 44.93443, -123.03748
 Time: 2019-12-18 09:40:12 -0800



Size of Drainage Area
and Percentage of
Impervious Area

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	11.9	square miles
I24H2Y	Maximum 24-hour precipitation that occurs on average once in 2 years - Equivalent to precipitation intensity index	2.1	inches
SOILPERM	Average Soil Permeability	1.34	inches per hour
JANMAXT2K	Mean Maximum January Temperature from 2K resolution PRISM 1961-1990 data	46.2	degrees F
WATCAPORC	Available water capacity from STATSGO data using methods from SIR 2005-5116	0.15	inches
ORREG2	Oregon Region Number	10001	dimensionless
BSLOPD	Mean basin slope measured in degrees	2.48	degrees
JANMINT2K	Mean Minimum January Temperature from 2K resolution PRISM PRISM 1961-1990 data	32.5	degrees F
ELEV	Mean Basin Elevation	311	feet
IMPERV	Percentage of impervious area	38.5	percent

Figure 4.3 Example of a StreamStats Report.

4.4 Complete the Value Tab of the SFAM Workbook

Use the information from the SFAM Report, StreamStats Report and Map Viewer analyses to answer the following questions on the Values tab of the SFAM Workbook by selecting options from the drop-down menu (Column H of the Workbook). Refer to **Table 2.1** for function acronyms used below.

Answer the following questions using information from the SFAM Report

V1. Rare Species Occurrence & Special Habitat Designations

Are there rare species or special habitat designations in the vicinity of the Project Area? Informs SWS, FV, SM, MB, STS, NC, CR, and TR values.

Answer each submeasure using information from the site's SFAM Report (Rare Species scores and Special Habitat Designations section), as well as any available survey data for the PA and its vicinity, or personal knowledge about the site. Rare species, Essential Salmonid Habitat and Important Bird Areas are evaluated in this question. Special Protected Areas will be evaluated in question V3.

If users are aware of more recent onsite observation of rare species by a qualified observer under conditions similar to what now occur, they should upgrade the associated ranking to High and provide information regarding the survey in the External Data section on the Cover Page.

If you would like to explore the fish and waterbird habitat data further, load the Essential Salmonid Habitat and Important Bird Area layers (Habitat group).

V2. Water Quality Impairments

Is the reach on the 303(d) list or other Total Maximum Daily Load (TMDL) (Categories 3B-5) for any of the following impairments: sediment, nutrient, metal & toxics, temperature or flow modification? Informs FV, SC, CMH, STS, NC, CR, and TR values.

Use information from the SFAM Report to answer questions on the water quality impairments for the site. While the SFAM Report provides information about all impairments in Categories 3B-5, the user only needs to report those that fall into one of the categories identified in SFAM. If there are no data or insufficient data available for a specific pollutant, select the 'No Impairment' option in the drop-down menu.

Water quality impairment data is collected and maintained by the Oregon Department of Environmental Quality. If users are aware of more recent data/information, provide this information in the Assessment Notes section on the Cover Page but do not change the answer to the question based on this information.

If you would like to explore this data further, load the Water Quality Lakes and Water Quality Streams layers (Water Quality & Quantity group).

V3. Protected Areas

Is the Project Area boundary within 300 feet of a Special Protected Area? Informs MB and STS values.

Use information from the SFAM Report to determine if your site is within 300 feet of a Special Protected Area. Special Protected Areas are identified using the Protected Areas Data for the United States (PAD-US) and available through the USGS. The data consists of mainly open space and resource lands owned in fee by agencies and non-profits. Conservation easements that were suitable for distribution in the public domain are also included, as are other lands with long-term easements, leases, agreements, Congressional (e.g. Wilderness Areas), Executive (e.g. National Monuments), and administrative

designations (e.g. Areas of Critical Environmental Concern) documented in agency management plans. Only those lands identified as having a USGS Gap Analysis Project (GAP) Status of 1 or 2 are included because these lands are specifically managed for biodiversity. If users are aware of other lands within 300 feet of the site that are protected specifically for their high ecological significance and managed for biodiversity, provide this information in the Assessment Notes section on the Cover Page tab (i.e., tax lot number, ownership, and how it is protected) and answer “yes” to the question.

Answer the following questions using information from the StreamStats Report

V4. Impervious Area

What is the percent impervious area in the drainage basin? Informs SWS, FV, SC, SM, CMH, STS, NC, CR, and TR values.

Record the percent impervious area in the drainage basin (IMPERV). The value can be double-checked by loading the drainage basin polygon in the SFAM Map Viewer and evaluating the aerial imagery to determine the extent of impervious surfaces (rooftops, pavement, etc.).



Tip: *You can keep the 2-Mile Circle tool loaded as a general guide of how far to assess the area both upstream and downstream. If the stream is very linear, the tool will provide a good estimate of the 2-mile mark. However, if it is sinuous, then use the Measure tool to trace the stream to find the 2-mile mark.*

Answer the following questions using information from the SFAM Map Viewer about conditions either 2 miles upstream or downstream from the PA

V5. Riparian Area

What is the percentage of intact riparian area within 2 miles upstream of the Project Area? Informs CMH, STS, NC, CR, and TR values.

Intact refers to a riparian area with forest or otherwise unmanaged (i.e. natural) perennial cover appropriate for the basin that is at least 15 feet wide on both sides of the channel.

Use aerial imagery and the Flowline layer under the National Hydrology Dataset group to visually estimate the percentage of intact riparian area along all contributing flowlines within 2 miles of the upstream PA boundary.

Unmanaged perennial cover is vegetation that includes wooded areas, native prairies, sagebrush, vegetated wetlands, as well as relatively unmanaged commercial lands in which the ground and vegetation is disturbed less than annually, such as lightly grazed pastures, timber harvest areas, and rangeland. It does not include water, pasture, row crops (e.g., vegetable, orchards, Christmas tree farms), lawns, residential areas, golf courses, recreational fields, pavement, bare soil, rock, bare sand, or gravel or dirt roads.

V6. Extent of Downstream Floodplain Infrastructure

What is the extent of infrastructure (e.g., buildings, bridges, utilities, row crops) in the floodplain? Informs SWS, SC, CMH, and STS values.

Load the 100 Year Floodplain layer (Floodplain group) and identify the floodplain on both sides of the channel for the stream length between the Project Area and either the next largest water body or 2 miles

downstream of the PA, whichever is less. Estimate whether development such as (buildings, bridges, utilities, row crops, etc.) occupies >50% of this area.

V7. Zoning

What is the dominant zoned land use designation downstream of the Project Area? Informs SWS, CMH, and STS values.

Load the Zoning layer (Land Classifications group) and identify the dominant zoning designation within the floodplain downstream of the PA. Consider the distance from the PA to either the next largest water body or 2 miles downstream, whichever is less.



Tip: *The Identify tool (Find tab) could be helpful in distinguishing between the many different zoning designations within the Zoning layer. Clicking on a specific colored polygon within your 2-mile radius will display information about that designation in the left information panel.*

V8. Frequency of Downstream Flooding

What is the frequency of downstream flooding? Informs SWS value.

Determine the frequency of flooding within 2 miles downstream of the PA that affects infrastructure (i.e. affects use or causes economic loss). Infrastructure includes, but is not limited to, buildings, bridges, utilities and row crops. Flooding history may be documented in a city or county floodplain management plan or may be known by the local water management agency or landowner. Additional information may also be found at FEMA's Flood Map Service Center (<https://msc.fema.gov/portal/search#searchresultsanchor>) which contains flood maps and other flood risk information for communities across the country.

V9. Impoundments

What is the prevalence of impoundments within 2 miles upstream and/or downstream of the Project Area that are likely to cause shifts in timing or volume of water? Informs SWS, FV, SC, SM, and CMH value and FV function.

Load the Point layer of the National Hydrography Dataset (Hydrology group) and determine whether there are any dams or weirs within 2 miles upstream or downstream of the PA. Check for other impoundment types by assessing aerial imagery. If users are aware of an unmapped impoundment within 2 miles of the PA, provide this information in the Assessment Notes section on the Cover Page tab and include these impoundments when answering the question.

Definitions of small versus large impoundments will vary depending on the size of the stream and local hydrology. A decision on whether the impoundment is small or large could be made using the following descriptions:

- **Small:** impound on average less than 30% of the total annual discharge, low profile (i.e. fish passable for the stream of interest, e.g. three feet or less), or span only a portion of the channel.
- **Large:** impound greater than 30% of the total annual discharge, generally are not fish passable, or span the entire channel

For example, a run-of-river dam may be considered a small impoundment, whereas a flood control dam would be considered a large impoundment. Instream irrigation ponds may be considered either small or large impoundments, depending on size and amount of water impounded. If an impoundment is being operated for variable flow releases, it may still be considered a large impoundment if retaining greater than 30% of total annual discharge.

A majority of impoundments upstream will influence hydrology at the PA, especially if they are large impoundments. Impoundments downstream of the PA will only affect local hydrology if the impoundment backwaters the site (even temporarily during high flow events) or encourages sediment deposition at or just downstream of the PA that can aggrade the channel.

V10. Fish Passage Barriers

Are there man-made fish passage barriers within 2 miles upstream and/or downstream of the Project Area? Informs MB and STS values.

Load the Man-made Fish Passage Barriers data layer (under Fish Passage Barriers in the Habitat Group) and determine whether there are any barriers within 2 miles upstream or downstream of the PA. Refer to the symbology key to determine whether the barrier status is passable, unknown, partial, or blocked. If there are multiple barriers, answer for the one with the most restricted level of passage (e.g. Blocked). If qualified users are aware of unmapped fish passage barriers within 2 miles of the PA, provide this information in the Assessment Notes section on the Cover Page tab and include these barriers when answering the question.

V11. Water Source

Is there an area that is of special concern for drinking water sources or groundwater recharge within 2 miles downstream of the Project Area? Informs SST, NC, and CR values.

Load the following four data layers from the Water Quality and Quantity group: Surface Water Drinking Water Source Areas, Groundwater Drinking Water Source Areas, DEQ Groundwater Management Areas, and Sole Source Aquifer. Determine if the PA is within, or within 2 miles upstream of any of these designated areas.

Answer the following questions using specified layers from the Layer tab in the ORWAP and SFAM Map Viewer about conditions in the area specified.

V12. Surrounding Land Cover

What are the land cover types surrounding the Project Area? Informs MB and SST values.

Load the NLDC 2011 (National Land Cover Dataset) layer (Land Classifications group under Land Cover). Under the Find tab, select the 2 Mile Circle Tool, and create a circle to define the area within which the different types of land cover will be evaluated. Visually estimate the proportion of each cover type within the polygon and enter the amount into the appropriate cell.

Note – the values must sum to 100%.



Tip: The Identify tool (Find tab) could be helpful in distinguishing between the many different land cover types in the NLDC 2011 layer. Clicking on a specific colored polygon within your 2-mile radius will display information about that land cover type in the left information panel.

V13. Riparian Continuity

What is the longitudinal extent of intact riparian area that is contiguous to the Project Area? Informs MB, CMH, STS, NC, CR, and TR values.

Use aerial imagery to determine the longitudinal extent of intact riparian area that is contiguous to the PA in either the upstream or downstream direction, whichever is greater (but not including the PA itself) and whichever side has the greatest longitudinal extent. Intact refers to a riparian area with forest or otherwise unmanaged (i.e. natural) perennial cover appropriate for the basin that is at least 15 feet wide. Contiguous means there are no gaps greater than 100 feet in forested cover or unmanaged perennial cover. See **Figure 4.4**.



Figure 4.4 Example of an assessment for Riparian Continuity.

Intact riparian vegetation extends 120 feet upstream of the PA (blue polygon) and extends over 1,000 feet downstream of the PA (on the north side of the stream).

V14. Watershed Position

What is the relative position of the Project Area in its HUC 8 watershed? Informs SC, NC, and CR values.

To determine the PA's position in its watershed, load the 8-digit HUC layer (Watershed Boundary Dataset group), as well as the Flowline layer (National Hydrography Dataset group). Zoom out to an extent that allows you to view the entirety of the HUC8. Determine which end of the HUC is the "bottom" by looking at the direction of the "V" formed where streams join. The "V" points toward the bottom of the watershed.

- If the PA is (a) closer to the watershed's outlet than its upper end and (b) closer to the large stream/river exiting the watershed's outlet than it is to the boundary of the watershed, select "lower 1/3."
- If the PA is (a) closer to the watershed's upper end than its outlet and (b) closer to the watershed's boundary than its large stream/river, select "upper 1/3."
- If neither of the above conditions are met, select "middle 1/3."

V15. Flow Restoration Needs

What is the Streamflow Restoration Need ranking of the watershed within which the Project Area is located? Informs FV and CMH values.

Load the Flow Restoration Needs layer, under the Water Quality and Quantity group, and determine the 'streamflow restoration need' ranking, as designated in this data layer, for the watershed within which the PA is located.

4.5 Conduct Preliminary Assessment of Field Measures

One value measure (Unique Habitat Features) and five function measures (Vegetated Riparian Corridor Width, Exclusion, Fish Passage Barriers, Side Channels and Lateral Migration) benefit from a preliminary estimate in the office that is later confirmed in the field. Instructions for preliminary office estimates are provided below, and information for confirming the answers in the field is provided in **Section 5**.

V16. Unique Habitat Features

Are there rare aquatic habitat features within the EAA that are not common to the rest of the drainage area? Informs SM, MB, CMH, and TR values.

This question must be answered in the field, but the user can check for any mapped wetlands, seeps, springs, and tributaries contributing colder water in the EAA and in the drainage area using available data layers. To determine if there are wetlands in the floodplain, load all layers in the Wetlands group and determine whether there are mapped wetlands in more than 30% of the floodplain. Check for known seeps or springs by loading the two Springs layers (Hydrology group). Check for tributaries contributing colder water within the EAA by loading the two Cold Water Habitat layers (Water Quality and Quantity group). Since not all cold water habitat has been mapped, also look for tributaries entering the EAA by using the Flowline layer of the National Hydrography Dataset; whether that water contributes water that is cooler than the assessment reach will need to be determined in the field.

F5. Vegetated Riparian Corridor Width

What is the average width of the vegetated riparian corridor within the PAA? Informs NC and CR functions.

An intact vegetated riparian corridor is defined as one typified by largely undisturbed ground cover and dominated by "natural" species. Natural does not necessarily mean pristine and can include both upland plants and species with wetland indicator status, and native and non-native species. Natural does not include pasture or cropland, recreational fields, recently harvested forest, pavement, bare soil, gravel pits, or dirt roads. Note that relatively small features, such as a narrow walking trail, that likely have negligible effects on water quality can be included within the vegetated riparian corridor width.

In the office, use aerial imagery to estimate the average vegetated riparian corridor width of both sides of the channel within the PAA, up to a maximum distance of 330 feet from the bankfull edge.

F6. Fish Passage Barriers

Is there a man-made fish passage barrier in the PAA? Informs MB and CMH functions.

Select an answer from the drop-down menu in the PAA Field Form. Man-made barriers to fish passage can include structures such as dams, culverts, weirs/sills, tide gates, bridges and fords that can block physical passage or can create unsuitable conditions for passage (e.g. high velocity). The level of passage

provided can first be researched in the office using the Man-made Fish Passage Barriers data layer (Fish Passage Barriers in the Habitat Group) in the ORWAP and SFAM Map Viewer, then confirmed in the field. Do not include natural barriers. If more than one barrier is present, answer for the one with the most restricted level of passage (e.g. Blocked).

Not all fish passage barriers are documented, and recent actions to improve fish passage at a barrier may not be reflected in the Fish Passage Barrier data layer. Oregon's fish passage design criteria are found in Oregon Administrative Rule (OAR) 635-412-0035, which can be found at https://sos.oregon.gov/archives/pages/oregon_administrative_rules.aspx. Contact your local Oregon Department of Fish and Wildlife office with questions.

F7. Floodplain Exclusion

What percent of the floodplain has been disconnected within the PAA? Informs SWS and CMH functions.

For alluvial rivers, the floodplain is defined by a distinct break in slope at valley margins, a change in geologic character from alluvium to other, indications of historical channel alignments within a valley, or as 100-year flood limit. See more information on this measure in **Section 5**.

Steps in the office

1. Determine floodplain extent by looking at topography maps, FEMA flood maps, hydraulic model outputs, or a combination of these resources. It may, however, only be possible to evaluate small streams and/or streams with heavy cover while in the field.
2. Estimate the floodplain area within the PAA.
3. Identify elements that would disconnect the floodplain from the river or stream.
4. Estimate the amount of floodplain area within the PAA that is likely disconnected and record on the PAA Field Form.
5. Confirm estimates in the field.

F12. Side Channels

What proportion of the EAA length has side channels? Informs SWS, SST, MB, and CMH functions.

Side channels include all open conveyances of water, even if the channel is plugged (i.e. there is no above-ground flow to/from the main channel) on one end. If both ends are plugged, do not count as a side channel. See more information on this measure in **Section 5**.

Steps in the office

1. Determine floodplain extent by looking at the local topography, FEMA flood maps, aerial imagery during the time of the year with higher flows, local knowledge, or a combination of these resources. It may only be possible to evaluate small streams and streams with heavy cover while in the field.
2. Using the field map, evaluate the floodplain and determine whether side channels are present in the EAA.
3. Mark the approximate location of the start and end points of each side channel on the Site Map.
4. Confirm the presence of side channels in the field following the directions for F11 in **Section 5**.
5. Once back in the office, transfer the data into the EAA Field Form worksheet and the percent of the EAA length with side channels will be calculated:

$$(\text{sum of side channel lengths} \div \text{mainstem length}) \times 100$$

F13. Lateral Migration

What percent of both sides of the channel is constrained from lateral migration? Informs SC function.

Constraints on lateral migration of the channel within $2 \times$ BFW or 50 feet (whichever is greater) includes bank stabilization and armoring, bridges and culverts, diversions, roads paralleling the stream and any other intentional structures or features that limit lateral channel movement whether intentionally or not. For cross-channel structures (diversions, bridges, culverts, etc.), record $4 \times$ the bankfull width (BFW) as the length constrained on both sides of the channel. For linear features, record the length on each side of the channel. For segmented bank features, such as bendway weirs or log jams acting in concert, record the effective length of stabilization on each side of the channel affected. It is acceptable to include relevant armoring that is recorded in the Bank Armoring question. See more information on this measure in **Section 5**.

In the office, use aerial imagery to identify and map all constraints to lateral migration as defined above on both sides of the channel within the EAA, up to a maximum distance of 330 feet from the bankfull edge.

5.0 Field Component Instructions

The Field Component of an SFAM Assessment uses direct onsite measurements and observations to generate scores for the ecological functions provided by the site.

The Field Component involves visiting as much of the site as is safely and legally possible, and then filling out the field forms and verifying, as needed, responses from the Office Component. If you cannot access the entire assessment area, you must rely more on the aerial imagery, maps, other office information, field indicators, and discussions with the landowner and other knowledgeable sources.

The Field Component of SFAM is designed to be completed by two people in approximately one day (not including travel to and from the site). More time may be needed for large projects or projects that include multiple streams.

In addition to the detailed instructions below, an “Order of Operations” has been developed as a quick-reference list to guide your work in the field by providing the basic order of data collection steps. The list is included as **Appendix 2** of this User Manual.

5.1 Preparation for Site Visit

Schedule the field visit at a time best suited for data collection. The wet season is the recommended time to conduct an assessment, preferably after significant flow events that will leave signs of the extent of high water across the site but not during a high flow event that could prevent data collection efforts. However, the assessment may be conducted at any time of year. If possible, visit the PA at least once during the driest time of the year and once during the wet season.

Download and Print:

1. The Site Layout Field Form, PAA Field Form, and the EAA Field Form from the Excel Workbook; and
2. Plant lists and references, including **Appendix 3**. Plant Species Considered Invasive in Oregon.
3. You may also want to print the SFAM Report and StreamStats Report, as well as the list of questions from the Office Component that require confirmation in the field.

Assemble the equipment and gear listed in **Table 5.1**.

