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Project Partners

Washington Salmon and Steelhead Habitat Inventory and Assessment Program (SSHIAP)
People for Salmon
Northwest Power Planning Council
Washington Department of Ecology
Oregon Department of Fish and Wildlife
Columbia River Intertribal Fish Commission
British Columbia Sensitive Habitat Inventory & Mapping Partnership
British Columbia Department of Fisheries and Oceans
Northwest Habitat Institute
Washington Governor's Council on Environmental Education
Washington Department of Fish and Wildlife

Washington Department of
FISH AND WILDLIFE

Additional copies and periodic updates to this document are available on the WDFW web site at:
http://www.wa.gov/wdfw/hab/sshiap/dataptcl.htm

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Executive Summary

This document reflects an effort to establish a consistent format for the collection of salmonid habitat data across the Pacific Northwest. More specifically, our objectives were to: 1) provide a synthesis of the salmon habitat protocols applicable to the Pacific Northwest, 2) recommend a subset of these protocols for use by volunteers and management/research personnel across the region, 3) link these protocols with specific types of habitat projects, 4) establish a Quality Assurance/Quality Control framework for the data derived from the use of these protocols, and 5) to the degree possible, identify the format and destination where the data is routinely sent.

To achieve these objectives, we assembled 112 documents drawn from the Pacific Northwest and elsewhere in North America, and developed a 1-2 page synthesis of each. These documents embody 429 protocols for collecting data on 48 protocol *Focus Types* (physical and biological habitat attributes) relevant to salmonids. We organized the protocols under four main habitat categories: 1) Freshwater (e.g., streams, rivers, lakes, wetlands), 2) Water Quality, 3) Riparian/Upland Habitat, and 4) Estuarine/Nearshore Marine.

Following a detailed review of the protocols, we used selection criteria combined with a scientific peer-review process to recommend a subset of protocols for use across the Pacific Northwest. Protocols were evaluated in terms of: 1) a review of the protocol elements; 2) the accessibility and practicability to workers with diverse training; 3) applicability across the different environments of the region, so that data and analysis are comparable; 4) listing of tools and implements needed; and 5) kinds of data generated. We were not able to assess implementation costs, as budgetary information was seldom included in the protocols. We ultimately identified 68 protocols for use by volunteers, and 93 protocols for use by management/research personnel across the Pacific Northwest.

The principal purpose of monitoring is to help make decisions by reducing uncertainty and track progress toward identified goals. With the concerted investments being placed in salmonid habitat, there is an increasing desire to monitor aspects of management-, restoration-, and mitigation-based projects. To gain the greatest benefit from the protocols recommended herein, users must first articulate a set of inventory or monitoring questions to be answered. Then, by linking these questions with the protocols herein, users will be better able to maximize their inventory and monitoring investments. To aid in this important effort, we have linked 77 habitat *Project Types* with the recommended protocols. Further, to ensure clarity, we have provided descriptions of the project types and focus types in the glossary.

The data collected through the protocols recommended in this publication will aid in providing a consistent foundation for plans to restore and protect the health and biological capacity of salmon-bearing streams and nearshore marine areas in the Pacific Northwest. Likewise, the data will be an important basis for determining whether completed projects and related conservation actions are achieving their intended goals. To the extent possible, we have identified the type of format the data is stored in, as well as the agencies or entities that are the recipients and caretakers of this data. Local and regional data management is an area in urgent need of funding investments. Important advancements in data handling, accessibility, and analysis capability will stem from the overall efforts in monitoring in the region.

The geographic scope of this project includes the freshwater and nearshore marine areas of Oregon, Washington, British Columbia, Idaho, and Montana. The protocols recommended herein will also find important applications in the salmon-bearing areas of California and Alaska, and in other salmon regions (e.g., Pacific Rim).

Approach

Role of Habitat. Habitat plays a central role in salmonid conservation. Habitats are relatively stable through time, easily defined in intuitive physical terms, and provide a tangible resource for negotiations, decision-making, and restoration/mitigation actions. Habitat is now the basis of most impact assessments and resource inventories, many species management plans, mitigation planning, and environmental regulation. Six general classes of characteristics determine the suitability of aquatic habitats for salmonids: flow regime, water quality, habitat structure, food (energy) sources, biotic interactions, and access (Spence et al. 1996; Cederholm et al. 2001). Habitat loss and degradation are the primary reasons why the majority of species (plants, fishes, wildlife, invertebrates) are being listed at the state and federal levels in the United States (Endangered Species Acts), and at the Provincial (Red or Blue Lists) and federal levels in Canada (COSEWIC rankings). Benchmarks of improved and stabilized habitat conditions are subsequently used as de-listing criteria in recovery plans for these species.