Table 5.1 SFAM Field Equipment and Gear

Required	Equipment
	<ul style="list-style-type: none"> Calculator Clinometer Densiometer Field tape measures (3) (U.S. customary units; at least one 300 feet in length) Flagging tape GPS Measuring stick(s) (a pole with marked increments in decimal feet works very well; recommend 5 feet in length) Stadia rod(s) (recommend 25 feet in length; 16 or 18 feet will also work) Stake flags (11) (optionally marked from 1-11 or A-K)
	Documents
	Site Map
	A hard copy of the following forms from the SFAM Workbook: <ul style="list-style-type: none"> ■ Site Layout Field Form ■ PAA Field Form ■ EAA Field Form
	Aerial image of the assessment area that includes the floodplain and riparian corridor
	Gear
	Clipboard
	Writing instruments
	Waders
	Safety gear (lifejacket, first aid kit, cell phone, etc.)
	Optional
	Plant lists and references
	Laptop with SFAM Excel Workbook
	Laser rangefinder (recommended for non-wadeable streams or sites with large Project Areas)
	Raingear
	Right-angle level or a tube to aid in determining overhead riparian cover along transects

5.2 Preliminary Reconnaissance

Once at the site, walk the entire site. Identify boundaries delineated on the Site Map and explore any concerns you have about site accessibility. Exploring a site, including the floodplain with accessible terrain, could take one to three hours.

5.3 Locate Assessment Area Boundaries and Collect Data

The first step towards evaluating field measures is to locate assessment area boundaries and transects. Data is collected at a scale applicable for each measure and the Function or Value the measure is evaluating.



Tip: As you walk through the site to set up the assessment areas, it might be helpful to have Global Positioning System (GPS) coordinates of the corners of the PAA and EAA. In addition, tagging GPS coordinates and flagging each of the transect locations could facilitate data collection efforts.



Tip: The left and right banks of a stream are identified by looking downstream.



Tip: Photos of the assessment areas are highly recommended. Photos taken from the center of the stream and looking upstream and downstream from the center of the PA are helpful. If a larger stream or PA is being assessed, additional photos showing the riparian area, the PAA, and EAA, are recommended.

The steps for identifying assessment area boundaries are as follows:

Step 1. Lay out the Proximal Assessment Area (PAA):

- a. Identify the PA boundaries. The PA is the spatial extent of direct impact (e.g., removal, fill, grading, planting, etc.) that a project (permitted action, mitigation, restoration) will have on a stream and surrounding area. For example, a hypothetical restoration project plans to plant willow along 100 feet of streambank, including area on both sides of the stream (**Figure 5.1**). In a different example, a hypothetical development project plans to construct a pipeline across the stream, which will create a strip of ground disturbance 20 feet wide (**Figure 5.1**). Projects with multiple areas of impact that are part of a singular larger project should be considered one PA under most circumstances. Refer to **Section 3.5** for additional guidance.

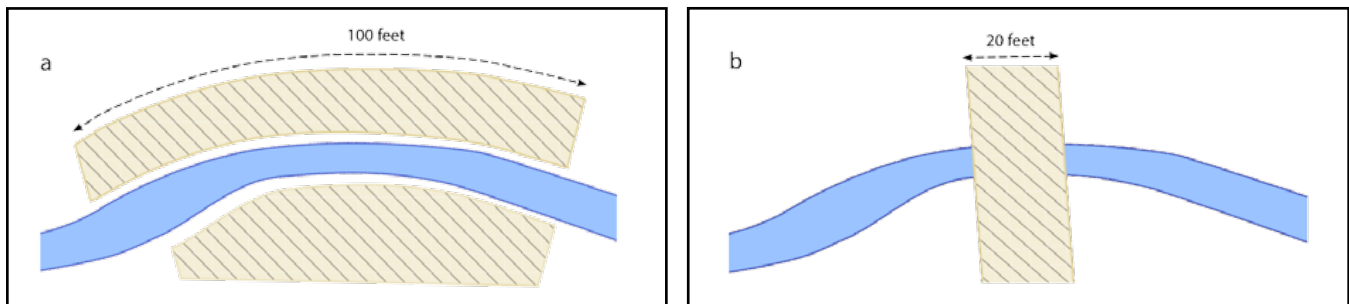


Figure 5.1 Example Project Areas.

- b. Identify the upstream and downstream (i.e. longitudinal) boundaries of the PAA. The PAA longitudinal boundaries are at the upstream and downstream extent of the PA, or 50 feet of stream length centered on the PA, whichever is the greater stream length (**Figure 5.2**).

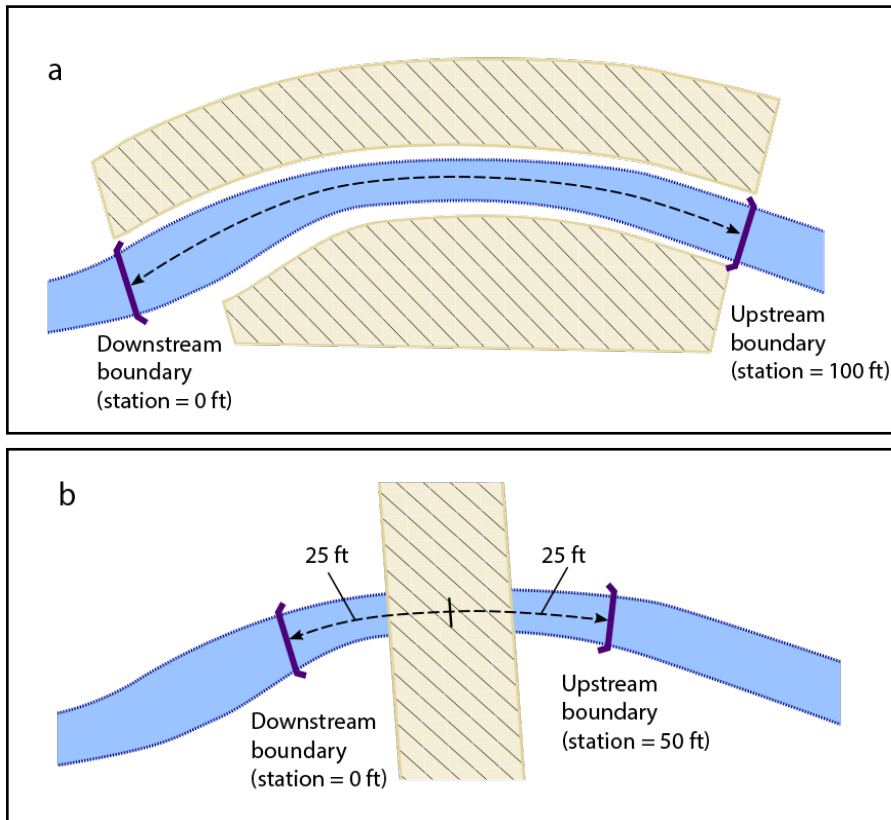


Figure 5.2 Longitudinal extent of Proximal Assessment Area.

- c. Using a measuring tape, locate the center of the PAA and measure the bankfull channel width (BFW) (“BFW 2” in **Figure 5.3**).
- d. At two additional locations equidistant between the PAA center and the PAA upstream and downstream boundaries, measure BFW. Flag these locations as these are also the locations of the 3 transects you will establish to collect data in the PAA (**Figure 5.3**).

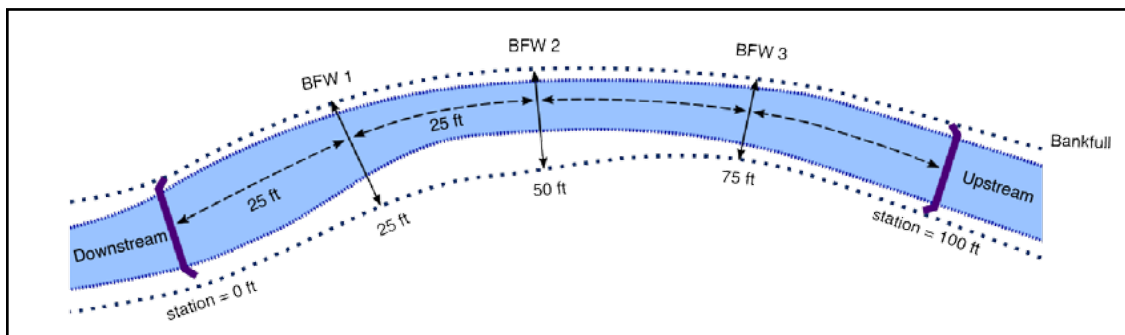


Figure 5.3 Bankfull width measurements for a hypothetical 100-foot PA.

- e. Locate the lateral boundaries of the PAA at a distance of $2 \times$ the average BFW or 50 feet from the stream edge (bankfull edge), whichever is greater, on each side of the stream (**Figure 5.4**).

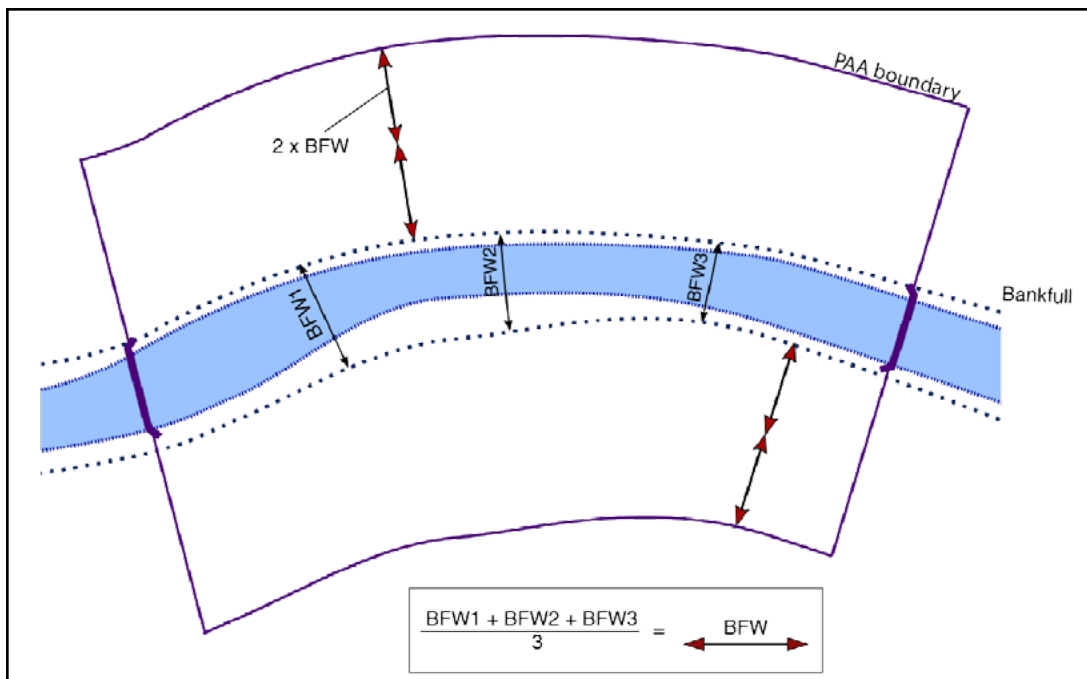


Figure 5.4 Lateral extent of the Proximal Assessment Area.

Step 2. Collect Proximal Assessment Area Data

- a. Complete transect assessments at the 3 PAA locations and collect data on:
 - Natural Cover (Cover)
 - Invasive Vegetation (InvVeg)
 - Native Woody Vegetation (WoodyVeg)
 - Large Trees (LgTree)
 - Vegetated Riparian Corridor Width (RipWidth)
- b. Complete longitudinal assessments by laying a tape from downstream to upstream and recording the start and stop locations of each of the following:
 - Fish Passage Barriers (Barriers)
 - Exclusion (Exclusion)
 - Bank Armoring (Armor)
 - Bank Erosion (Erosion)
 - Overbank Flow (OBFlow)
 - Wetland Vegetation (WetVeg)

Figure 5.5 shows the locations for data collection in the PAA.

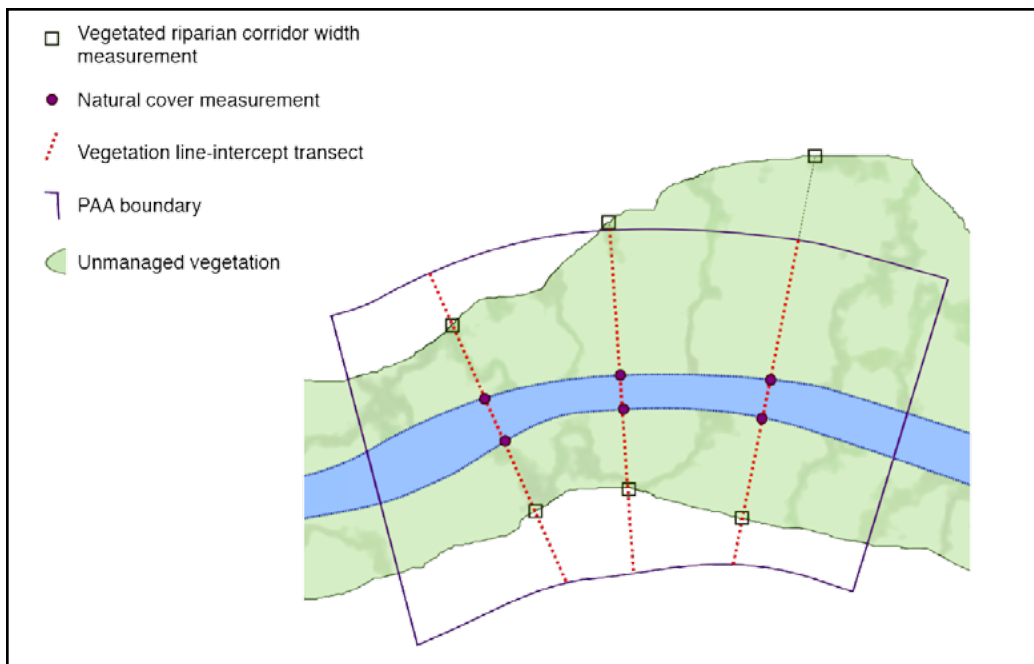


Figure 5.5 Measurements collected for the Proximal Assessment Area.

Vegetated Riparian Corridor Width and Natural Cover are measured at specific locations in the PAA (dark green squares and pink circles, respectively). Invasive Vegetation, Native Woody Vegetation, and Large Trees are all measured along set line-intercept transects (red dashed lines). The longitudinal features (Barriers, Exclusion, Armoring, Erosion, Overbank Flow, and Wetland Vegetation) are not measured at specific locations but, rather, are documented wherever they occur within the PAA.

Step 3. Lay out the Extended Assessment Area

- Locate the upstream and downstream EAA boundaries by multiplying the average BFW by 5 and measuring that distance upstream and downstream from the PAA upper and lower boundaries respectively (**Figure 5.6**).

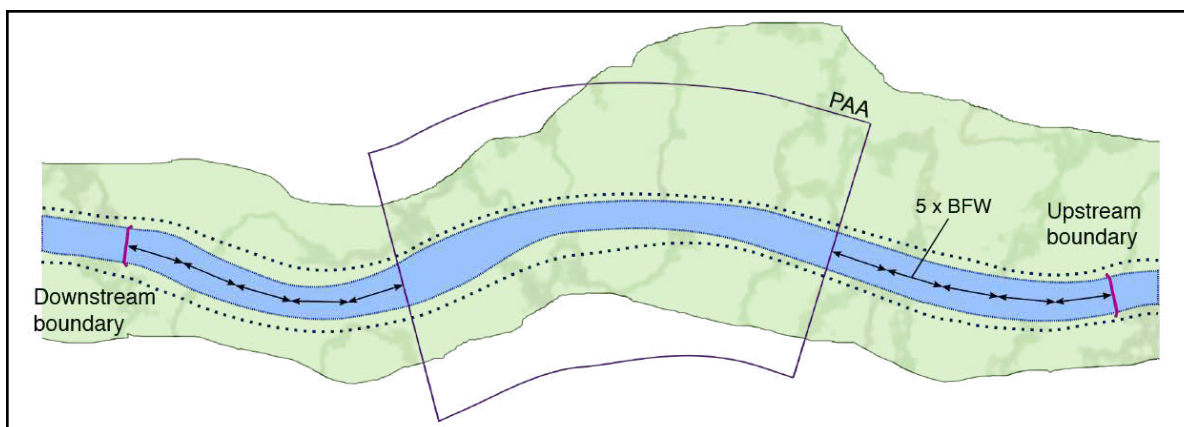


Figure 5.6 Longitudinal extent of Extended Assessment Area.

- b. Locate the lateral boundaries of the EAA. They are the same distance from the stream edge (bankfull) as for the PAA above (i.e. $2 \times$ the average BFW or 50 feet, whichever is greater). Note that the EAA contains the entire PAA (i.e. the PAA is part of the EAA) (**Figure 5.7**).

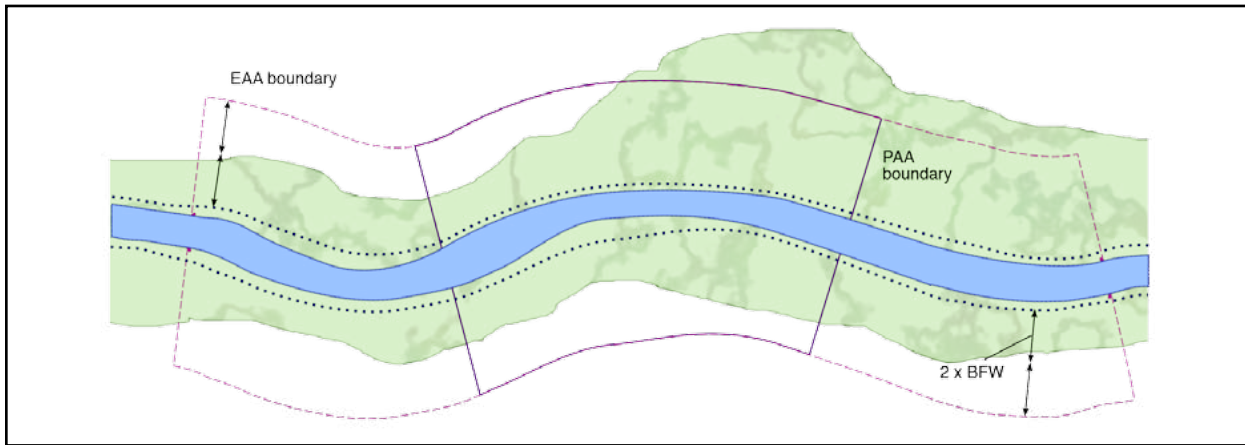


Figure 5.7 Lateral extent of the Extended Assessment Area.

- c. Locate 11 EAA transect locations by dividing the total EAA length by 10. The distance between each transect is $0.1 \times$ the total EAA length. Include the downstream and upstream EAA boundaries. For example, if the total EAA length is 250 feet, the first transect is at the EAA downstream boundary, the second is 50 feet upstream from the lower boundary, and so forth. The 11th and final transect is at the upstream EAA boundary (**Figure 5.8**).

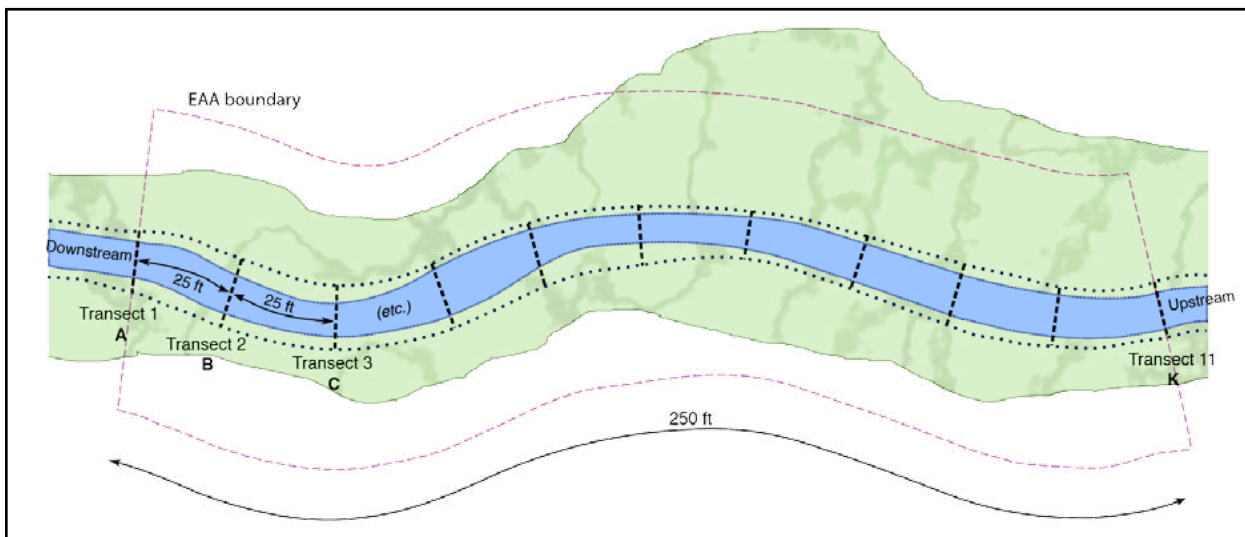


Figure 5.8 Locate Extended Assessment Area transects.

In this example, the total EAA length is 250 feet so the distance between the 11 EAA transects is 25 feet.

Step 4. Collect Extended Assessment Area Data


- a. Beginning at the downstream end of the EAA (i.e. “Transect A”), and at each subsequent EAA transect, record measurements on the EAA datasheet for:
 - Incision (Incision)
 - Embeddedness (Embed)
 - Channel Bed Variability (BedVar) – wetted width
 - b. While moving between transects, record nine evenly spaced measurements for:
 - Channel Bed Variability (BedVar) – thalweg depth
-  **Tip:** Thalweg depth is measured on each of the 11 transects and at nine equidistant points between each transect for a total of 100 measurements.
- c. While moving from the downstream end of the EAA to its upstream end, record observations and measurements for:
 - Side Channels (SideChan)
 - Lateral Migration (LatMigr)
 - Wood (Wood)

Figure 5.9 shows the locations for data collection in the EAA.

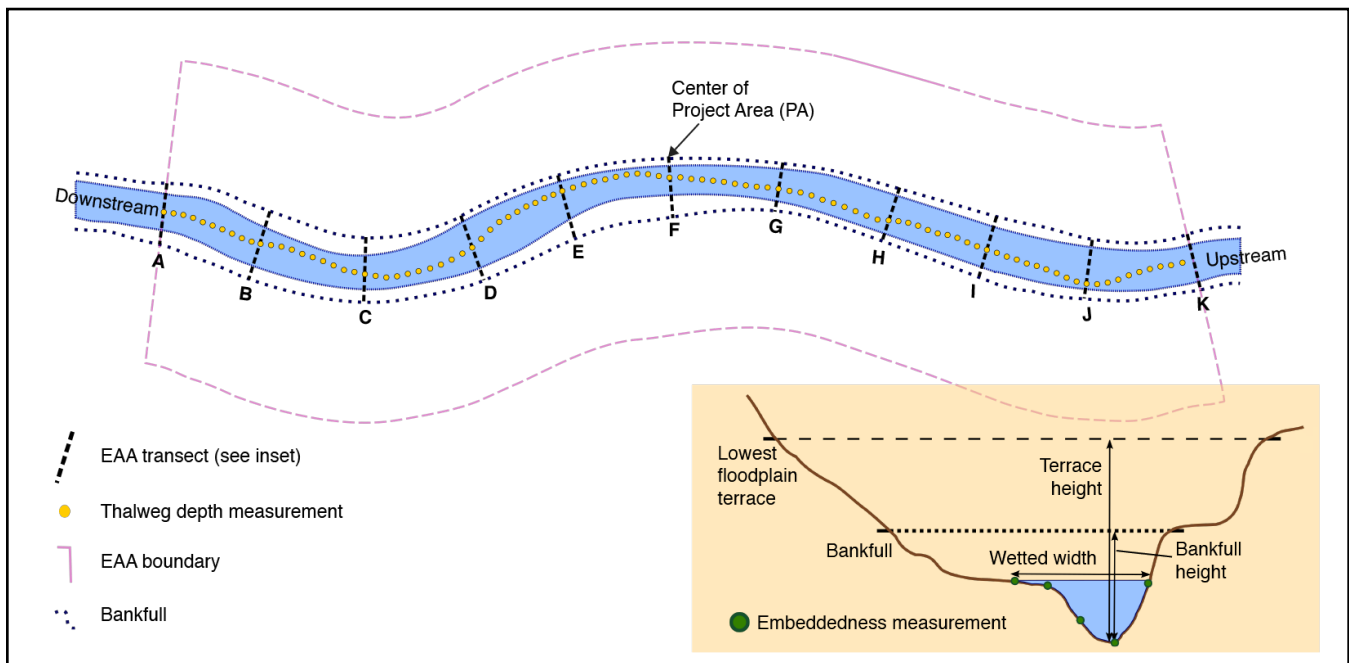


Figure 5.9 Measurements collected for the EAA.

Incision (i.e. bankfull height and terrace height), Embeddedness, and Channel Bed Variability (i.e. wetted width and thalweg depth) are measured at specific locations along or between each transect in the EAA. The longitudinal features (Side Channels, Lateral Migration, and Wood) are not measured at specific locations but, rather, are documented wherever they occur within the Extended Assessment Area.

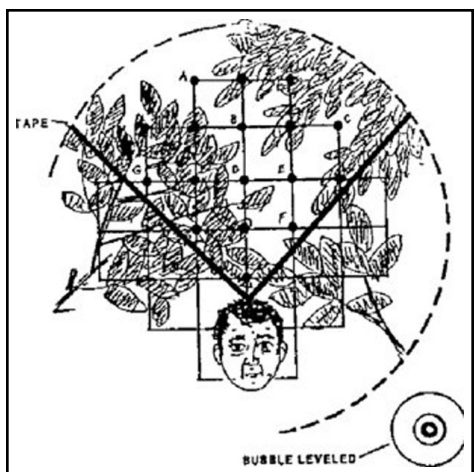
Proximal Assessment Area – Transect Survey

Assess the following measures along the three transects established within the PAA. The three plant composition measures (Invasive Vegetation, Native Woody Vegetation, and Large Trees) can be assessed simultaneously.

F1. Natural Cover

What is the percent natural cover above the stream within the PAA? Informs STS, NC, and TR functions.

Measure the percentage of cover above the stream, including overstory and understory vegetation, and overhanging banks, by averaging spherical densiometer measurements taken at each transect within the PAA.



Use a spherical densiometer (model A convex type) (Lemmon 1957). Mark the densiometer with a permanent marker or tape exactly as shown in **Figure 5.10** to limit the number of square grid intersections read to 17. Densiometer readings can range from 0 (no canopy cover) to 17 (maximum canopy cover). Obtain two measurements at each cross-section transect and one at the water's edge nearest each bank.

Figure 5.10 Densiometer markings.

From Mulvey et al., 1992 as used in USEPA 2013. Note the positioning with the bubble level and face reflected in the apex of the "V". In this example, 10 of 17 intersections are covered with canopy, giving a densiometer reading of 10.

Directions

1. While at the water's edge and facing the streambank, hold the densiometer level (using the bubble level) 1 foot above the water surface with your face reflected just below the apex of the taped "V", as shown in **Figure 5.10**. Concentrate on the 17 points of grid intersection on the densiometer that lie within the taped "V". If the reflection of a tree, branch, leaf, overhanging root, or part of the bank itself overlies any of the intersection points, that particular intersection is counted as having cover. Do not count cover by artificial structures. However, do not shift measurement locations to avoid artificial structures.
2. For each of the six measurement locations, record the number of intersection points (maximum=17) that are covered by vegetation or banks. If measurements are being taken in winter when leaves of deciduous woody vegetation are not fully expressed, count all grid intersections that lie within the branches of the woody vegetation (i.e. zone of influence).
3. Enter the data on the PAA Field Form. Once back in the office, transfer the data into the PAA Field Form worksheet and the average percent natural cover will be calculated.



Dry Channels – For dry channel assessments, the cover measure is taken at the left and right margins (toe of bank) of the streambed (at 1-foot height) rather than at the water's edge.



Undercut Banks – Cover provided by the streambank is included in this measure. If the densiometer can be physically placed at the normal 1-foot elevation under the bank at stream



edge, then that is where the measure is taken. If the densiometer cannot be placed under the cut bank due to problems with access, then take the measurement over the water as close to the water's edge as possible.

Crossings - The percent natural cover for any measurement location that occurs under a bridge or in a culvert (or under any other 'non-natural' structure) can be assumed to be 0. Therefore, the data entry for the densiometer reading at that location will be 0.0.

F2, F3, F4. Invasive Vegetation, Native Woody Vegetation, & Large Trees

What is the percent cover of (a) Invasive Vegetation, (b) Native Woody Vegetation, and Large Trees? Informs MB, STS, and CMH functions.

Conduct a line-intercept survey³ along each of the three transects in the PAA to evaluate riparian vegetation composition. This method will be used to collect data for three functional groups of vegetation (rather than recording plants to species): invasive vegetation, native woody vegetation, and large trees (only those trees with a diameter at breast height (DBH) greater than 20 inches). Note that cover from large, native trees will be counted twice; once as native woody vegetation and once as large trees. If vegetation is dead but expected to regrow (e.g. dormant perennial vegetation or recently sprayed vegetation that is likely to regrow) then it should be counted.

Directions

1. Extend a tape measure along the transect. Vegetation transects begin at the bankfull boundary and extend perpendicular away from the stream channel to the lateral boundary of the PAA ($2 \times \text{BFW}$), on each side of the stream channel.
2. Walking along the transect, observe where vegetation intercepts the tape. These points of interception are typically called "starts" (when you enter into a plant's cover) and "stops" (when you emerge from cover). Record all "start" and "stop" interceptions using 0.1-foot precision for three vegetation functional groups: invasive vegetation, native woody vegetation, and large trees (DBH > 20 inches). Reference **Appendix 3**. Plant Species Considered Invasive in Oregon for guidance. Note that different functional groups may overlap: a given location along the line may intersect cover from native woody vegetation, large trees, and invasive vegetation.






Calculations for the line-intercept method are illustrated in **Figure 5.11**. In this example, the transect line extends 75 feet from bankfull to the PAA boundary, and the points of interception with relevant riparian vegetation are from 12 feet to 29 feet, and from 51 feet to 75 feet where the transect ends. Cover beyond the end of the PAA is not included.

The extent of vegetation cover is based on "zone of influence" rather than the location of individual leaves or stems (**Figure 5.12**). To assess tree canopy interception, look directly upwards, perpendicular to the measuring tape. Using this method, a "start" is when the line enters the zone and a "stop" is when the line emerges from the zone. If a building or other man-made structure occurs along the transect, it is not considered cover. Move past the structure and continue collecting transect data on the opposite side of the structure to the end of the transect.

3. Repeat this process at each of the PAA transects.
4. Enter the start/stop information into the PAA Field Form. Once back in the office, transfer this data into the PAA Field Form worksheet and the average percent cover for each functional group will be calculated:

$$(\text{total length of cover for the functional group} / \text{total length of all transects}) \times 100$$

³ Instructions and diagrams for completing a line-transect survey are taken from <http://oregonstate.edu/instruct/bot440/wilsomar/Content/HTM-perarea.htm#Intercept>.

-  Collecting data for this measure is best done with two people: one estimating extent of vegetation cover and one recording results on the datasheet.
-  Scope out which trees fall in the “large tree” category before starting the transect. Ensure you are sighting “straight up” - perpendicular to the tape. A right-angle level or a tube that one person looks through while the other ensures it is vertical are helpful aids.
-  DBH refers to the tree diameter measured at 4.5 feet above the ground. DBH can be measured quickly with a specially calibrated diameter tape wrapped around the circumference of the tree at this height. If using a regular measuring tape, a “large tree” will have a circumference > 62.8 inches at breast height.
-  **Sites with Limited Access** - For sites where accessing the other side of the stream is not feasible, limit the transects to a single side.
-  **Crossings** - These should be evaluated as described even if the transect falls on top of a road. This may result in 0% cover in any/all of the vegetation categories.

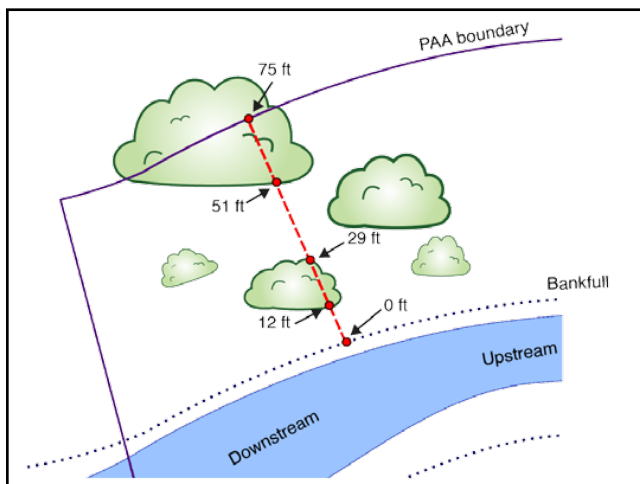


Figure 5.11 Overhead view of example line-intercept transect.

The red dashed line shows the location of Transect 1 on the right bank measuring riparian vegetation as Invasive Vegetation (not Weeds), Native Woody Vegetation, and/or Large Trees.

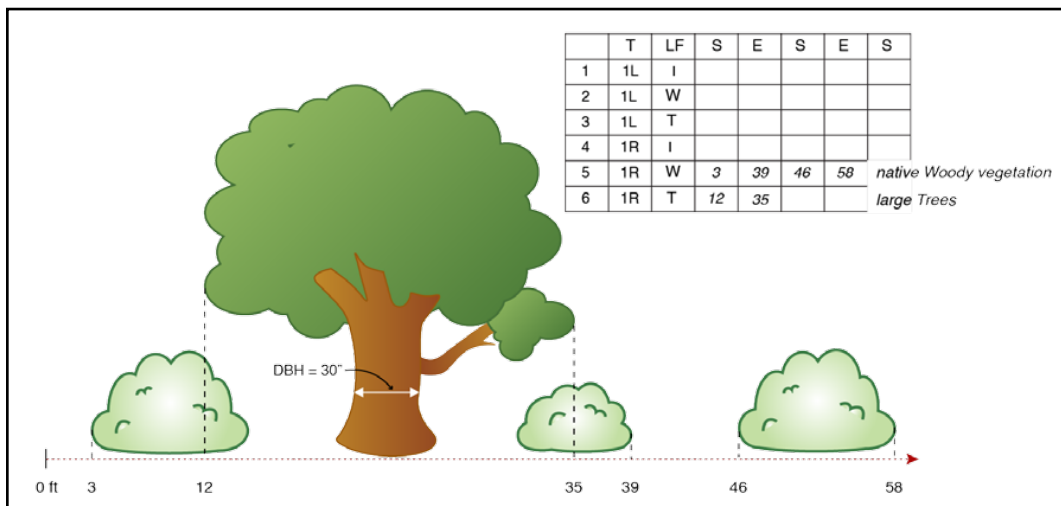


Figure 5.12 Side view of a line-intercept transect.

The red-dashed line represents the transect, and the associated recorded measurements are shown on the field datasheet (inset). Because the Native Woody Vegetation category (“W” in the field datasheet) includes both shrubs and trees, here the transect intercepts Native Woody Vegetation continuously between 3 feet and 39 feet, but intercepts Large Trees (“T” in the field datasheet) only between 12 feet and 35 feet.

F5. Vegetated Riparian Corridor Width

How wide is the vegetated riparian corridor throughout the PAA? Informs NC and CR functions.

Vegetated riparian corridor is defined as one typified by largely undisturbed ground cover and dominated by “natural” species. Natural does not necessarily mean pristine and can include both upland plants and species with wetland indicator status, and native and non-native species. Natural does not include pasture or cropland, recreational fields, recently harvested forest, pavement, bare soil, gravel pits, or dirt roads. Note that relatively small features, such as a narrow walking trail, that likely have negligible effects on water quality can be included within the riparian corridor width.

Directions

1. Estimate the answer to this question in the office prior to field visit if possible. Riparian corridor extent can be estimated by looking at aerial imagery, but should be confirmed in the field.
2. At each PAA transect, record the width of the riparian corridor in feet, up to a maximum possible distance of 330 feet from the bankfull edge (**Figure 5.13**). Use aerial imagery to look for vegetation breaks if onsite measurements are not possible.
3. Enter the values on the PAA Field Form. Once back in the office, transfer the data into the PAA Field Form worksheet and the average width will be calculated.

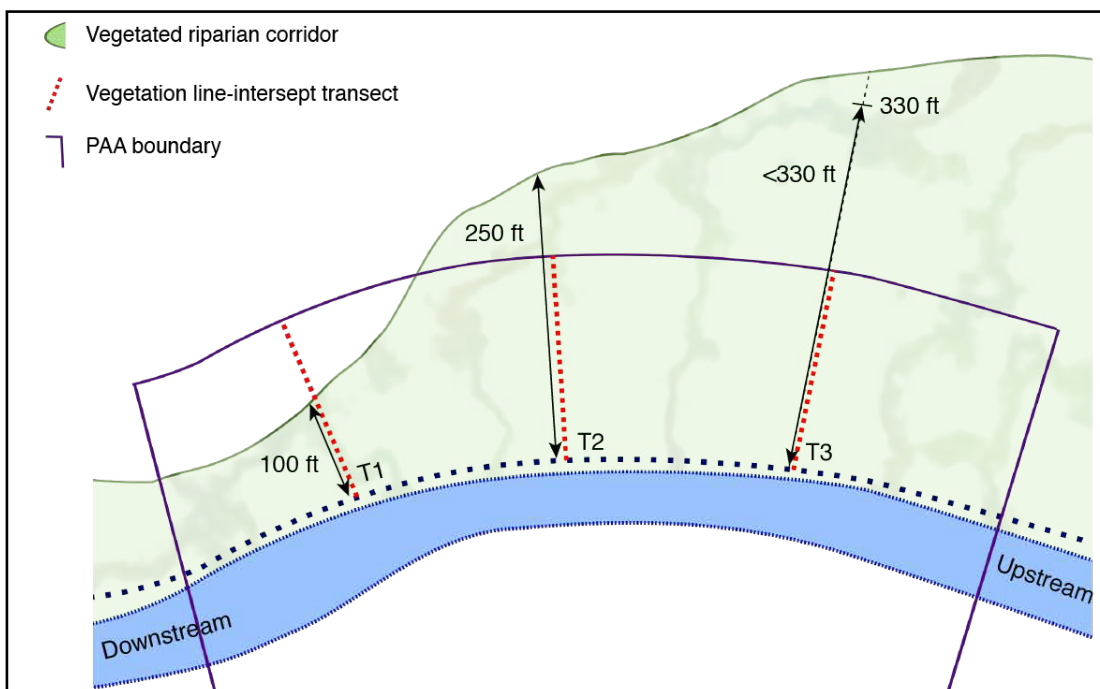


Figure 5.13 Vegetated Riparian Corridor Width measurements.

Note that vegetated riparian corridor widths may be greater than the lateral extent of the PAA (T2, T3), but are not measured beyond 330 feet (T3) for the purposes of SFAM.



Sites with Limited Access - For sites where accessing the other side of the stream is not feasible, limit the field data collection along transects to a single side. Use aerial imagery to estimate width on the other side.

Proximal Assessment Area (PAA) – Longitudinal Survey

Assess the following measures throughout the entirety of the PAA.

F6. Fish Passage Barriers

Is there a man-made fish passage barrier in the PAA? Informs MB and CMH functions.

Select an answer from the drop-down menu in the PAA Field Form (Blocked, Partial, Passable, Unknown). Man-made barriers to fish passage can include structures such as dams, culverts, weirs/sills, tide gates, bridges and fords that can block physical passage or can create unsuitable conditions for passage (e.g. high velocity). The level of passage provided can first be researched in the office using the Man-made Fish Passage Barriers data layer (Fish Passage Barriers in the Habitat Group) in the SFAM Map Viewer, then confirmed in the field. Do not include natural barriers. If more than one barrier is present, answer for the one with the most restricted level of passage (e.g. Blocked).

Not all fish passage barriers are documented, and recent actions to improve fish passage at a barrier may not be reflected in the Fish Passage Barrier data layer. Oregon's fish passage design criteria are found in Oregon Administrative Rule (OAR) 635-412-0035, which can be found at https://sos.oregon.gov/archives/pages/oregon_administrative_rules.aspx. Contact your local Oregon Department of Fish and Wildlife office with questions.

F7. Exclusion

What percent of the floodplain area has been disconnected within the PAA? Informs SWS and CMH functions.