Target audiences. There are two primary audiences for the protocols contained in this document: 1) volunteers, and 2) management/research personnel. These user groups have differing skill levels, access to equipment, availability of time and funding, and applications of the gathered data. Both groups generate baseline and monitoring data important to the conservation of salmonids in the region (Fore et al. 2001).

Overview of the Protocols. Numerous and varied methods of inventorying and monitoring salmonid habitat conditions have been developed by federal, state, tribal, provincial, non-governmental organizations (NGOs), and private entities across the Pacific Northwest. Many entities already inventory or monitor habitat components relevant to salmonids, but the efforts are largely uncoordinated or unlinked, have different objectives, use different indicators, and lack support for sharing and statistically analyzing the data (Independent Science Panel 2000). A diversity of methods is desirable in the initial stages of any rapidly developing field, but enough time has passed to now assess the state-of-the-science and recommend selected data collection methods that robustly capture data on freshwater and marine habitats. While the geographic scope of data collection methodologies is often initially designed for use at the local or watershed level, the use of consistent methodologies across larger regions, in our case the Pacific Northwest, is now appropriate.

The central theme of this document is on protocols for collecting *habitat* data. The protocols in this document outline the steps for obtaining field-, laboratory-, and office-based data about physical and biological conditions relevant to salmonid conservation and the health of aquatic systems. While we have not addressed protocols for the sampling or handling of fish (e.g., smolt trapping, seining), we have included protocols on macroinvertebrates, plankton, and biomonitoring of fish communities. Because of the crucial role that salmon carcasses play in the overall ecology of aquatic systems (e.g., nutrient cycling), we have also incorporated protocols relevant to acquiring, handling, and depositing carcasses in streams.

In this project, we assembled 112 documents containing 429 data protocols addressing 48 focus areas relevant to Pacific Northwest salmonids. The majority of these documents were published between 1995 and 2001. A number of the documents (e.g., Bain and Stevenson 1999; Slaney and Zaldokas 1997; Barbour et al. 1999; Jamieson et al. 1999) are robust synthesis of science and contain an array of habitat protocols. Most of the protocols referenced in this publication have been previously published. A number of "new" protocols on specific topics where a methodology had been developed but had not yet been formally published (e.g.,

hydromodifications) has also been included in this document. While the science involved in aquatic protocols continues to advance, a solid foundation of techniques has been developed to address the data collection needs of salmonid habitat.

Recommended Protocols. We recommend a specific subset of 126 protocols for consistent use across the region. To capture information on the 48 *Focus Types* (reflecting habitat and biological attributes), we recommend 68 protocols for use by volunteers, and 93 protocols for use by management/research personnel across the Pacific Northwest. So, why are we recommending more than one protocol per focus type? Typically, one protocol addresses a single focus type (e.g., we are recommending one protocol for measuring *water turbidity*). However there are instances where multiple protocols are associated with one focus type. For example, we are recommending two protocols for acquiring *temperature* data – one protocol reflects the use of data loggers and the other protocol reflects the use of an automated monitoring station. High-quality temperature data can be gathered under either protocol, but not all users have access to the more expensive automated monitoring station equipment.

While the protocols recommended in this document are reasonably comprehensive, specialized or research needs may require the development of new or different methodologies. For these needs, we urge users to first review the recommended protocols (Table 5). Thereafter, we direct users to the other documents summarized in this publication (see Appendix II), as they are likely to find many of the key building blocks to support their specialized needs. New protocols should be developed consistent with the "Essential Elements of Protocols" (Table 2).

Linking Restoration and Mitigation Projects with the Protocols. A wide array of agencies, tribes, volunteer groups, schools, watershed committees, and private citizens undertake salmon habitat and restoration/mitigation project data collection, so having consistency in methods is fundamental. Our objective was to provide linkages between the projects and the protocols such that if monitoring of habitat data at (or inventory of conditions prior to) projects is desired, there are consistent methodologies to do so. In this document, we identified 77 types of projects affecting salmonid habitat, and have cross-linked these projects to specific protocols to guide their data collection (Table 5). Also, it is important that the terminology surrounding project types be clear. To help support this, we have placed descriptions of the project types in Appendix I (Glossary) of this publication. Additional terminology of aquatic habitat inventories can be found in Armantrout (1998).

The Role of Protocols in Monitoring Strategies
Establishing a baseline and monitoring changes in habitat conditions is fundamental to the recovery and conservation of salmonids. To efficiently undertake these efforts requires a thoughtful approach to monitoring and evaluation. A well-structured monitoring and evaluation plan results in the collection of extremely valuable data. In a broad sense, monitoring can be defined as the collection of information necessary to understand the condition and trends of components and processes in a system of interest. More specifically, monitoring efforts provide a context for: 1) confirming that management decisions were implemented; 2) making accurate status assessments of the resource to determine whether management objectives are being achieved, and 3) improved understanding of salmonids and their environments to determine the extent to which changes in status were the result of management actions. Examples of web sites for key planning efforts and legislation on monitoring and evaluation in the Pacific Northwest are shown in Table 1. A set of common Objectives for monitoring and evaluation efforts includes the following:

- Measure attributes of environmental conditions and biological resources in the system of interest within relevant temporal and spatial scales.
- Conduct ecological research to better understand the distribution and abundance of ecological variables at the watershed and landscape scales.
- Improve the integration, coordination, and

sharing of monitoring efforts across organizations, geographic scales, and relevant elements of the ecosystem.

- Ensure that management decisions are based on the best and most current information.
- Predict future conditions and suggest hypotheses for subsequent scientific testing.

Typically, monitoring and evaluation plans include the following aspects:

Driven by questions to be addressed: Identification of management questions form the basis of the monitoring effort. Imperative to inventory and monitoring efforts is the prior articulation of specific questions to be addressed (to guide data collection), and the accuracy/quality level of the data developed (to guide uses of the data). More specifically, the questions to be asked should be akin to: "What questions are we trying to address through this habitat inventory/monitoring effort? "Are the most appropriate methods being applied?" and "Where will the data developed from this effort reside?" Because considerable time and resources are spent on monitoring activities, the clear articulation of the questions to be addressed is fundamental. While questions regarding salmonid habitats are similar across the Pacific Northwest, they are not necessarily consistent across the region. Thus, we strongly urge users to think through, and write down, the specific inventory/monitoring objectives and questions they are trying to address.

Contains a consistently applied set of attributes: Monitoring involves a series of observations, measurements, or samples of these attributes collected and analyzed over time. The selection of the appropriate protocol(s), clear definition of the data attributes, and adherence to careful sampling design is essential to fulfill the identified needs.

Quantifiable through direct observation: The focus of monitoring efforts should be on the acquisition of data that specifically quantify amounts and conditions of habitat.

Statistically valid approach: Monitoring efforts will need to meet assumptions for standard statistical analysis and results in estimates with known boundaries of error.

Repeatable: The protocols used should provide a statistically defensible method for evaluating and minimizing observer bias and sampling error. This consideration is intended to reduce the inherent variability surrounding many of the data attributes so that replication of sampled attributes will be meaningful across time and space.

Coordinated with other resource entities: It is imperative that the protocols used and the data collected are compatible across the Pacific Northwest. The development of a regional data system for habitat (centralized or distributed data sets) is clearly warranted at this time. In this context, management actions can be evaluated, trends in salmonid responses identified, and changes in recovery and conservation strategies supported.

Cost efficient: Funding resources will always be limited; utilizing focused data collection and analysis procedures by volunteers and management/research personnel will prioritize specific data needs and yield the greatest long-term benefits.

Listed below are components of an existing Monitoring Plan (see Oregon water quality monitoring tech guide book pp. 2-2 and 2-3; http://www.oregon-plan.org/Chapters1-5.pdf); the items preceded by an "*" reflect topics supported by the protocols identified in this document.