For alluvial rivers, the floodplain is defined by a distinct break in slope at valley margins, a change in geologic character from alluvium to other, indications of historical channel alignments within a valley, or as the 100-year flood limit.

Disconnection refers to any portion of the floodplain area no longer inundated due to levees, channel entrenchment, roads or railroad grades, or other structures (including buildings and any associated fill) within the PAA. All barriers should be included when estimating disconnection, even if the barrier is not present during all flood stages (e.g. a barrier up to the 25-year flood, but not during the 100-year flood); except where the structure is expressly managed for floodplain function and inundation.

Determining Floodplain Extent

The floodplain is defined as the area that would be inundated during the 100-year flood flow if no constructed barriers were present; therefore, it may be useful to gain an understanding of the flow record for this site. (Flow estimates can be found using StreamStats or other tools.) For example, if a levee was built within the floodplain, the area beyond the levee and up to the extent of the historic floodplain should be included in the percentage of floodplain area that is disconnected. Areas outside of natural barriers (e.g., landslide deposits) should not be included as part of the inundation area.

Directions

1. Answer this question in the office prior to field visit if possible. Floodplain extent can be estimated by looking at the local topography, FEMA flood maps, hydraulic model outputs, local knowledge, or a combination of these resources. It may, however, only be possible to evaluate small streams and/or streams with heavy cover while in the field.
2. Estimate the floodplain area within the PAA.
3. Identify elements that would disconnect the floodplain from the river or stream.

4. Estimate the amount of floodplain area within the PAA that is disconnected and record on the PAA Field Form (**Figure 5.14**).
5. Confirm estimates in the field.

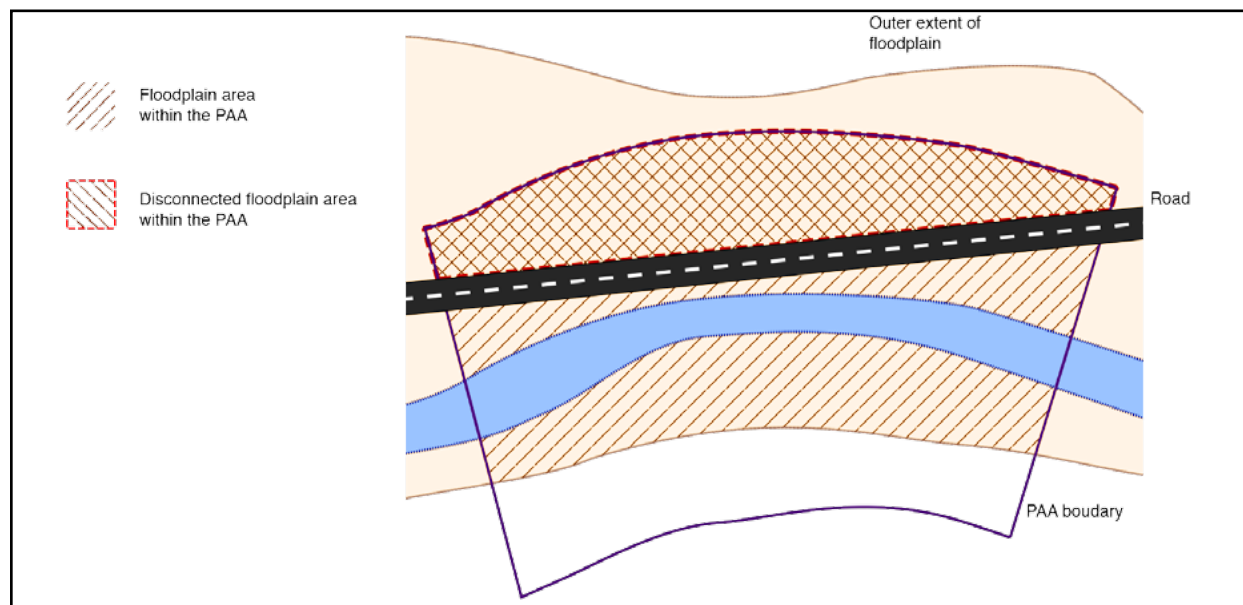


Figure 5.14 Exclusion.

This example shows a road blocking access to part of the floodplain. In this example, about 40% of the PAA floodplain area is disconnected.

Determining elements that disconnect the floodplain

Disconnection can be estimated based on the presence of structures that require tree clearing (e.g. buildings) or infrastructure or barriers that cross the site (e.g., roads, power lines (stations), levees), however, the floodplain may be tree covered and difficult to observe directly from aerial imagery. If the floodplain cannot be easily observed using available imagery and data in the office, observations should be made in the field to verify. Note: All barriers should be included when estimating disconnection, even if the barrier is not present during all flood stages (e.g. a barrier to the 25-year flood, but not during the 100-year flood).

Estimating disconnection

Consider whether a barrier blocks flows entering the entire floodplain area, or only a portion of the floodplain (i.e. a road that is set back allowing some of the floodplain to be accessed, but not all of the floodplain).

F8. Bank Armoring

What percentage of the banks are armored? Informs SM function.

What percentage of the streambank has been stabilized using rigid methods to permanently prevent meandering processes? Examples of armoring include gabion baskets, sheet piles, rip rap, large woody debris that covers the entire bank height, and concrete. Bank stabilization methods that return bank erosion to natural rates and support meandering processes are not counted as armoring. Examples include many bioengineering practices, large woody debris placed along the bank toe, and in-stream structures that still use native vegetation cover on the streambanks. Percent armoring is calculated as the sum of the armored lengths of the left and right banks, divided by the sum total of both banks within the PAA (i.e. twice the total PAA length).

Directions:

1. As part of the PAA longitudinal survey, record the starting and ending points of stabilized/armored streambank. Do this for both the left and right banks.
2. Enter this information into the PAA Field Form. Once back in the office, transfer this information to the PAA Field Form worksheet and the percent of banks armored will be calculated:

$$\frac{(\text{length of armoring on right bank} + \text{length of armoring on left bank})}{(2 \times \text{total PAA length})} \times 100$$

Calculating bank stabilization

Include the length of both continuous armoring treatments and the channel length between treatments acting in concert.

Bank armoring is any practice that permanently prevents natural lateral migration/meandering processes.

Bank stabilization is a practice that returns excessive bank erosion rates to normal rates. These practices typically use minimal amounts of toe protection with natural vegetative cover on the streambanks and should not be counted as armoring.

F9. Bank Erosion

What percentage of the bank is actively eroding or recently (within previous year or high flow) eroded? Informs SC function.

Bank erosion is indicated by vertical or near vertical streambanks that show exposed soil and rock, evidence of tension cracks, active sloughing, or largely void of vegetation or roots capable of holding soil together. Percent eroding is calculated as the sum of the eroded lengths of the left and right banks, divided by the sum total length of both banks within the PAA (i.e. twice the total PAA length).

Directions

1. Record the approximate ‘station’ of the starting and ending points of eroding streambank. Do this for both left and right banks.
2. Enter this information into the PAA Field Form. Once back in the office, transfer this information to the PAA Field Form worksheet and the percent of streambanks eroding along the PAA will be calculated:

$$((\text{eroding length on right bank} + \text{eroding length on left bank}) \div (2 \times \text{total PAA length})) \times 100$$

Signs of erosion

Clear evidence of erosion includes banks that are slumping or where tension cracks have formed and blocks can fall away from the bank. Often where banks are actively eroding, fine roots are exposed. Additional evidence includes undermining of trees, fences, buildings, bridge abutments, or other structures. If the channel is armored and the armor is not being compromised by additional erosion, then it should not be considered an eroding section of bank. If the bank is free from vegetation, but does not appear to be eroding at a rapid pace and displaying indicators such as those above, then it does not get included in this measure.

F10. Overbank Flow

Does the stream interact with its floodplain? Informs SWS, SST, STS, NC, and CR functions.

Is there evidence of fine sediment deposition (sand or silt) on the floodplain, organic litter wrack on the floodplain or in floodplain vegetation, or scour of floodplain surfaces, extending more than $0.5 \times \text{BFW}$ onto floodplain on either the right or left bank floodplain within the PAA? Do not include evidence from inset floodplains developing within entrenched channel systems.

If the abutting land use limits the opportunity to observe evidence of overbank flow, is there other credible information that would indicate regular (at least every two years) overbank flow in the PAA? Examples of “other credible information” include first-hand knowledge, discharge/stream gauge measures, etc. Note the evidence on the Cover Page.

Directions

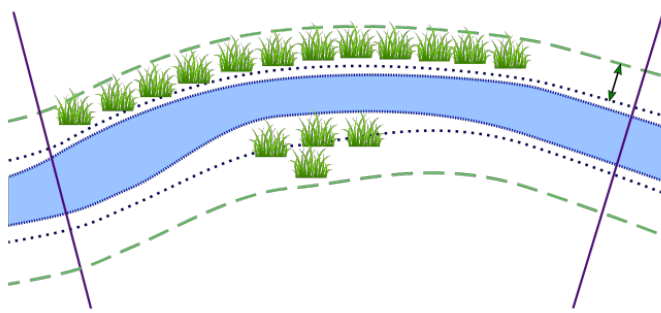
1. During the site walk-through and when conducting the vegetation surveys and longitudinal surveys, search for evidence of overbank flow in the PAA. Note areas of overbank flow evidence on the site map and determine if it extends more than $0.5 \times \text{BFW}$ away from the bankfull boundary.
2. Record a yes or no response on the PAA Field Form in the first cell. Once back in the office, select yes or no from the dropdown menu to link the answer into the Functions tab.



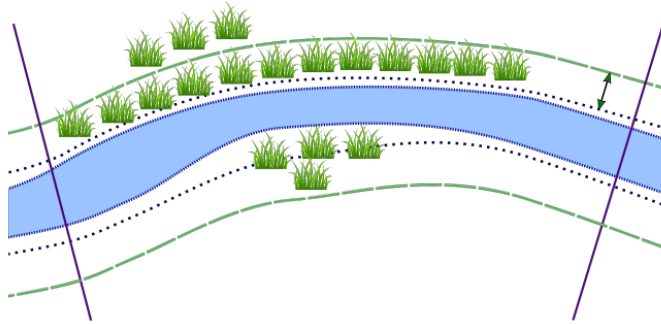
Sites with Limited Access - For sites where accessing both sides of the stream is not feasible, limit the data collection to a single side.

Reference the National Wetland Plant List for wetland plant indicator status: http://wetland-plants.usace.army.mil/nwpl_static/v33/home/home.html

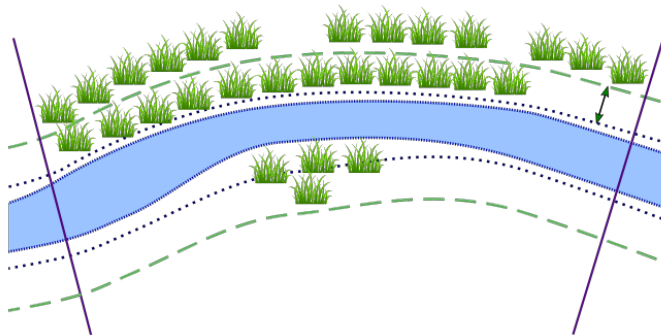
There are two wetland regions in Oregon: Western Mountains, Valleys and Coast or Arid.



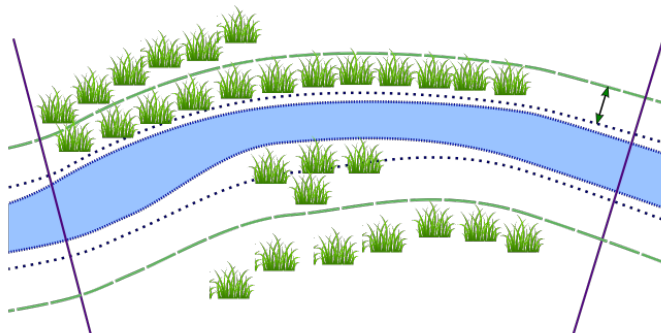
1. Are there wetland plants present in the PAA?	YES
2. If yes, are any wetland plants located more than 0.5*BFW from the bankfull edge?	NO
3. If yes, are the wetland plants that are located beyond 0.5*BFW distributed along >70% of the length of the PAA?	--



1. Are there wetland plants present in the PAA?	YES
2. If yes, are any wetland plants located more than 0.5*BFW from the bankfull edge?	YES
3. If yes, are the wetland plants that are located beyond 0.5*BFW distributed along >70% of the length of the PAA?	NO



1. Are there wetland plants present in the PAA?	YES
2. If yes, are any wetland plants located more than 0.5*BFW from the bankfull edge?	YES
3. If yes, are the wetland plants that are located beyond 0.5*BFW distributed along >70% of the length of the PAA?	YES



1. Are there wetland plants present in the PAA?	YES
2. If yes, are any wetland plants located more than 0.5*BFW from the bankfull edge?	YES
3. If yes, are the wetland plants that are located beyond 0.5*BFW distributed along >70% of the length of the PAA?	YES

Figure 5.15 Examples of different configurations of wetland vegetation within the Proximal Assessment Area and associated responses to the questions on the field datasheet.

In (a), wetland vegetation is present in the PAA, but located only right along the channel. In (b), some wetland vegetation is located farther back from the channel. In (c) and (d), wetland vegetation is located farther back from the channel ($> 0.5 \times \text{BFW}$) for at least 70% of the length of the PAA; all on one side of the stream in (c), and split between both sides of the stream in (d).

F11. Wetland Vegetation

Are there wetland indicator plants adjacent to the channel and/or in the floodplain? Informs SST, MB, STS, NC and CR functions.

Determine if vegetation in the riparian area of the PAA has a wetland indicator status of obligate or facultative wet.

Directions

1. Walk the PAA within the floodplain, or if no floodplain, walk the channel banks and make note of any plants having wetland indicator status of obligate or facultative wet.
2. Determine if any wetland plants are present more than $0.5 \times \text{BFW}$ from the bankfull edge.



For purposes of measuring the distance from the bankfull edge, measure to the center of the rooted stem of identified wetland plants. For example, a tree must have the center of the tree trunk more than $0.5 \times \text{BFW}$ away from the bankfull edge to be included.

3. If there are wetland plants located beyond $0.5 \times \text{BFW}$, then determine if they are also distributed along more than 70% of the length of the PAA on at least one side of the stream. Distribution can be continuous or discontinuous (**Figure 5.15**).
4. Record yes or no responses to steps 1-3 on the PAA Field Form in the first cell. Once back in the office, select yes or no from the dropdown menu in the second cell for steps 1-3 to link the answer to the Functions tab.



Sites with Limited Access - *For sites where accessing both sides of the stream is not feasible, limit the data collection to a single side.*

Extended Assessment Area – Longitudinal Survey

Assess the following three measures throughout the entirety of the EAA.

F12. Side Channels

**What proportion of the EAA length has side channels?
Informs SWS, SST, MB, and CMH functions.**

Side channels include all open conveyances of water, even if the channel is plugged (i.e. there is no above-ground flow to/from the main channel) on one end. If both ends are plugged, do not count as a side channel. A side channel that exists due to an instream island has less flow by volume relative to the main channel.

Directions

1. Answer this question in the office prior to field visit, if possible. It may only be possible to evaluate small streams and streams with heavy cover while in the field.
2. Using the map of the assessment area, evaluate the floodplain and determine whether side channels are present.
3. Record the approximate location of the start and end points of each side channel on the EAA Field Form (see **Figure 5.16**).
4. Once back in the office, transfer the data into the EAA Field Form worksheet and the percent of the EAA length with side channels will be calculated:

$$(\text{sum of lengths with side channels} \div \text{total EAA length}) \times 100$$

Identifying side channels

Inundation frequency or duration of water in the side channels is not a determining factor.

Note that side channels are not within the bankfull channel of the main channel (i.e., there must be an area of land that is above bankfull separating the side channel from the main channel). Water flowing around a dry bar is not a side channel.

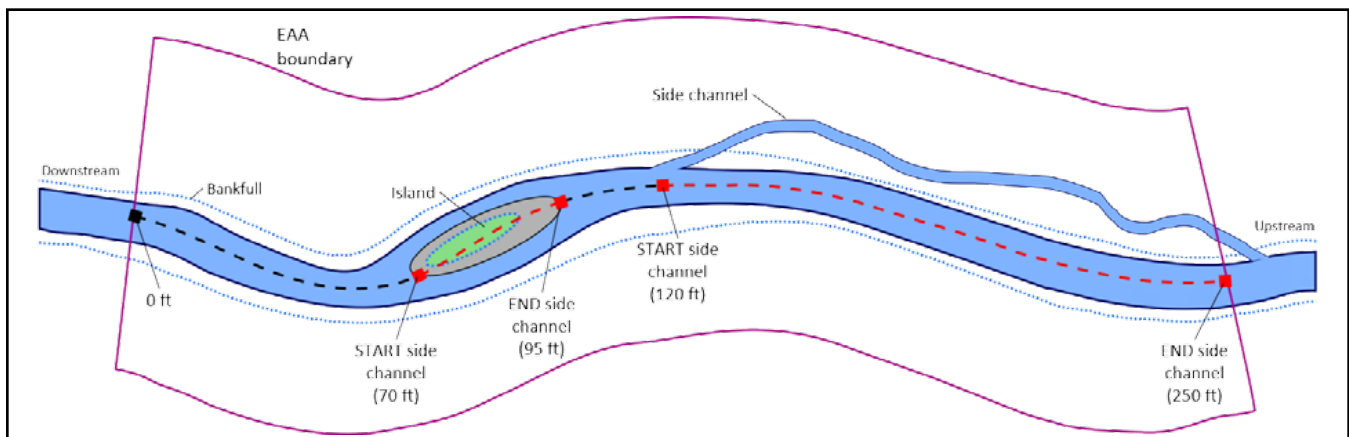


Figure 5.16 Measuring side channels within the Extended Assessment Area.

In this example, 155 feet of the total 250 feet length of the EAA (i.e. 62%) includes side channels (including the multiple channels flowing around the island).

F13. Lateral Migration

What percent of both sides of the channel is constrained from lateral migration? Informs SC function.

Constraints on lateral migration of the channel within $2 \times \text{BFW}$ or 50 feet (whichever is greater) include bank stabilization and armoring, bridges and culverts, diversions, roads paralleling the stream and any other intentional structures or features that limit lateral channel movement whether intentionally or not. For cross-channel structures (diversions, bridges, culverts, etc.), record $4 \times$ the bankfull width (BFW) as the length constrained on both sides of the channel or the actual length constrained by the structure, whichever is greater. For linear features, record the length on each side of the channel. For segmented bank features, such as bendway weirs or log jams acting in concert, record the effective length of stabilization on each side of the channel affected. It is appropriate to include relevant armoring that is recorded in the Bank Armoring question; these measures are not double-counted in SFAM.

While bank armoring is a subset of lateral migration constraints, these measures are not interchangeable as used in SFAM:

- Data for each measure is collected at different scales, PAA and EAA, respectively.
- Bank armoring informs the Substrate Mobility function, while lateral migration informs the Sediment Continuity function.
- There is no redundancy/double counting as they inform different functions.

Directions

1. Identify and map all constraints to lateral migration as defined above. This should be done initially in the office using aerial imagery and confirmed while conducting the on-site longitudinal survey of the EAA.
2. Record the location of the start and end points of constraints in the EAA Field Form. Do this for both left and right banks.
3. Once back in the office, transfer the information into the EAA Field Form worksheet and the percent of the EAA that is constrained will be calculated:

$$(\text{sum of constraints for each bank} \div (2 \times \text{EAA length})) \times 100$$

F14. Wood

What is the frequency of large wood in the bankfull channel? Informs SWS, MB, and CMH functions.

What is the frequency (pieces per 328 feet (100 m) of channel) of independent pieces of wood, defined here as woody material with a diameter of at least 4 inches (10 cm) and a length of 5 feet (1.5 m) within the EAA? This means that at least 5 feet of the piece of wood must be larger than 4 inches in diameter (i.e. a circumference > 12.5 inches). To be counted, wood must have at least some part of its qualifying length (> 4 inches diameter) located within the bankfull channel and lying below the bankfull elevation. Independent pieces include all those individual pieces that meet size criteria either separate from or within log jams. Exclude any wood that has been intentionally anchored to or within channel banks (using spikes, cables, ballast, etc.) for the purpose of preventing bank erosion (armoring). Live trees (i.e. trees that are standing, rooted, with or producing foliage) are not considered “wood” for this measure. Trees that are fully or partially fallen, have an exposed root wad, show evidence of being removed from the soil, or show other signs of dying (e.g. bare branches) are counted as “wood.”