Problem definition
Goal
Objectives
Hypotheses
Site description
* Data gathering strategy
* Methods
* Data Quality
* Data Storage and Analysis
Timetable and Staff Requirements
Landowner Permission/Relations

Table 1. Examples of web sites on key planning venues and legislation on monitoring and evaluation in the Pacific Northwest.

Area/State	Name of the Plan/Act/Program	Web Site Address
Oregon	SB 924 – The Oregon Plan for Salmon Watersheds	http://www.oregon-plan.org/index.html http://www.orst.edu/Dept/ODFW/freshwater/
Washington	SSB 5637 – Monitoring Strategy and Action Plan	http://www.governor.wa.gov/esa http://nwifc/TFW/
Oregon and Washington	Northwest Forest Plan	http://www.or.blm.gov/nwfp.htm
Puget Sound	Puget Sound Water Quality Monitoring Program	http://www.wa.gov/puget_sound/Programs/Monitor.htm
Idaho	HB 337 – Office of Species Conservation	
Montana	-Natural Streambed and Land Preservation Act -Stream Protection Act	
British Columbia	Bill 25 – 1997 – Fish Protection Act	http://www.for.gov.bc.ca/ric/
Pacific Northwest		http://research.nwfsc.noaa.gov/cbd/trt/index.html http://www.nps.gov/ccso/salmonid.htm
Columbia River Basin		http://www.nwcouncil.org/library/2000/2000-19_toc.htm
Columbia Estuary		http://www.columbiaestuary.org/descrip.html
Columbia River Inter-Tribal Fish Commission:		http://www.critfc.org/text/TRP.HTM
California		http://ceres.ca.gov/cra/coastal_salmon_plan.html

How to Use this Document

Definitions of key terms used in this publication. We make frequent use of the following terms:

Document Number: As we assembled publications containing protocols for this project, we gave them a Document Number. While some publications included only a single protocol, other publications contained multiple protocols. In the latter case, we did not separate the protocols, rather, for ease of use and quick recognition by users (several protocols are well known and are easily identifiable by their cover, which we scanned and incorporated into our publication), we left them intact. Thus, each publication (but not each protocol) is identified as a separate document. Protocols are listed by the Document Number of the publication they are

contained within.

Document Directory: The Document Directory serves as an index, and precedes the document summaries in this publication. The Document Directory lists all of the documents by their number, title, and page number. The Document Directory starts on page 44.

Focus Type: We have developed the term Focus Type for this publication; the term reflects themes or focus areas of protocols relevant to the assessment of aquatic environs. Focus types include topics such as habitat attributes or habitat elements, biological features (e.g., measuring biological community richness), and general techniques such as photodocumentation. In this project, we identified 48 focus types; each of the protocols were ascribed to one of these focus types.

Project Type: A commonly practiced restoration, mitigation, or protection action. Project types are typically conducted as local-scale management activities that physically alter the terrestrial or aquatic environment (or protect it from alteration).

Protocol: A detailed method or technique designed to generate data on the conditions of a feature of interest. In this document, protocols reflect methods to inventory or monitor the physical and biological conditions of the freshwater and estuarine/ nearshore marine environment relevant to salmonids.

Quality Assurance ensures that your data will meet defined standards of quality with a stated level of confidence; *Quality Control* refers to technical activities that reflect error control. Together, QA and QC help you produce data of known quality, enhance the credibility of your group in reporting results, and ultimately saves time and money, and results in a greater contribution to salmon and aquatic system conservation.

Finding a Particular Protocol or Project Type. In order to find a recommended protocol for a particular habitat attribute or management project, you are encouraged to use Table 5 (page 23) and locate a *Project Type* or *Focus Type* of interest, read across the table and find the corresponding document number, and then locate the document in the Document Directory. Please note the *Comments* section of Table 5, as this may address specific features of the protocol and may aid your search. Following the Document Directory is a summary of each document containing contact information (web site, phone number, address) so you can acquire a physical copy of the document containing the protocol of interest.

Acknowledgments

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Methods

Between August 2000 and September 2001, we assembled 112 documents containing 429 salmonid habitat-related protocols applicable to the Pacific Northwest. The 'Pacific Northwest' reflects the states of Montana, Oregon, Idaho, Washington, and the Province of British Columbia. Nationally-accepted water quality protocols (i.e., Environmental Protection Agency) were collected from elsewhere in the United States.