Directions

1. As part of the longitudinal survey, tally the total number of large wood pieces for the entire EAA. It may be helpful to record the approximate ‘station’ (distance from the downstream end of the EAA) of each piece of large wood meeting the above criteria to prevent double-counting.
2. Record the tally on the EAA Field Form. Once back in the office, enter the total count into the EAA Field Form worksheet and the large wood frequency of the stream will be calculated.



Figure 5.17 An example of a live tree in the bankfull channel.

This would not be considered as “wood.”

Extended Assessment Area – Transect Survey

Assess the following measures within the EAA. Incision, Embeddedness, and Wetted Width data are collected on the 11 lateral transects; Thalweg Depth data are collected on each transect plus at nine evenly spaced locations between the transects (**Figure 5.9**).

F15. Incision

What is the degree of channel incision within the EAA? Informs SWS, SC, and CMH functions.

At each of the 11 transects within the EAA, measure the Bank Height Ratio (BHR). The BHR is the height from the stream thalweg to the level of the first terrace of the valley floodplain divided by the bankfull height. Do not consider inset floodplains. Note that in a very connected/ non-incised stream, the first terrace height and bankfull height are equal.

Directions

1. Observe both streambanks and identify the first terrace of the valley floodplain. If the first terrace is lower on one bank, select this bank to assess. Have one person stand on this bank and locate both the bankfull elevation and the elevation of the first terrace of the valley floodplain.
2. Have a second person position a stadia rod in the thalweg and hold the rod with the numbers facing the person on the bank.
3. The person on the bank will use a clinometer to site the bankfull height and the floodplain terrace height.
4. Record the bankfull height and floodplain terrace height for each transect into the EAA Field Form to the nearest 0.1 feet. Once back in the office, transfer the data into the EAA Field Form worksheet and the average bank height ratio will be calculated.

If the stream is in a 'V' shaped valley and the stream banks simply extend uphill indefinitely not reaching a floodplain or terrace, record the floodplain height as equal to the bankfull height and note this on the field forms.

Bankfull height refers to the vertical height from the streambed in the thalweg to the bankfull elevation.

First terrace of the valley floodplain refers to the first major depositional surface at or above the bankfull elevation, whether or not it is an active floodplain. Inset floodplains on incised streams are not considered the first terrace of the valley floodplain.

Thalweg refers to the flow path of the deepest water in a stream channel. The thalweg profile is a longitudinal survey of maximum flow path depth, which may not always be found at mid-channel (and may not always be the absolute deepest point in every channel cross-section).



Crossings - If the intended transect location for measuring bankfull height and floodplain height (to calculate Bank Height Ratio) are inaccessible because they fall in a culvert or under a bridge crossing, measure(s) for BHR can be taken at the up-stream or down-stream edge of the culvert or bridge and used as a proxy to estimate the Bank Height Ratio for all of the transects within the culvert. In this case, the height of the road surface (above the streambed) would be equal to the 'lowest floodplain terrace' height.



Figure 5.18 Using a clinometer to site the bankfull height (a) and the first terrace of the valley floodplain (b).

F16. Embeddedness

What is the degree of substrate embeddedness in the stream channel? Informs FV, SM, and CMH functions.

To what extent are larger stream substrate particles surrounded by finer sediments (i.e. silt and/or sand) on the surface of the streambed (**Figure 5.19**). Measurements are taken at 11 transects within the EAA.

Directions

1. At each of the 11 EAA transects, measure the wetted width of the stream (i.e. the width of the portion covered in water). Wetted width is measured across and over mid-channel bars and boulders. Note that wetted width measurements are a submeasure for Channel Bed Variability.
2. Record the widths on the EAA Field Form to the nearest 0.1 feet.
3. Along each of the 11 EAA transects evaluate substrate embeddedness at five equidistant points across the wetted width of the stream channel (**Figure 5.20**). Record the percent (0, 25, 50, 75, or 100) that best describes the degree of embeddedness at each point.
4. At each location, estimate the percent embeddedness of particles in the 4-inch (10 cm) circle around the measuring stick on each transect plus at nine evenly spaced locations between the transects. This can be done by sight and feel, or by using a 'pole drag' or 'pole tapping' technique to 'feel' the substrate and estimate the embeddedness.
5. Record the percent (0, 25, 50, 75, or 100) on the EAA Field Form that best describes the degree of embeddedness at each point. Two of the measurements will be taken at the edge of the wetted channel, which may be underneath an overhanging bank.

Wetted width measurements should be taken across (and including) any mid-channel bars and boulders.

Embeddedness is the fraction of a particle's volume that is surrounded by (embedded or buried in) sand or finer sediments on the stream bottom (see **Figure 5.19**). For particles larger than sand, examine the surface for stains, markings, and algae. By definition, sand and fines (particles smaller than 2 mm diameter) are embedded **100%**; bedrock and hardpan are embedded **0%**. Unnatural surfaces (e.g., concrete or metal) should be recorded as **100%** embedded.

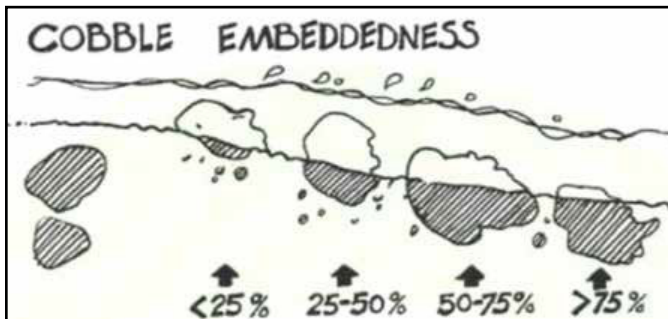


Figure 5.19 Examples of percent embeddedness on a stream bottom.
(from West Virginia, Department of Environmental Protection).

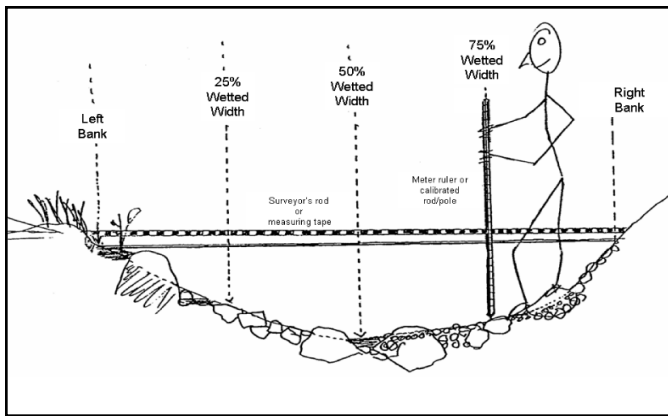


Figure 5.20 Substrate embeddedness measurement locations.
(from USEPA, 2013)

- Record the percentages on the EAA Field Form. Once back in the office, transfer the data to the EAA Field Form worksheet and the average percent embeddedness will be calculated.



Dry Channels – For dry channel assessments, substitute the wetted-width measurement with a streambed width measurement. Instead of measuring the width of the wetted portion of the stream, the width of the entire streambed (from toe of the right bank to toe of the left bank) is used. If any portion of the stream bed within the EAA is dry, then the ‘dry channel’ method must be used for all of the transects even if there is water in the channel in parts of the EAA.



Multiple Channels - If a stream has multiple channels within the assessment area, collect embeddedness data from five equidistant points across the largest (by volume) channel.



Crossings - Under many bridges and in some culverts, it will still be possible to measure the substrate embeddedness. When circumstances prevent the direct observation of embeddedness, it may be possible to assume or infer the values for the transects in the culvert or under the bridge. For example, if a culvert clearly has a uniform metal or concrete bottom (streambed) with no alluvial substrate then the embeddedness measures should be recorded as “100.” For a transect location where embeddedness cannot be measured or reasonably assumed (as described above) then the entry should be left blank.

F17. Channel Bed Variability

Is the channel bed variable? Informs SWS, SST, FV, SM, MB, CMH, NC, and CR functions.

Channel bed variability submeasures include variation in wetted channel width and stream thalweg depth along the EAA.

Directions

Wetted width

- At each of the 11 EAA transects, wetted widths have previously been recorded on the EAA Field Form for Embeddedness. Once back in the office, transfer the data into the EAA Field Form worksheet and the coefficient of variation for wetted width will be calculated.



Dry Channels – For dry channel assessments, substitute the wetted width measurement with the streambed⁴ width measurement as described for Embeddedness dry channel assessments in the EAA Field Form worksheet to calculate the coefficient of variation for wetted width.

⁴ In a cross-section, the ‘streambed’ lies between the ‘toe’ of the left and right streambanks. The streambed margin is at the transition between the streambed and toe of the bank and is often characterized by a distinct break in slope and change in substrate composition or structure.

Crossings - there may be a few circumstances where the observed values for depth and width can be assumed even if the transect locations are not directly accessible. If a stream is flowing through a uniform culvert, the width and depth measures within the culvert can be assumed to also be uniform. If width or depth measures are unknowable (not accessible or reasonably assumed) then those entries should be left blank.

Thalweg depth

1. Determine the appropriate sampling interval by dividing the total length of the EAA by 100.
2. Beginning on the first EAA transect (downstream boundary of the EAA), take a thalweg depth measurement using a calibrated pole or rod. Measure the deepest point within the stream's deepest flow path (from the substrate surface to the water surface). Read the depth on the side of the rod to avoid inaccuracies due to the wave formed by the rod in the moving water. Work upstream towards the second EAA transect taking an additional nine thalweg depth measurements at the determined sampling interval. Repeat this process along the longitudinal extent of the EAA, resulting in a total of 100 data points (no measurement is taken at the upstream EAA boundary).
3. Record the thalweg depths on the EAA Field Form to the nearest 0.1 feet. Once back in the office, transfer data into the EAA Field Form worksheet and the coefficient of variation for thalweg depth will be calculated.

If the thalweg is too deep to measure directly, stand in shallower water and extend the stadia rod or pole at an angle to reach the thalweg. Hold the rod at a 45-degree angle, determined using a clinometer resting on the upper surface of the rod. The thalweg depth equals 70% of the reading on the rod at the water surface.

For deeper depths, use the same procedure with a calibrated line as the measuring device. Tie a weight to one end of the line and toss the weight into the deepest channel location.

Draw the string up tight and hold it at a 45-degree angle, determined using a clinometer resting on the upper surface of the string. The thalweg depth equals 70% of the length of the line that is underwater.

If a direct measurement cannot be obtained, make the best estimate you can of the thalweg depth. Note on the SFAM Cover Page that it is an estimated measurement.

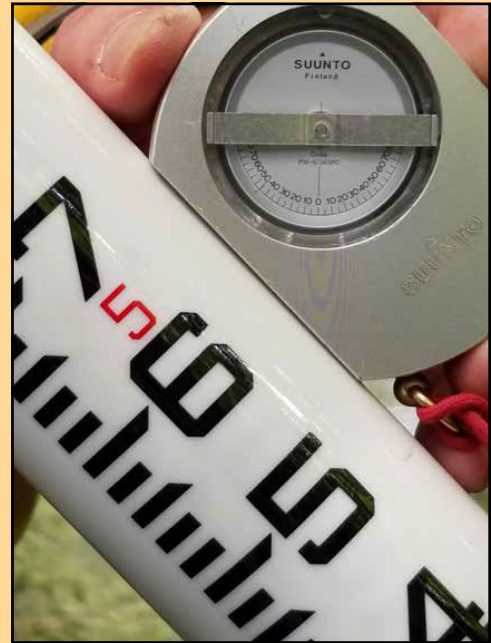


Figure 5.21 Using a clinometer to hold a stadia rod at a 45-degree angle.



Dry Channels – For dry channel assessments of thalweg depth, each water depth measurement is substituted with a ‘depth’ measured from the thalweg to the level of the streambed margin at the toe. Conceptually, the intent is to measure thalweg depths that are equivalent to ‘water-depths’ when the streambed is completely covered with water. Refer to description of ‘streambed’ above. If any portion of the streambed within the EAA is dry, then the ‘dry channel’ method must be used for all of the transects even if there is water in the channel in parts of the EAA.



Multiple Channels - If a stream has multiple channels within the assessment area, collect all thalweg depth data from the largest (by volume) channel.

6.0 Instructions for Entering, Interpreting, and Reporting the Data

6.1 Post-Site Visit Data Entry

All information and data collected during the Office and Field Components of an SFAM Assessment must be entered into the Workbook on the Cover Page, Values tab, Site Layout Field Form, PAA Field Form, and EAA Field Form. Some data entry requires inputting information (e.g., name of project area, elevation, percent cover of large trees in the PAA, etc.), while some requires selecting the appropriate response (e.g., “Yes” or “No”) or a category (e.g., “A”, “B”, “C”, or “D”) from a drop-down menu (indicated by an arrow on the lower right-hand corner of the yellow data entry cell when it is selected).

The Functions tab is linked to the Cover Page and the field forms. The data entry and measure score columns will automatically populate once all data required is entered. If required information is left blank there will be error messages in the functions sheet (**Figure 6.1**).

Data Entry (linked to field forms)	Error Messages	Measure Score
nks, by averaging spherical densiometer measurements		
#DIV/0!	#DIV/0!	Please complete 'Cover Page' cells E17 & E18
#DIV/0!	#DIV/0!	#DIV/0!

Figure 6.1 Example of error message in the SFAM Workbook.

Data Entry for Long Project Areas (PA > 1000 feet)

When the PA is longer than 1000 feet, additional PAA transects are needed to represent Natural Cover, Vegetated Riparian Corridor Width, and vegetation in the riparian area (Invasive Vegetation, Native Woody Vegetation, and Large Trees). The maximum distance between transects should be 250 feet. Data for nine additional transects can be entered in the Extra Transects or Data tab of the SFAM Workbook. Hand calculate the average “% of Transect” numbers from Column AX for each vegetation type (InvVeg, WoodyVeg, LgTree). Enter the results for each measure, to the nearest whole number, into the Functions tab. This change will result in an alert message in Column I of the Functions tab for these measures, indicating that the answer was manually entered and is no longer linked to the field form (**Figure 6.2**).

F	G	H	I	J	K
The answer will be a percentage rounded to nearest whole number.		90	Caution! Entry not linked to Field Form		0.68

Figure 6.2 Example of a message in the Functions tab when a link to a field form has been broken.

Data Entry When Using SFAM Predictively

When using SFAM predictively to estimate outcomes of proposed activities some field data will need to be adjusted (see **Section 7.0** for detail). There are two approaches to making these changes. The first option is to make changes to the PAA and EAA Field Data Forms that reflect the predicted site conditions. The second option is to overwrite the answers in the Functions tab. This change will result in an alert message in Column I of the Functions tab indicating that the answer was manually entered and is no longer linked to the field forms (**Figure 6.2**). It is necessary to enter the correct type of data for the function score to calculate accurately. A description of the type of data necessary for each answer is in Column F/G.

6.2 Final Steps and Interpreting Outputs

When all inputs have been entered to the Workbook, the scores for the functions and values will calculate automatically and appear in the Scores and Subscores tabs. SFAM produces several different outputs. They are described in **Table 6.1**:

Table 6.1 SFAM Outputs

Output	Description
Function Score	Numerical score between 0.0 and 10.0. A score of 0.0 indicates that negligible function is being provided by the stream whereas a score of 10.0 indicates that the stream is providing maximum function (as defined) given certain contextual factors (e.g., ecoregion, size).
Value Score	<p>Numerical score between 0.0 and 10.0. A score of 0.0 indicates that there is low opportunity for the site to provide a specific ecological function and that, even if it did, the specific function would not be of particular significance given the context of the site. Conversely, a value score of 10.0 indicates that a site has the opportunity to provide a specific function and that it would be highly significant in that particular location.</p> <p>A value score results from two subscores:</p> <p>Opportunity subscore: represents the set of circumstances that makes it favorable for the site to be able to provide a specific set of functions, predicted in part by what is upslope and upstream of the Project Area.</p> <p>Significance subscore: represents the importance of a specific function (or set of functions) being provided at a particular location, predicted by what is adjacent to (floodplains) and downstream of the site (that may be affected by the function being provided at the site), and by how unique or rare the function or the aquatic resource type is in the landscape.</p>
Function & Value Ratings	To facilitate conceptual understanding, numerical scores are translated into ratings of Low, Moderate, or High. The numerical thresholds for each of these rating categories are consistent across all functions except Fish Passage Barriers, such that scores of <3.0 are rated “Low,” scores ≥ 3.0 but ≤ 7.0 are rated “Moderate,” and scores that are > 7.0 are rated “High.”
Group Scores & Ratings	Each specific function, and its associated value, is included in one of the four functional groups: hydrologic, geomorphic, biologic, and water quality functions. Group scores/ratings provide a summary of the degree to which each group of processes is present at a site. Groups are represented by the “highest” function with the “highest” associated value among the 2-3 functions that comprise each group. The score sheet in the SFAM Workbook is programmed to select the highest-rated function with the highest-rated associated value within each group. This hierarchical selection system ensures that thematic functional groups are represented by the highest performing and highest valued ecological function. If multiple functions are equally ranked in the selection hierarchy, the function with the highest numerical function score is selected.

If you wish to see how specific measures contributed to each function or value score or rating, click on the cell next to each measure on the Subscores tab (i.e., Measure Score, Function Score, Opportunity Subscore, Significance Subscore or Value Score) to see the formula that is used to calculate that score.

6.3 Evaluating Results

Once you have a complete set of computed SFAM scores, a trained professional should review the results. If the scores and ratings do not match best professional judgment, review the equation for a particular function or value as well as the SFAM Scientific Rationale to see how the score was determined. If there is a measure that the data collector noted as problematic (perhaps because part of the EAA was not accessible, or could not be viewed during a preferred time of year), you can change the value entered on the data entry cell and then check the Scores tab to see what effect that had. If you still question the results, provide your rationale in the space provided in the Assessment Notes section on the Cover Page. If you disagree with the assumptions of how a score was calculated, explain why that assumption is not appropriate for the stream reach or site being assessed and provide supporting information in the Assessment Notes section of the Cover Page (add additional sheets if needed).

6.4 Submitting Your SFAM Assessment

Submission of an SFAM Assessment should include the following items for regulatory purposes:

1. A completed Workbook (check with the agencies for submittal instructions)
 - Electronic file with the permit number(s), if applicable, or the site name in the file name;
 - Printed sheets from the Workbook, consisting of the Cover Page, Values, Functions, Scores, PAA Field Form, and EAA Field Form.
2. Two site maps, one showing an aerial photo and a second a 7.5' topo map, illustrating the approximate PA, PAA and EAA boundaries.
3. Photographs of the stream and riparian area within the PA, PAA, and EAA, are helpful but not required.

Up to four SFAM assessments may be necessary for a project for regulatory purposes:

1. Current state at the impact site.
2. Predicted state at the impact site assuming that the proposed project is authorized and constructed.
3. Current state at the proposed compensatory mitigation site.
4. Predicted state at the proposed compensatory mitigation site, assuming that the proposed actions are authorized and constructed.

Current state should be assessed at the time that field work is conducted. An exception may be if the site was recently and significantly disturbed; consult with agency staff if this is the case.

Predicted state should be assessed using a reference site if available, or by assuming the site has had time to adjust to a variety of flow conditions and planted vegetation has time to mature (**Section 7**).

6.5 Troubleshooting SFAM

If Workbook cells contain error messages such as “#DIV/0!” or “#VALUE”, there is likely an error or blank in an input cell that needs to be corrected. The Subscores tab may help determine which measure entry has the error.

For difficulties with the ORWAP and SFAM Map Viewer, there is a “Feedback” link at the bottom right corner of the Map Viewer from which an email can be directly sent Oregon Explorer technical support staff (virtualoregon.support@oregonstate.edu).

7.0 Informing Restoration Design and Predicting Functional Change with SFAM

While SFAM is designed to assess current stream function and values, it can also be used to inform restoration design and predict stream function. This can be accomplished by:

1. Conducting a baseline SFAM assessment.
2. Evaluating the baseline SFAM function and value scores/ratings to identify stream characteristics which can be targeted for restoration.
3. Designing restoration actions that will improve stream function and services provided.
4. Using the SFAM Excel workbook as a calculation tool to predict outcomes of proposed activities.