Each document contained data collection methodologies for one or more protocols. We examined each document and prepared a synthesis of each that included the *Title*, *Citation*, *Source*, *Abstract*, *Target Application*, *Suitability for Volunteers*, *Training aspects*, *Monitoring Focus*, *Geographic Scale*, *Methods*, *QA/QC Levels*, the *format and destination of the data*, *Equipment and Tools*, and *Examples of Filled-in Data Forms* (See Document Summaries beginning on p.50). As it is important that the full text of the documents be readily available to users, we identified the website, mailing address, and phone number of the publishers of the documents in the *Source* section.

Table 2. Essential Elements of Protocols (adapted from Fancy 2001); criteria for selecting the recommended protocols.

I. Background and Objectives: 1. Background – history, resources being addressed 2. Rationale – justification of selecting a given resource to inventory or monitor 3. Objectives – list of measurable tasks
II. Sampling Design: 4. Site selection – criteria for site selection; defining boundaries or "populations" sampled; procedures for selecting sampling locations; stratification, spatial design 5. Sampling Frequency and replication – recommended number and location of sampling sites; frequency and timing of sampling; level of change that can be detected for the amount/type of sampling
III. Field/Office Methods: 6. Setup – field season preparations and equipment setup (including permitting/compliance procedures). 7. Events sequence – sequence of events during field season or during preparation of a monitoring plan 8. Measurement details – details of taking measurements, with examples of field forms 9. Sample processing – post-collection processing of samples (e.g., lab analysis, preparing specimens)
IV. Data Handling, Analysis and Reporting: 10. Metadata procedures – descriptions of fields and sizes; sample collection information; site description; quality assurance procedures 11. Database design – overview of database design and structure illustrating relationships between tables 12. Data entry – data entry procedures; verification and editing of data 13. Data summaries – data summaries and procedures for conducting statistical analyses 14. Report format – recommended report format with examples of summary tables and figures 15. Trend analysis – recommended methods for trend analysis 16. Archival procedures – data archival procedures
V. Personnel Requirements and Training: 17. Responsibilities – roles and responsibilities 18. Qualifications 19. Training availability, locations, timing, and procedures
VI. Operational Requirements: 20. Workload and schedule 21. Equipment needs – list of equipment, materials and facilities needed 22. Budget considerations
VII. References 23. Scientific basis for the protocols (Literature Cited)

Our primary criteria for selecting the protocols recommended in this report are shown in Table 2. These criteria reflect 23 'Essential Elements' of protocols (adapted from Fancy 2001). We examined each document and tallied an "X" or "+" where the protocol document contained in full, or in part (respectively) that essential element. The protocols having the greatest number of essential elements were initially selected for recommendation. In addition to the essential elements review, we recognized that some protocols (or minor variations) have had long-standing regional acceptance (e.g., McNeil and Ahnell 1960). Other protocols have been previously reviewed and recommended as part of multi-agency efforts (e,g., IRICC 2000). Thus, we also considered protocols for recommendation based on 1) their long-standing acceptance and applicability in the region, and 2) robustness of earlier multi-agency efforts. All protocols were examined for application to either a volunteer or research/management audience; this process was relatively easy, as the majority of protocols clearly articulated either (or both) of these groups in their descriptions.

Data Quality Standards and Quality Assurance/Quality Control Aspects

We recognize that different protocols, and personnel with different skill sets, generate data of differing strengths and weaknesses. To assist in establishing standards for data quality, and to more accurately portray the appropriate uses for the data, we developed a data quality guidance table (Table 3). This guidance table, based on Washington Dept. of Ecology Publication #96-2014-WQ&FA May 1996, Rev. April 1999, and expanded here, helps to characterize the quality of data generated by volunteers, students, and professionals. In our summaries of the protocol documents, specific reference is made as to the "*Level of Data Quality*". This level of data quality reflects levels 1-4 as shown in the left hand column of Table 3.