Below, a hypothetical stream and two restoration scenarios are used to illustrate how to use SFAM to inform restoration and predict functional change. Restoration Scenario #1 is a relatively simple restoration targeting two highly valued but underperforming stream functions; Restoration Scenario #2 is a more comprehensive and complex restoration project.

Step 1. Baseline Assessment

The first step is to conduct an SFAM baseline assessment for the stream reach being considered for restoration. This includes completing both office and field components and entering all data into the SFAM Workbook.

The hypothetical stream reach used in describing the restoration scenarios is an urban/residential Willamette Valley stream. The stream is relatively incised; has partially armored banks (to prevent bank erosion from encroaching on adjacent residential properties built on the floodplain); has significant invasive vegetation, but also some native woody vegetation in the riparian area; has wetland vegetation growing along the banks, but not on the floodplain. The stream averages 13 feet wide along the 150 feet project area length.

The baseline assessment for this site was completed following the SFAM office/field protocols found in previous sections of this User Manual, resulting in function and value scores/ratings (**Figure 7.1**) prior to any impact or restoration activities.

SPECIFIC FUNCTIONS	Function Score	Function Rating	Value Score	Value Rating
Surface Water Storage (SWS)	2.08	Lower	7.42	Higher
Sub/Surface Water Transfer (SST)	1.52	Lower	0.00	Lower
Flow Variation (FV)	7.86	Higher	6.58	Moderate
Sediment Continuity (SC)	6.94	Moderate	1.73	Lower
Sediment Mobility (SM)	4.44	Moderate	6.75	Moderate
Maintain Biodiversity (MB)	2.81	Lower	3.58	Moderate
Create and Maintain Habitat (CMH)	4.07	Moderate	4.33	Moderate
Sustain Trophic Structure (STS)	2.91	Lower	4.21	Moderate
Nutrient Cycling (NC)	3.06	Moderate	3.00	Moderate
Chemical Regulation (CR)	2.14	Lower	7.00	Moderate
Thermal Regulation (TR)	6.77	Moderate	7.13	Higher

Figure 7.1 Baseline SFAM function and value scores/ratings excerpted from the Scores tab.

Step 2. Evaluate the Baseline Assessment Function and Value Scores/Ratings

The output of the SFAM baseline assessment displayed on the Scores tab (**Figure 7.1**) can be used to identify opportunities for improving stream function and increasing the ecosystem services provided by the stream reach. Recall that the scores/ratings for the 11 SFAM stream functions represent how well the stream is performing each function at the reach/site scale and can be altered by on-site activity (impacts or restoration). In SFAM, values generally describe the broader landscape context within which the function provides services valued by society. Thus, value measure inputs and resultant value scores at a particular site will generally not be affected by on-site impacts or restoration activities; we will assume this to be the case for the following scenarios.

The value ratings resulting from the baseline assessment of values for all 11 functions are listed on the Scores tab. A ‘higher’ value rating indicates that the assessment reach has both the opportunity to provide that particular function and that function is locally significant (need for the ecosystem services provided by that function is high). Functions with a ‘higher’ value rating and ‘lower’ or ‘moderate’ function rating should be primary targets for restoration activities (e.g. **Figure 7.1**, Surface Water Storage) because they are of high local value and there is opportunity to improve that stream function and the associated services it provides. Restoration Scenario #1 provides a relatively simple example of this. Restoration Scenario #2 illustrates this principle using a more comprehensive and extensive restoration project as an example.

Restoration Scenario #1 – Targets only those functions with ‘lower’ or ‘moderate’ ratings that are highly valued (i.e. ‘higher’ rated values):

The baseline assessment results in **Figure 7.1** show that two functions, Surface Water Storage (SWS) and Thermal Regulation (TR), have ‘higher’ value ratings. The function ratings for SWS and TR are ‘lower’ and ‘moderate,’ respectively. Because the value ratings for SWS and TR are ‘higher’ and there is room for improvement for both functions, they will be targeted for restoration activities in this scenario.

Restoration Scenario #2 – Targets all functions with value ratings that exceed the corresponding function rating:

The baseline assessment results in **Figure 7.1** indicate there are five functions with value ratings that exceed the corresponding function rating (e.g. Maintain Biodiversity (MB) has a ‘moderate’ value rating and a ‘lower’ function rating). In addition to MB, SWS, and TR, Sustain Trophic Structure (STS) and Chemical Regulation (CR) all have value ratings that exceed their corresponding function rating. The restoration design in this scenario will include elements targeting improvement in all five of these functions.

Step 3. Use SFAM to Inform Restoration Design

SFAM informs the elements to include in restoration design by identifying which stream attributes are underperforming and could be improved to increase stream function. SFAM does not replace the judgement of a reasonable and experienced practitioner who still must design a restoration project that will achieve improvements to stream attributes identified by SFAM as contributing to improved function. Neither does SFAM replace a well implemented restoration project; practical implementation is still in the purview of restoration practitioners who must consider and apply standard practices of the stream and river restoration industry.

Identifying SFAM measures to improve through restoration activities

In SFAM, function measures are field metrics that allow a quantitative assessment of specific stream attributes that represent a particular stream function and the extent to which that function is active (e.g. overbank flow; see **Section 2, Figure 2.2**). Once stream functions have been selected for improvement using the baseline assessment as described, the SFAM Subscores tab can be used to identify the specific

measures that contribute to those functions. Restoration activities can then be designed to improve the identified measures.

SFAM function measures are assigned an index value between 0.0 and 1.0, with 1.0 indicating the highest possible function. Index values are determined using the data collected in the field assessment (or from the office component for value measures) and the standard performance index for that measure (see **Section 4.1** for details) and are displayed in the green cells on the Functions tab in the SFAM Workbook and listed by function on the Subscores tab. Any measure with an index value less than 1.0 can potentially be improved with restoration activities, which could in turn improve stream function and increase function scores. Measure index values for all 11 SFAM functions can be found in the Subscores tab of a completed SFAM Workbook.

To identify specific measures to include in restoration design, open the Subscores tab of the SFAM Workbook, locate the functions previously targeted for improvement and identify contributing measures with an index value (score) less than 1.0.

Restoration Scenario #1 – Identify all measures that contribute to the targeted functions SWS and TR which have index values less than 1.0:

FUNCTIONS			
Function	Measure Name	Measure Score	Function Score
SWS	OBFlow	0.00	2.08
	Incision	0.50	
	Exclusion	0.00	
	BedVar	0.36	
	Wood	0.27	
	SideChan	0.00	

TR	Cover	0.68	6.77

Figure 7.2 SFAM measure and function scores for SWS and TR functions excerpted from the Subscores tab of the baseline assessment.

The SWS function has six contributing measures (**Figure 7.2**). All measures for this function have index scores less than 1.0; thus, improvement to any of these measures will increase the SWS function score. Because the TR function has only one measure (Cover), the restoration design must include activities that will increase natural cover, and thus the Cover measure score, to improve the TR function rating. For the SWS function any, or all six of the measures could be included in restoration design to help improve the SWS function score.

There are many factors to consider when deciding which measure(s) to address to improve stream function, including: cost, time, and practicality of a particular restoration design element given access or other site constraints. In this scenario, the project sponsor has determined that while OBFlow, Incision, Exclusion, and SideChan could all be addressed to improve stream function, because accomplishing those improvements would require reconnection of the stream to its floodplain and expensive earth moving work, they will not address those restoration elements in this project. Rather, the project sponsors decide that placement of large wood to improve the Wood measure would be the most cost-effective way to improve the SWS function, and that a relatively limited amount of streamside vegetation planting to increase natural cover (Cover measure) would increase the TR function in a meaningful way.

Determining the effect of restoration design elements on SFAM outputs

To begin, it is important to understand the underlying physical and ecological characteristics contributing to each function measure. To do this, review 1) the measure description and data

collection instructions in the SFAM User Manual, and 2) the detailed description of the scientific underpinning for that measure that can be found in **Section 4.2** of the SFAM Scientific Rationale. In the current scenario, determining restoration activities to improve the Wood and Cover measures is relatively straightforward: to improve the Wood measure, additional in-stream wood meeting the described criteria must be placed, and to improve the Cover measure additional natural stream cover (shading) needs to be achieved.

Determining how much appropriately sized wood to place in the stream can be informed by evaluating the Wood measure index score resulting from the baseline assessment using the standard performance index for the measure in the SFAM Scientific Rationale document (**Section 4.2(n)**). Simply put, conducting some “what if” exercises and using the completed baseline assessment in the SFAM Workbook as a tool.

For example, the baseline assessment (**Figure 7.3**) identified that there was 1 piece of wood (1.17 per 328 feet) in the Extended Assessment Area (EAA). This resulted in an index value of 0.27 (**Figure 7.3**). “What if” 25 pieces of wood of the appropriate size were added to the PAA for a total of 26 pieces in the EAA? This can be evaluated by changing the Wood measure entry from ‘1’ to ‘26’ on the EAA field form worksheet to calculate a new Wood measure input (30.46 pieces per 328 feet) and entering this into the Functions tab in the yellow data entry cell for the Wood measure (**Figure 7.4**). The resulting index value for the Wood measure is 0.79, which in turn results in an increase in the SWS function rating from ‘lower’ to ‘moderate.’

Measure	Frequency (pieces per 328 ft)	Index Value
Wood	1.17	0.27

Figure 7.3 Baseline data entry (1.17) and index value (0.27) for the Wood measure.

Measure	Frequency (pieces per 328 ft)	Index Value
Wood	30.46	0.79

Figure 7.4 Data entry change for the “what if” exercise adding 25 pieces of wood (30.46 per 328’).

The same process can be used to inform how much natural cover planting is needed. Completing a “what if” exercise for the Cover measure shows that increasing natural cover in the Proximal Assessment Area (PAA) from 90% (baseline assessment) to 95% would increase the Cover measure index value enough to result in increasing the TR function rating from ‘moderate’ (baseline assessment) to ‘higher.’

Restoration Scenario #2 - Identify all measures that contribute to the targeted functions SWS, MB, STS, CR, and TR which have index values less than 1.0.

Again, using the Subscores tab of the SFAM Workbook and the same process as described above for Restoration Scenario #1, all measures that could potentially improve the targeted functions are identified; there are ten (**Table 7.1**). In this scenario, most of the function measure scores identified that have index values less than 1.0 (OBFlow, Incision, Exclusion, Armor, WetVeg, WoodyVeg, SideChan and RipWidth) are largely a result of armoring and other structures related to streamside development that disconnect the stream from its floodplain. Therefore, removal of these impediments to floodplain access and restoration of those areas will greatly improve stream function; these actions are a significant aspect of this restoration scenario.

As with Restoration Scenario #1, specific restoration design elements are informed by evaluating what physical changes are needed to improve each of these ten measures. The evaluation includes reviewing the measure description, baseline assessment index value, and in some cases, “what if” exercises for each of these measures to evaluate the effect of possible actions on targeted functions. Combining this information with knowledge of the project site, professional experience, potential constraints to restoration activities, and cost considerations results in the following proposed restoration elements:

- Removal of all armoring and constraints to lateral migration within 100 feet of the stream in the PAA (which encompasses all of the 100-year floodplain).
- Reshaping the stream banks in the PAA, providing better stream connection to the floodplain.
- Construction of an approximately 150 feet (54% of the EAA length) side channel to carry water during the wet season.
- Placement of 30 pieces of large in-stream wood in the PAA.
- Construction of three in-channel pools in the PAA.
- Planting woody and herbaceous wetland plants within 50 feet of the stream in the PAA.
- Removing invasive plants and implementing a program to control invasive vegetation in the PAA.
- Creating and managing all area within 100 feet of the stream in the PAA as a ‘natural’ riparian area.

Step 4 describes how to project changes to function measure inputs and predict the overall outcome of these restoration activities on stream function as determined by SFAM.

Table 7.1 Restoration Objectives and Design Elements for Two Restoration Scenarios.

	Restoration Scenario #1	Restoration Scenario #2
Target Functions	SWS, TR	SWS, MB, STS, CR, and TR
Target measures (contribute to the target function and have a baseline index value less than 1.0)	Wood, Cover	OBFlow, Incision, Exclusion, BedVar, Wood, SideChan, InvVeg, WoodyVeg, WetVeg, RipWidth
Proposed restoration design elements improving the targeted functions	Placement of 25 additional pieces of wood; streamside planting of woody shrubs and forbs to provide 5% additional natural cover.	Removal of all armoring and constraints to lateral migration within 100 feet of the stream (which encompasses all of the 100-yr floodplain); Reshaping the stream banks, providing better stream connection to the floodplain; Construction of a 150 feet long (54% of the EAA length) side channel to carry water during the wet season; Placement of 30 pieces of large wood in-stream; Construction of three in-channel pools in the PAA; Planting woody and herbaceous wetland plants within 50 feet of the stream; Removing invasive plants and implementing a program to control invasive vegetation; Creating and managing all area within 100 feet of the stream as a ‘natural’ riparian area.

Step 4. Use SFAM to Predict Restoration Outcomes

To predict the outcome of restoration activities on stream function, use the SFAM baseline assessment as a tool in which to make predictive changes to the function measure inputs; the SFAM Workbook will calculate the resulting changes to the function scores and ratings. Recall that SFAM value measures are largely landscape scale based and are not expected to change with most restoration projects; they are assumed constant for this exercise, as are all baseline assessment Cover Page inputs.

As seen above in Restoration Scenario #1 with the Wood measure example (**Figure 7.3** and **Figure 7.4**) the SFAM Workbook can be used to evaluate changes in SFAM outputs resulting from changes in SFAM function measure inputs. It can also be used to evaluate changes to groups of measures or to evaluate projections over time as restoration elements develop (e.g. trees and shrubs mature, providing more cover and shade). Using each of our two scenarios, below we predict changes to function measure inputs 10 years post- restoration and calculate the associated changes to function scores/ratings.

Predicting changes to measure inputs

Restoration Scenario #1 - Use the projected measure input values, determined above during the “what if” exercise, for Wood and Cover:

1. Additional wood placement, 26 total pieces (25 added pieces plus one piece identified in baseline assessment) for a measure input value of 30.5 (pieces per 328 feet).
2. Native shrub and forb planting for stream-side cover, such that projected (ten-year) Cover is 95%.

Restoration Scenario #2– Determining projected function measure inputs for this scenario is more complicated than for Restoration Scenario #1.

Based on the target functions, associated measures, and restoration elements identified in Step 3 above (**Table 7.1**), Restoration Scenario #2 is an extensive restoration which aims to reconnect the stream with its floodplain, rehabilitate the riparian community, and increase in-channel complexity. Implementation of this restoration plan is expected to result in the following specific function measure input changes. Any measure not mentioned is assumed to stay at the baseline assessment value.

- Reduce Armor from 54% to 0%

- Reduce LatMig from 13% to 0%
- Reduce Exclusion to below 20%
- Increase Wood from 1.17 to 36.31 pieces per 100m (328 ft)
- Increase SidChan from 0% to 54%
- Increase RipWidth from 27 feet to 100 feet
- Increase Cover from 90% to 95%
- Increase WoodyVeg from 46% to 60%
- Reduce InVeg from 54 to 0%
- Reduce Incision (BHR) from 1.75 to 1.3
- Increase BedVar depth from 0.31 to 0.42
- Increase BedVar width from 0.27 to 0.4
- Decreased incision and increased channel complexity are expected to result in much more frequent floodplain inundation events and therefore direct observations of overbank flow (i.e. OBFlow = ‘yes’)
- Increase the extent of riparian Wetland Vegetation beyond 0.5 x BFW to achieve wetland plant distribution along more than 70% of the length of the PAA

Projecting the above expected values for specific function measures ten years post-restoration requires a clear understanding of how each of the measures are assessed and scored using SFAM, a well-designed and executed restoration plan, and knowledge about how stream and riparian structure is likely to change in response to the restoration actions for the restored stream reach within its landscape context.

For many function measures, projecting the 10-year post-restoration SFAM inputs is relatively straightforward based on the restoration design, assuming the design is implemented as planned. For example, the plan above includes “removal of all armoring and structures that restrict the stream’s access to the floodplain,” therefore projecting that Armor, LatMig and Exclusion will be at or near 0% is reasonable. Similarly, designs for SideChan and RipWidth call for a riparian width of 100 feet and a 150 feet SideChan (54% of the EAA length); these projections can be entered directly into the Functions tab of the SFAM Workbook. For projecting the Wood measure, it is helpful to use the EAA Field Form worksheet to calculate the needed input (pieces per 328 feet) for the SFAM Functions tab; this can be done by entering the number of pieces of wood expected to be within the EAA following restoration activities. This scenario assumes that all of the placed and existing wood would remain in the PAA after ten years. It might be reasonable to expect that some of the placed wood will be lost from the reach, in which case the projections should include only the wood pieces that are expected to remain in the EAA after ten years. Alternatively, the restoration design could account for expected losses of wood by replacing any lost wood such that the target amount of 31 pieces is maintained after ten years.

For the more data-driven function measures (i.e. vegetation cover and physical habitat measures) we suggest two approaches for projecting input values to use for a ten-year post-restoration prediction. The preferred approach is to use the field data worksheets from the baseline assessment and, based on the restoration design and best professional judgement, enter adjusted data for function measures that are consistent with expected restoration outcomes. For example, in the current scenario the restoration plan includes constructing three pools within the PAA to increase channel bed variability (BedVar measure). If the anticipated depth of those pools is between 2 and 2.5 feet, a new thalweg depth coefficient of variation (CV) can be estimated by replacing several of the baseline assessment depth measurements with estimated measurements consistent with the expected pools. **Figure 7.5** highlights predicted thalweg depth changes, and resultant predicted CV, from constructing three pools in the PAA; the predicted CV is then entered as the value for the thalweg depth submeasure (BedVar measure) in the predicted SFAM Workbook.

Baseline thalweg depths:

Thalweg Depth (F17)									
Record the thalweg depth at 10 equidistant points <u>between</u> each cross-channel transect while moving upstream.									
Depth 1	Depth 2	Depth 3	Depth 4	Depth 5	Depth 6	Depth 7	Depth 8	Depth 9	Depth 10
0.8	1	0.9	0.9	0.9	0.7	0.9	0.8	0.6	0.7
0.6	0.4	0.7	0.8	0.7	0.8	0.8	1	1	1
0.6	0.6	0.7	1	0.9	0.9	1	0.8	0.8	0.6
1	1.4	1.3	1	1	0.7	0.6	0.6	0.6	0.4
1	0.8	1	1	1	0.9	1.3	1.7	1.8	1
0.8	0.6	0.6	0.8	0.8	0.7	0.9	1	0.9	1.4
0.8	0.5	0.6	0.6	0.6	0.7	0.9	1	0.6	0.7
1	1.1	0.9	0.6	1.2	1.2	1	1	0.6	0.7
0.7	0.9	0.8	1.5	0.9	0.8	0.6	0.6	0.9	1.2
0.8	0.6	0.8	0.8	0.6	1.3	1.6	1.4	1.2	1.3
Baseline calculated CV									
Thalweg Depth - CV (F17)									
0.31									

Predicted thalweg depths:

Thalweg Depth (F17)									
Record the thalweg depth at 10 equidistant points <u>between</u> each cross-channel transect while moving upstream.									
Depth 1	Depth 2	Depth 3	Depth 4	Depth 5	Depth 6	Depth 7	Depth 8	Depth 9	Depth 10
0.8	1	0.9	0.9	0.9	0.7	0.9	0.8	0.6	0.7
0.6	0.4	0.7	0.8	0.7	0.8	0.8	1	1	1
0.6	0.6	0.7	1.5	2	2.4	2	1.4	0.8	0.6
1	1.4	1.3	1	1	0.7	0.6	0.6	0.6	0.4
1	0.8	1	1	1.5	2	2	1.9	1.8	1
0.8	0.6	0.6	0.8	0.8	0.7	0.9	1	0.9	1.4
0.8	1.4	1.5	2	2.2	2	1.5	1	0.6	0.7
1	1.1	0.9	0.6	1.2	1.2	1	1	0.6	0.7
0.7	0.9	0.8	1.5	0.9	0.8	0.6	0.6	0.9	1.2
0.8	0.6	0.8	0.8	0.6	1.3	1.6	1.4	1.2	1.3
Predicted CV									
Thalweg Depth - CV (F17)									
0.42									

Figure 7.5 Baseline and predicted thalweg depth measurements and calculated coefficient of variation (CV) values.

Excerpted from SFAM EAA field form worksheets. Yellow cell entries have been changed from the baseline measurements to estimated measurements representing the additional pools in the restored stream.

The other approach, applicable when there is insufficient information available to predict field measurement changes as described above, is to assume (if justified) a categorical standard performance index rating (lower, moderate, higher) change for a projected measure, and enter a value for that measure that results in a standard performance index value at the mid-point of the predicted index rating category. Recall that each function measure is translated into an index value using scientifically based standard performance indices (See **Section 4.1** for a description of standard performance indices); index values 0-<0.3 represent 'lower'; 0.3-0.7 'moderate' and >0.7-1.0 'higher' contribution to function. Thus, the mid-point of each of these standard performance index categories equals 0.15, 0.5, and 0.85 for 'lower', 'moderate' and 'higher,' respectively. To project a function measure value using these performance categories, the measure input that corresponds with a mid-point index value (.15, 0.5, or 0.85) needs to be entered into the function measure cell (yellow) in the Functions tab of the SFAM Workbook. The appropriate input can be identified using the standard performance index graphs and equations in the SFAM Scientific Rationale (**Section 4.2**), or by simply changing the input value in the measure input cell until the target index value is displayed in the green "measure score" box.

Figure 7.6 illustrates this using the thalweg depth submeasure of the BedVar measure. The thalweg depth index value from the baseline assessment is 0.29 (lower), based on a CV of 0.31. For the ten-year predicted SFAM assessment, we expect the thalweg depth variability (CV) to increase to 'moderate' due to the in-channel work and placement of wood. Therefore, we would project the thalweg depth CV (input) to result in a measure score (standard performance index value) of 0.5 (mid-point of the 'moderate' category). The thalweg depth CV that corresponds to a measure score of 0.5 is 0.45, which is then entered into the Functions tab of the post-restoration (predicted) assessment.

a)	Hydrology, Geomorphology, Biology, Water Quality		BedVar	Enter the wetted width coefficient of variation:	0.27		0.43
				Enter the thalweg depth coefficient of variation:	0.31		0.29
						AVERAGE	0.36
b)	Hydrology, Geomorphology, Biology, Water Quality		BedVar	Enter the wetted width coefficient of variation:	0.27		0.43
				Enter the thalweg depth coefficient of variation:	0.45		0.50
						AVERAGE	0.47

Figure 7.6 Projecting a change in thalweg depth a) baseline, b) predicted.

The thalweg depth is projected to increase from the baseline 'lower' score (0.29) to the mid-point of the 'moderate' category (0.5) using the SFAM Workbook.

Predicted SFAM outputs

To calculate predicted SFAM outputs, use the completed baseline assessment SFAM Workbook as a template and change the affected function measure input values as described above. Be sure to save this as a new SFAM Workbook (check 'Predicted' box on the Workbook Cover Page). Once function measure inputs are changed, the function scores will be calculated automatically and available on the Scores tab.

Figure 7.7 summarizes the changes to the function measures and resulting outputs (scores/ratings) for each predicted assessment compared with the baseline assessment.

Restoration Scenario #1 (added Wood and Cover) improved four of the 11 Functions (SWS, MB, STS and TR) from 'lower' functioning to 'moderate' functioning and increased the total sum of all function scores from 44.6 to 49.4, an 18.8% increase.

The comprehensive floodplain reconnection and riparian restoration of Restoration Scenario #2 predicts that all functions will now have a 'higher' rating and raised the sum of all function scores to 92.41, more than double the baseline score of 44.61.

SFAM input (entered into 'Function' page)		Baseline	Scenario #1	Scenario #2
	F1 Cover	90	95	95
	F2 InvVeg	54	54	0
	F3 WoodyVeg	46	46	60
	F4 LgTree	40	40	40
	F5 RipWidth	27	27	100
	F6 Barriers	Passable	Passable	Passable
	F7 Exclusion	D	D	A
	F8 Armor	54	54	0
	F9 Erosion	0	0	0
	F10 OBFlow	No	No	Yes
	F11 WetVeg Q1	Yes	Yes	Yes
	F11 WetVeg Q2	No	No	Yes
	F11 WetVeg Q3	No	No	Yes
	F12 SideChan	0	0	54
	F13 LatMigr	13	13	0
	F14 Wood	1.17	30.5	35.71
	F15 Incision	1.75	1.75	1.3
	F16 Embed	7	7	7
	F17 BedVar (wet width)	0.27	0.27	0.4
	F17 BedVar (depth)	0.31	0.31	0.42
Calculated Function ratings (scores):		Baseline	Scenario #1	Scenario #2
	Surface Water Storage (SWS)	Lower (2.08)	Moderate (3.13)	Higher (8.17)
	Sub/Surface Water Transfer (SST)	Lower (1.52)	Lower (1.52)	Higher (8.31)
	Flow Variation (FV)	Higher (7.86)	Higher (7.86)	Higher (8.66)
	Sediment Continuity (SC)	Moderate (6.94)	Moderate (6.94)	Higher (9.09)
	Sediment Mobility (SM)	Moderate (4.44)	Moderate (4.44)	Higher (8.39)
	Maintain Biodiversity (MB)	Lower (2.81)	Moderate (3.68)	Higher (7.78)
	Create and Maintain Habitat (CMH)	Moderate (4.07)	Moderate (4.07)	Higher (7.75)
	Sustain Trophic Structure (STS)	Lower (2.91)	Moderate (3.22)	Higher (9.21)
	Nutrient Cycling (NC)	Moderate (3.06)	Moderate (3.06)	Higher (8.3)
	Chemical Regulation (CR)	Lower (2.14)	Lower (2.14)	Higher (8.25)
	Thermal Regulation (TR)	Moderate (6.77)	Higher (8.5)	Higher (8.5)

Figure 7.7 Predicted SFAM measure inputs and function outputs for Restoration Scenarios #1 and #2 relative to baseline assessment.

Yellow indicates a projected change in measure input due to restoration activity and green highlights predicted change in function rating.

8.0 References

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9.0 Appendices

Appendix 1. Instructions for Common ORWAP and SFAM Map Viewer Functions & Tasks

The ORWAP and SFAM Map Viewer is available at http://tools.oregonexplorer.info/OE_HtmlViewer/Index.html?viewer=orwap_sfam.

Note - The SFAM Map Viewer works with all (updated) internet browsers.

Navigate to a Site

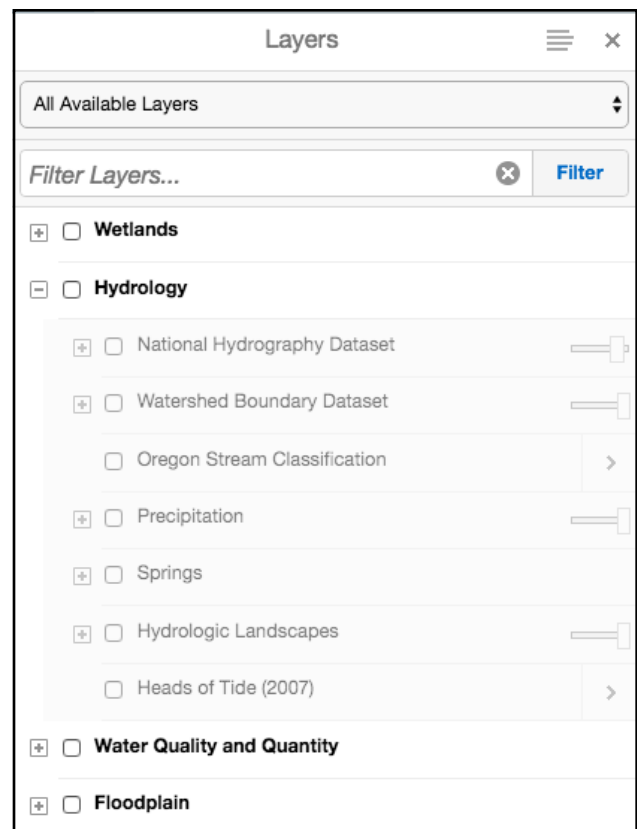
Users can navigate to a known location in the SFAM Map Viewer using three different methods:

1. **Plot Coordinates:** Enter the latitude and longitude of a site (e.g. 44.930, -123.033) in the Search box on the Home screen
2. **Search Tool:** Enter an address (e.g. 123 River Road, City, State) or place name (e.g. Willamette University) in the Box on the Home screen.
3. **Zoom/Pan Tools:** Use the Zoom In (+) or Zoom Out (-) functions on the map or on the Find tab to change the scale of the map. Use the Pan function or click and drag map to where it displays the area of interest.

Load and Manage Layers

Datasets available in the SFAM Map Viewer are listed in the Layers table of contents window. Layers are grouped by category (e.g., Wetlands, Hydrology, Water Quality and Quantity, Floodplain, etc.).

To view the specific data layers available in each group, select the “+” symbol to the left of the group name to expand the list, or the “-” symbol to collapse the list.

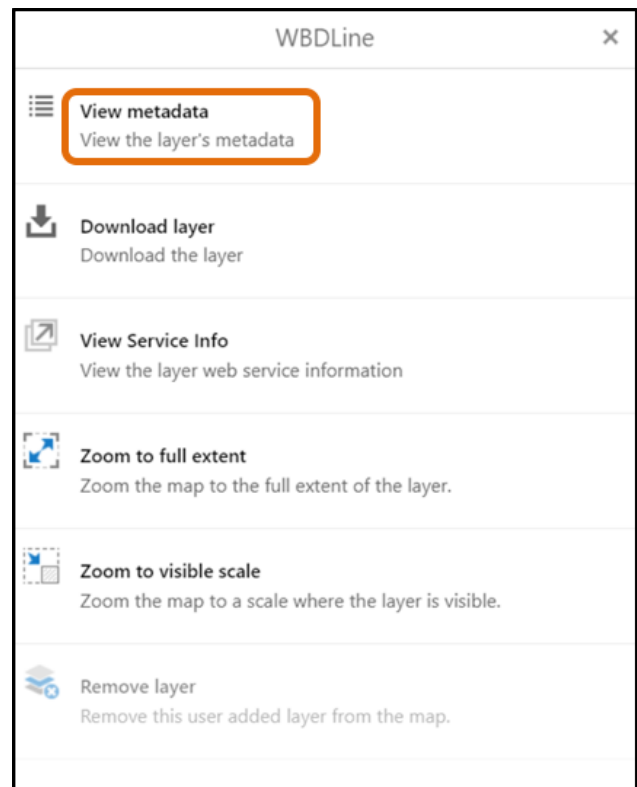
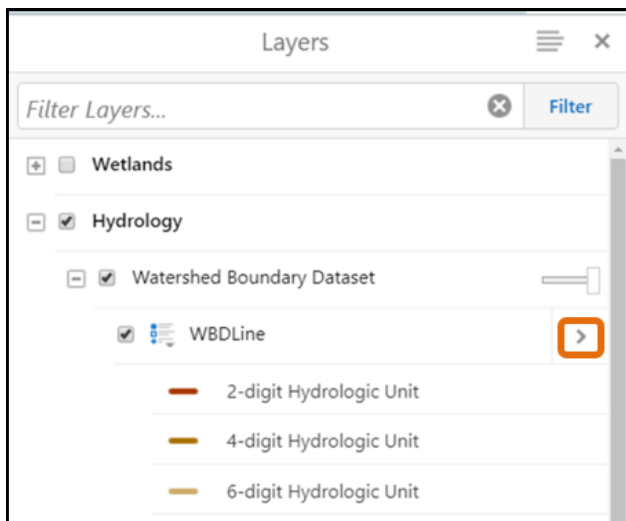
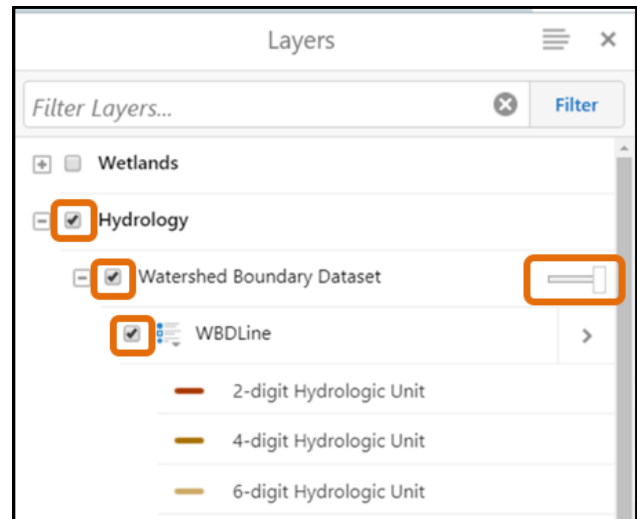


Check the box to the left of a layer name to display the layer in the Map Viewer (i.e. to activate the layer).

Note - In order to display a specific layer, you must first select the group or subgroup that the layer belongs to. That will activate all layers within the group so that they can be turned on or off individually.

Slider symbols to the right of a group name or layer name can be used to adjust the transparency of the layer(s).

The > symbol to the right of a layer name displays a menu with a link to the metadata available for that layer, as well as options to zoom the display relative to the layer.



Tip: Many layers are visible only at certain spatial scales. If a layer is greyed out even when checked (activated), zoom in or out until the layer appears, or use the “Zoom to Visible Scale” tool in the Layer menu.

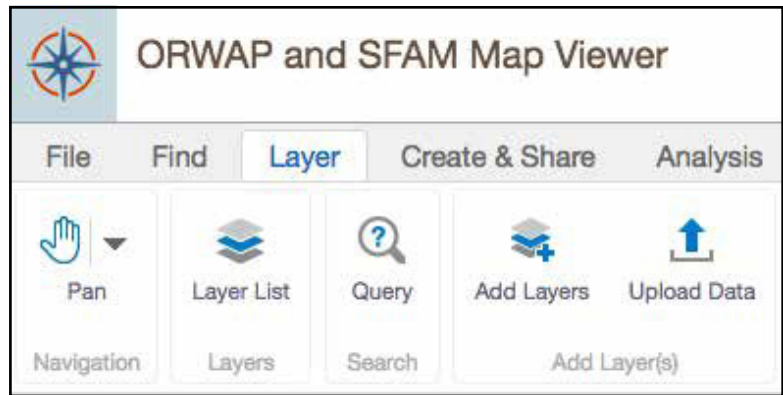


Tip: If you find that it is becoming difficult to view the basemap or individual lines or polygons associated with each layer, you may need to deselect layers that are not part of your current analysis.

Upload Data

Users can upload data such as a shapefile to the ORWAP and SFAM Map Viewer using the Upload Data tool under the Layer tab, browsing to the location of the files, and selecting the file to upload. Supported file types include .csv, .xlsx, .kml, .shp, .gpx, or a .zip containing a FileGDB or shapefiles.

Users need to upload a shapefile of the Contributing Area for their site as part of the SFAM Assessment.



Draw

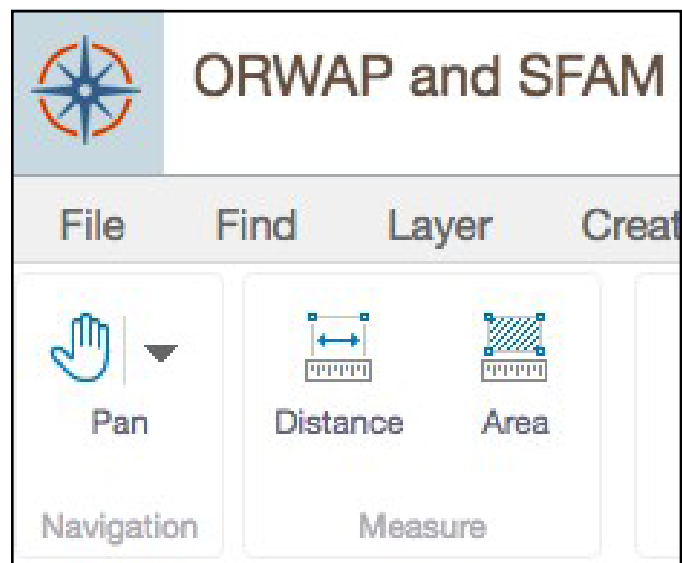
The Draw tools in the ORWAP and SFAM Map Viewer allow users to add features such as rectangles, circles, polygons or lines to base maps. These tools are useful in estimating the boundaries of the different SFAM Assessment areas on a field map.

- Draw tools are found under the Create and Share tab.
- To draw ellipses, circles or rectangles, click on the drop-down menu with the Point icon and select the shape you wish to add to the map.
- Place the cursor on the map and use the mouse/trackpad to create the shape.
- To add another drawn object, select the shape from the toolbar and add it to the map.
- To draw a polygon, select the Polygon shape, place the cursor over the starting point and tap the map. Drag the mouse or trackpad along the boundaries of the shape you are delineating. Clicking on the map will create an endpoint to a line segment. To finish your polygon, double click the map.
- To edit an object, select the Edit tool, then click the object you wish to edit and use the cursor to move the boundaries of the object. You may also select the Styles icon to change the color of an object.
- To delete an object, select the Erase tool under the Edit function and click the object you wish to remove. Note - the object will be immediately deleted; this action cannot be undone.
- To remove all objects from the map, use the Clear tool. This action cannot be undone.

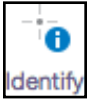
Measure Distance and Area

Users can measure both distance and area on a map using the Measure tools located on the Analysis tab.

Select either the Distance or Area measurement tool. Then select the units for your straight line (distance) or polygon (area). Click the map to start a measurement, and click additional locations to add vertices to your line or polygon. Double click to finish a measurement. The results will be displayed in a text box on the map.



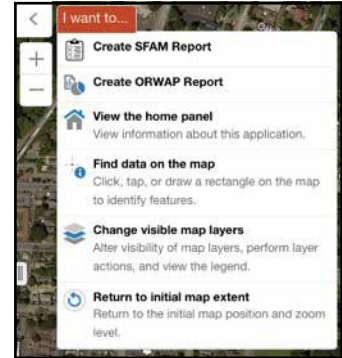
Identify Feature



The Identify tool under the Find tab allows users to obtain information about specific features in the map. For example, if the map is displaying a layer of point features or polygons, click on an individual point or polygon feature. Available information or data associated with that location will appear in the left panel.

Map Viewer Shortcuts

The **“I want to”** Tool gives users the option to select from a suite of commonly performed tasks in the ORWAP and SFAM Map Viewer such as create an SFAM Report, identify features on the map, and return to original map extent.



Export

Users can export images (including basemaps and maps with drawn objects) from ORWAP and SFAM Map Viewer using the Export and Export Drawing tools under the Create and Share tab.

Directions:

1. Click the Export button and select the preferred format for your exported file (e.g., PNG, JPEG, PDF).
2. Click “View Image” and a new tab will open in your browser. Right click the image displayed in the new tab and save it to your computer.
3. Note – the exported image will be what is currently shown in the map viewer; there is no option to outline or select the print area.

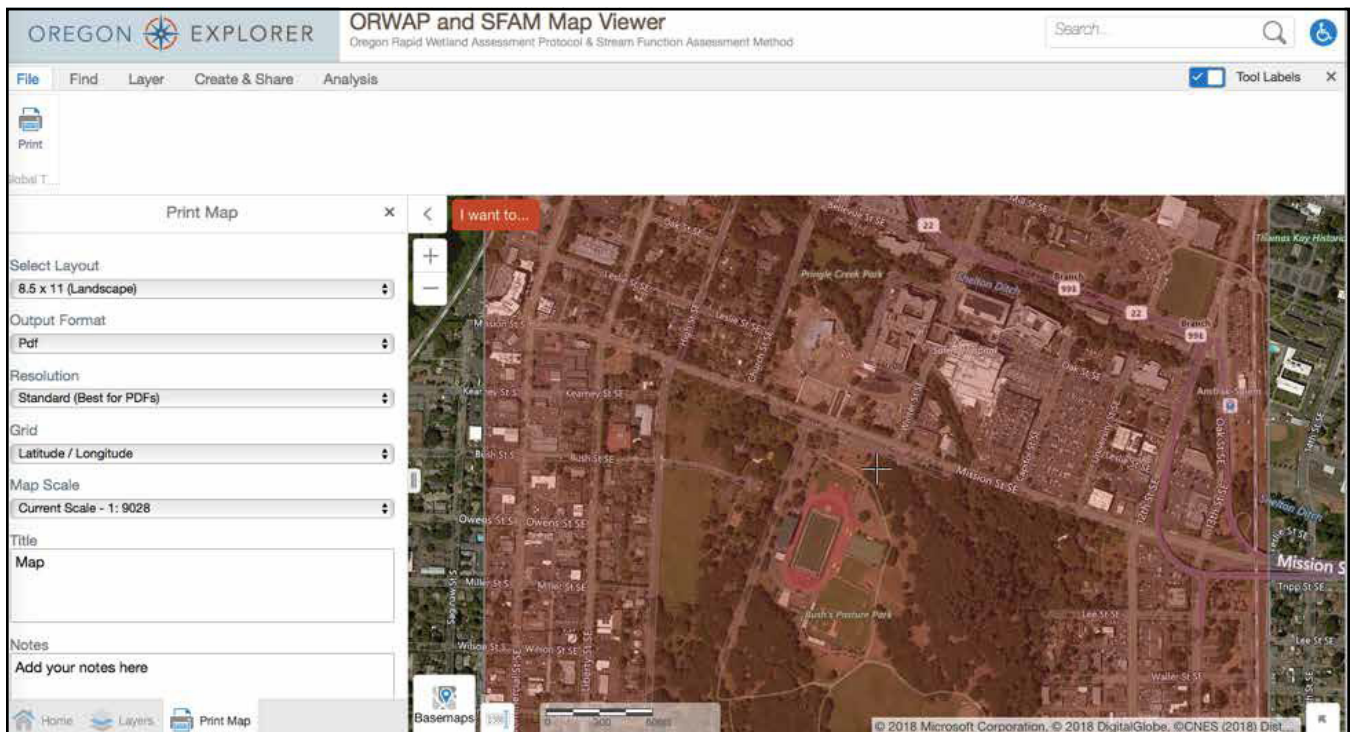
To export drawings as shapefiles, select the Export Drawing tool and save the .SHP file to your computer.

Print

Users can print images (including basemaps and maps with drawn objects) from the Map Viewer using the Print tool under the Create and Share tab.

Directions:

1. Click the Print tool.
2. A sidebar will provide options for selecting output size, format, and resolution. Users can set the scale of the map from this sidebar, separate from the scale of the viewer.
3. Users can also add a title, latitude and longitude gridlines, and any notes about the site. This information will be included on the printed version of the map.
4. Once your selections are made, click the “Print” button. The printable map will open in a new browser. You can download the file and print it from your computer.



Notes:

- Selecting “current extent” for the map scale will print everything shown in the current map view.
- When you select Print, a “print box” (transparent orange box) appears on the map viewer to preview what portion of the map will be printed. To resize or relocate the print box, uncheck the box in the sidebar labeled “Lock print preview with map.” This option locks the print box to its initial scale and location.
- The printed map will include a legend for any SFAM data layers that are selected at the time you create your map. You may want to minimize the number of layers selected so as not to have unnecessary items in the legend.
- You may increase the extent of the map view by narrowing the menu panel on the left.

Appendix 2. Field Work Order of Operations

This quick-reference list can help guide your work in the field by providing the basic order of data collection steps. Read through the entire list before beginning your work. Reference the appropriate sections of the User Manual to find more information about specific data collection methods.

1. Survey the entire site
2. Locate the boundaries of the Project Area
3. Measure bankfull width at three designated areas within the Project Area
4. Establish Proximal Assessment Area boundaries (based on bankfull width measurements)
5. Lay out three survey transects (at same locations where bankfull width was measured)
6. Work along each of the three transects to collect data for:
 - a. Natural Cover (F1)
 - b. Invasive Vegetation (F2)
 - c. Native Woody Vegetation (F3)
 - d. Large Trees (F4)
 - e. Vegetated Riparian Corridor Width (F5)
7. Survey the entire Proximal Assessment Area to collect data for:
 - a. Fish Passage Barriers (F6)
 - b. Exclusion (F7)
 - c. Bank Armoring (F8)
 - d. Bank Erosion (F9)
 - e. Overbank Flow (F10)
 - f. Wetland Vegetation (F11)
8. Establish Extended Assessment Area boundaries (based on bankfull width measurements)
9. Determine the appropriate transect interval (i.e. distance between each of 11 transects)
10. Moving downstream to upstream in the Extended Assessment Area, collect data for:
 - a. Side Channels (F12)
 - b. Lateral Migration (F13)
 - c. Wood (F14)
 - d. it is most efficient to collect data for these three measures at the same time you collect the transect data detailed in Step #11 (i.e. you can make observations for these measures as you move upstream between the transects)
11. At each of the 11 transects, collect data for:
 - a. Wetted Width - submeasure of Channel Bed Variability (F17)
 - i. *this measurement should be collected first as it is used to determine the sampling interval for the embeddedness measure
 - b. Incision (F15)
 - c. Embeddedness (F16)
 - d. Thalweg depth - submeasure of Channel Bed Variability (F17)
 - i. *this measurement is collected on each transect plus at nine evenly spaced locations between the transects

Appendix 3. Plant Species Considered Invasive in Oregon

From Oregon Department of Agriculture list, 2017.

The iMAPInvasives website (<https://www.inaturalist.org/lists/258254-Oregon-iMapInvasivess-Check-List?rank=species>) and the iNaturalist web site (<https://www.inaturalist.org/lists/258254-Oregon-iMapInvasivess-Check-List?rank=species>) have additional information on invasive vegetation.

Scientific Name	Common Name
<i>Abutilon theophrasti</i>	Velvetleaf
<i>Acaena novae-zelandiae</i>	Biddy-biddy
<i>Acroptilon repens</i>	Russian knapweed
<i>Adonis aestivalis</i>	Pheasant's eye
<i>Aegilops cylindrica</i>	Jointed goatgrass
<i>Aegilops ovata</i>	Ovate goatgrass
<i>Aegilops trunci</i>	Barbed goatgrass
<i>Ailanthus altissima</i>	Tree of heaven
<i>Alhagi pseudalhagi</i>	Camelthorn
<i>Allaria petiolata</i>	Garlic mustard
<i>Alyssum murale</i> , <i>A. corsicum</i>	Yellowtuft
<i>Ambrosia artemisiifolia</i>	Ragweed
<i>Amorpha fruticosa</i>	Indigo bush
<i>Anchusa officinalis</i>	Common bugloss
<i>Bertoroa incana</i>	Hoary alyssum
<i>Brachypodium sylvaticum</i>	False brome
<i>Bryonia alba</i>	White bryonia
<i>Buddleja davidii</i> (<i>B. varibilis</i>)	Butterfly bush
<i>Butomus umbellatus</i>	Flowering rush
<i>Carduus acanthoides</i>	Plumeless thistle
<i>Carduus crispus</i>	Wetted (Curly plumeless) thistle
<i>Carduus nutans</i>	Musk thistle
<i>Carduus tenuiflorus</i>	Slender-flowered thistle
<i>Carthamus baeticus</i>	Smooth distaff thistle
<i>Carthamus lanatus</i>	Wooly distaff thistle
<i>Centaurea calcitrapa</i>	Purple starthistle
<i>Centaurea diffusa</i>	Diffuse knapweed
<i>Centaurea iberica</i>	Iberian starthistle
<i>Centaurea pratensis</i>	Meadow knapweed
<i>Centaurea solstitialis</i>	Yellow starthistle

Scientific Name	Common Name
<i>Centaurea stoebe</i> (C. maculosa)	Spotted knapweed
<i>Centaurea virgata</i>	Squarrose knapweed
<i>Chondrilla juncea</i>	Rush skeletonweed
<i>Cirsium arvense</i>	Canada thistle
<i>Cirsium pycnocephalus</i>	Italian thistle
<i>Cirsium vulgare</i>	Bull thistle
<i>Clematis vitalba</i>	Old man's beard
<i>Conium maculatum</i>	Poison hemlock
<i>Convolvulus arvensis</i>	Field bindweed
<i>Cortaderia jubata</i>	Jubata grass
<i>Crupina vulgaris</i>	Common crupina
<i>Cuscuta japonica</i>	Japanese dodder
<i>Cuscuta</i> spp.	Dodder
<i>Cynoglossum officinale</i>	Houndstongue
<i>Cyperus esculentus</i>	Yellow nutsedge
<i>Cyperus rotundus</i>	Purple nutsedge
<i>Cytisus scoparius</i>	Scotch broom
<i>Cytisus striatus</i>	Portuguese broom
<i>Daphne laureola</i>	Spurge laurel
<i>Delarirea odorata</i>	Cape-ivy
<i>Dipsacus laciniatus</i>	Cutleaf teasel
<i>Echium plantagineum</i>	Paterson's curse
<i>Egeria densa</i> (Elodea)	South American waterweed
<i>Erica lusitanica</i>	Spanish heath
<i>Euphorbia esula</i>	Leafy spurge
<i>Euphorbia myrsinites</i>	Myrtle spurge
<i>Euphorbia oblongata</i>	Oblong spurge
<i>Fallopia japonica</i> (Polygonum)	Japanese knotweed
<i>Fallopia sachalinensis</i> (Polygonum)	Giant knotweed
<i>Galega officinalis</i>	Goatsrue
<i>Genista monspessulana</i>	French broom
<i>Geranium lucidum</i>	Shiny leaf geranium
<i>Geranium robertianum</i>	Herb Robert geranium
<i>Halogeton glomeratus</i>	Halogeton
<i>Hedera helix</i>	English ivy

Scientific Name	Common Name
<i>Hedera hibernica</i>	Atlantic ivy
<i>Hemizonia pungens</i>	Spikeweed
<i>Heracleum mantegazzianum</i>	Giant hogweed
<i>Hypericum perforatum</i>	St. Johnswort
<i>Hydrilla verticillata</i>	Hydrilla
<i>Hydrocharis morsus-ranae</i>	Common frogbit
<i>Impatiens glandulifera</i>	Policeman's helmet
<i>Iris pseudacorus</i>	Yellow flag iris
<i>Isatis tinctoria</i>	Dyer's woad
<i>Kochia scoparia</i>	Kochia
<i>Lamiastrum galeobdolon</i>	Yellow archangel
<i>Lathyrus latifolius</i>	Perennial peavine
<i>Lepidium chalepensis</i>	Lens-podded whitetop
<i>Lepidium draba</i>	Whitetop (hoary cress) whitetop
<i>Lepidium latifolium</i>	Perennial pepperweed
<i>Lepidium pubescens</i>	Hairy whitetop
<i>Limnobiium laevigatum</i>	West Indian spongeplant
<i>Linaria dalmatica</i>	Dalmatian toadflax
<i>Linaria vulgaris</i>	Yellow toadflax
<i>Ludwigia grandiflora</i>	Large-flower primrose willow
<i>Ludwigia hexapetala</i>	Floating primrose willow
<i>Ludwigia peploides</i>	Water primrose primrose willow
<i>Lysimachia vulgaris</i>	Garden yellow loosestrife
<i>Lythrum salicaria</i>	Purple loosestrife
<i>Myriophyllum aquaticum</i>	Parrot feather
<i>Myriophyllum spicatum</i>	Eurasian watermilfoil
<i>Nardus stricta</i>	Matgrass
<i>Nymphoides peltata</i>	Yellow floating heart
<i>Onopordum acanthium</i>	Scotch thistle
<i>Onopordum tauricum</i>	Taurian thistle
<i>Orbanche minor</i>	Small broomrape
<i>Peganum harmala</i>	African rue
<i>Phalaris arundinacea</i> var. <i>Picta</i>	Ribbongrass
<i>Phragmites australis</i> ssp. <i>Australis</i>	Common reed
<i>Pilosella aurantiacum</i> (<i>Hieracium</i>)	Orange hawkweed

Scientific Name	Common Name
<i>Pilosella caespitosum</i> (Hieracium)	Meadow hawkweed
<i>Pilosella floribundum</i> (Hieracium)	Yellow hawkweed
<i>Pilosella pilosella</i> (Hieracium)	Mouse-ear hawkweed
<i>Pilosella piloselloides</i> (Hieracium)	King-devil hawkweed
<i>Polygonum polystachyum</i>	Himalayan knotweed
<i>Potentilla recta</i>	Sulfer cinquefoil
<i>Pueraria lobata</i>	Kudzu
<i>Ranunculus ficaria</i>	Lesser celandine
<i>Rorippa sylvestris</i>	Creeping yellow cress
<i>Rubus armeniacus</i> (R. procerus, R. discolor)	
Armenian (Himalayan) blackberry	
<i>Saccharium ravennae</i>	Ravennagrass
<i>Salvia aethiopsis</i>	Mediterranean sage
<i>Senecio jacobaea</i> (Jacobaea vulgaris)	Tansy ragwort
<i>Silybum marianum</i>	Milk thistle
<i>Solanum elaeagnifolium</i>	Silverleaf nightshade
<i>Solanum rostratum</i>	Buffalobur
<i>Sorghum halepense</i>	Johnsongrass
<i>Spartina alterniflora</i>	Smooth cordgrass
<i>Spartina anglica</i>	Common cordgrass
<i>Spartina densiflora</i>	Dense-flowered cordgrass
<i>Spartina patens</i>	Saltmeadow cordgrass
<i>Spartinum junceaum</i>	Spanish broom
<i>Sphaerophysa salsula</i>	Sainsonpea
<i>Stratiotes aloides</i>	Water soldiers
<i>Taeniatherum caput-medusea</i>	Medusahead rye
<i>Tamarix ramosissima</i>	Saltcedar
<i>Trapa natans</i>	European water chestnut
<i>Tribulus terrestris</i>	Puncturevine
<i>Tussilago farfara</i>	Coltsfoot
<i>Ulex europaeus</i>	Gorse
<i>Xanthium spinosum</i>	Spiny cocklebur
<i>Zygophyllum fabago</i>	Syrian bean-caper

Appendix 4. Sample Field Forms

SFAM Proximal Area Assessment (PAA) Field Data Form

Version 1.1

Assessment Timing:

Project Area Name: Pringle CreekDate: 5/29/2018Assessor: SFAM Project Team

Print this form to take to the field. Only the defined print area is needed (i.e. not the data calculation columns). After collecting data in the field, transfer data into the Excel worksheet below using drop-down menus where available. Cells in the "Calculations" section and on the "Functions" tab will populate automatically.

What is the longitudinal length of the PAA?	Natural Cover (F1): Record densiometer readings from both left and right banks at each transect.				See F2-F4 below	Riparian Corridor (F5): Record the width (ft) of the riparian corridor at each PAA transect. If > 330 ft, enter 330.				Barriers (F6): Does a man-made structure limit fish passage (barrier, partial, passable, unknown, none)?		Exclusion (F7): What % of the 100-yr floodplain is excluded due to features (<=20%, >20-40%, >40-80%, >80%)?	
		T1	T2	T3			T1	T2	T3	Passable	>20-40%		
	Left	17	0	16		Left	240	166	140				
	Right	15	0	16		Right	10	0	28				

Invasive Vegetation (F2), Native Woody Vegetation (F3), and Large Trees (F4): For each of the three vegetation classes, record the start and end positions (distance from bankfull, to the nearest 0.1ft) of each occurrence along the length of the transect. Transects run perpendicular to the stream edge, from the bankfull edge to the lateral boundary of the PAA.

What is the length of the transect (ft)?		72		Vegetation transects are conducted on both banks. If it is physically or legally unfeasible to access one side, indicate which side was surveyed by selecting Left or Right from the dropdown menu.													
Transect	Vegetation Class	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End	Start	End
1 (left)	InvVeg	22	37	54	72												
	Native WoodyVeg	0	72														
	LgTree	18	72														
1 (right)	InvVeg	0	5														
	Native WoodyVeg	0	0														
	LgTree	0	0														
2 (left)	InvVeg	56.5	57	61	72												
	Native WoodyVeg	0	72														
	LgTree	0	63														
2 (right)	InvVeg	0	9														
	Native WoodyVeg	0	51														
	LgTree	0	33														
3 (left)	InvVeg	19	72														
	Native WoodyVeg	0	72														
	LgTree	0	72														
3 (right)	InvVeg	0	64														
	Native WoodyVeg	0	72														
	LgTree	39	62														

Armor (F8) and Erosion (F9): Record start and end locations (ft) of bank armoring features and bank erosion evidence along the length of the PAA.								
	Start	End	Start	End	Start	End	Start	End
Armoring (left)	46	54						
Armoring (right)	35	64						
Erosion (left)	60	100						
Erosion (right)	0	0						

Overbank Flow (F10): Is there evidence of overbank flow at least 0.5 × BFW from the bankfull edge? (yes or no)	YES
---	-----

Wetland Vegetation (F11): Are there FACW or OBL wetland plants on the banks or in the floodplain? (yes or no)		YES
If yes, answer the following questions: If no, enter N/A		
→ Are any located > 0.5 × BFW from the bankfull edge?	YES	
→ ...for more than 70% of the PAA length?	NO	

SFAM Field Data Form (2 of 3)

SFAM Extended Area Assessment (EAA) Field Data Form

Version 1.1

Assessment Timing:

Project Area Name: Pringle CreekDate: 5/29/2018Assessor: SFAM Project Team

Print this form to take to the field. Only the defined print area is needed (i.e. not the data calculation columns). After collecting data in the field, transfer data into the Excel worksheet below using drop-down menus where available. Cells in the "Calculations" section and on the "Functions" tab will populate automatically..

What is the total longitudinal length of the EAA (ft)?	480
--	-----

Wood (F14): Tally each piece of wood along the EAA that measures > 4" diameter and is at least 5' long. You can record the location of the wood to avoid double counting.

Total =	0
---------	---

Side Channels (F12) and Lateral Migration (F13): Record start and end locations (ft) of adjacent side channels and evidence of constraints to lateral migration along the length of the EAA.

	Start	End	Start	End	Start	End	Start	End	Start	End
Side channels (either side)	0	55	380	460						
Constraints to lateral migration (left)	158	302								
Constraints to lateral migration (right)	50	302								

Unique Features (V16): Note the presence of any unique habitat features throughout the EAA including, but not limited to: log jams, braided channels, >30% wetlands in floodplain, springs, seeps, cold water inputs, etc.

No special features are present

Wetted Width (F17)	Incision (F15)	Substrate Embeddedness (F16)	Thalweg Depth (F17)
Record width and height at each cross-channel transect (round to nearest 0.1 ft).		Record % embeddedness (to the nearest quartile: 0, 25, 50, 75, 100) at 5 equidistant points along each cross-channel transect.	Record the thalweg depth at 10 equidistant points <u>between</u> each cross-channel transect while moving upstream.

EAA Transect	Feet from EAA lower boundary	Wetted width	Bankfull height	Lowest floodplain height	Embed1	Embed2	Embed3	Embed4	Embed5	Depth1	Depth2	Depth3	Depth4	Depth5	Depth6	Depth7	Depth8	Depth9	Depth10
A	0	22.2	2	3.7	50	25	100	0	0	2	2.1	2	0.6	0.6	0.7	0.8	0.6	0.6	0.5
B	46	39.5	2	3.9	0	0	0	0	0	0.4	0.4	0.5	0.6	1	1.1	1.6	2.1	2.8	2.8
C	92	20.5	6.5	7.2	0	25	50	50	25	3	3.2	3.4	3.6	3.9	4	3.8	3	2.2	1.8
D	138	20.5	3.7	4.2	100	25	25	0	50	1.6	1.4	1.5	1.3	1.3	1.1	0.7	0.6	0.4	0.3
E	184	27.5	1.8	2.8	75	0	0	0	0	0.3	0.3	0.5	0.4	0.3	0.4	0.4	0.5	0.4	0.5
F	230	33	1.6	2.3	25	0	0	0	100	0.3	0.4	0.6	0.8	0.8	0.7	0.7	0.6	0.7	0.6
G	276	27.3	1.6	2.2	50	25	0	0	25	0.6	0.6	0.6	0.8	0.8	0.7	0.7	0.6	0.7	0.6
H	322	24.5	2.9	3.6	25	25	0	25	100	1.3	1.5	1.6	1.9	2	2.1	2	1.9	1.5	1.3
I	368	19.5	2.3	3.1	100	50	25	25	100	1.4	1.4	1.6	1.5	1.4	1.3	1.1	1	0.7	0.7
J	414	27.5	2	5.5	25	0	0	25	50	1	0.8	0.8	0.7	0.7	0.6	0.9	1	1.2	1
K	460	33.2	2.7	4.7	25	0	0	0	0										