In Table 3, and reading straight across each of the four levels, the descriptors indicate the quality of the data. For example, a Level Two volunteer, trained to use a color comparator kit and working under the guidance of a coordinator with specific expertise, may conduct proper Dissolved Oxygen measurements which might serve as an early warning, indicating new or suddenly worsening problems in a stream. A Level Three effort might find certified Streamkeepers following a written quality assurance project plan (QAPP), properly collecting riparian vegetation conditions, and submitting data to the state/province data system. Level Four monitors would probably use a calibrated pH meter, document their QA follow-through, and perhaps submit data for the 303(d) list. The levels are not rigid; a monitor may rate "higher" in one column than in another. There may be exceptions or variations, depending on the specific project. Reading down the columns, each level includes requirements of preceding levels as uses become more demanding. For instance, all Level Three requirements apply to Level Four, plus the more rigorous standards as well. Additional information on aspects of Quality Assurance for Project Plans can be found at: http://www.epa.gov/quality1/qs-dos/r5-final.pdf

Guidelines for preparing Quality Assurance Project Plans are available from the Washington Department of Ecology (Lombard and Kirchmer 2001). A good example of a completed Quality Assurance Project Plan is one developed by the Streamkeepers of Clallam County (Washington) (Baccus and Chadd 2000).

Table 3. Data quality standards, data levels, and QA/QC aspects.

Level	QA/QC Levels	Examples of QA/QC Standards	Examples of Activities	Education/ Training Guidelines	Expected Uses of Data
One	No formal QA/QC plan required	Field observations on standard forms; EPA Streamwalk	General field observations, including the **number and diversity** of organisms	Volunteer or student with brief orientation	Educational, general awareness, anecdotal observations
Two	Basic written plan – purpose, parameters, methods, sites, schedule	GREEN field manuals; Color comparator kit instructions	Field sampling; analysis using field kits; observing categorical abundance[1] of organisms and identifying them to the **order** level; repeat photography	Volunteer, student or technician supervised by an expert monitor	Educational; watershed characterization; red flag or early warning; general characterization of landscape changes through time (from repeat photography)
Three	Formal QA plan or data standards *(i.e. meets requirements of EPA's Vol. Mon. Guide to QAPP, 1996);* all tests needing lab analysis done at an accredited lab	Technical guidelines *(e.g., Adopt-A-Stream's Streamkeepers Field Guide, 1999; EPA's Volunteer Monitoring Methods Manuals)*	Using calibrated meters for field measurements; collecting and analyzing water samples; identifying benthics to the **family** level; assessing stream width or riparian conditions	Trained volunteer *(e.g., Stream-keepers);* technician with experience or training; or a participant in an established monitoring program (e.g., WA-TFW).	Screening level information; scoping phase of watershed approach; 305(b) Report[2]; BMP[3] evaluation data; water quantity/ flow data; aquatic habitat and riparian conditions for SSHIAP[4]
Four	Follows formal QA plan and documents exactly how it's implemented; sample chain-of-custody	WA Ecology technical guidelines *(e.g. Cusimano 1993, Coots 1995); Plotnikoff's Instream Biological Assessment Monitoring Protocols,1994*	Toxic substance sampling; sampling for enforcement; bioassays; identifying benthics to the **genus/species** level; conducting fish passage barrier inventories	Professional/ Qualified individual with degree and specific training *or equivalent experience*	Key baseline assessments; recovery planning and policy development; tracking trends in salmon habitat; 303(d) list[5]; data for TMDLs[6]

[1] Categories of abundance: absent, rare, present, abundant, very abundant

[2] WA State Dept. Of Ecology's 305(b) Report shows whether water bodies support beneficial uses such as swimming and fishing – or whether these uses are impaired. Contributions of data are solicited from various sources, but must meet high standards (see Level 3).

[3] Best Management Practices

[4] Contributions to SSHIAP (WA Salmon and Steelhead Habitat Inventory and Assessment Project) data system are solicited from various sources, but must meet high standards (Levels 3 and 4).

[5] WA Dept. of Ecology's 303(d) list shows impaired and threatened waters that don't or probably couldn't meet water quality standards. Ecology accepts data for this list from outside sources, but it must meet the highest professional standards (see Level 4).

[6] TMDLs (Total Maximum Daily Loads, also known as Water Cleanup Plans) identify the pollution problems in a specific waterbody and allocate the maximum allowable pollution from various sources.

This guide, based on WA Dept. of Ecology Publication #96-2014-WQ&FA May 1996, Rev. April 1999, and modified by the authors and may be viewed at: http://www.wa.gov/ecology/wq/wow/wdw/monlevel.html

Results

Essential Elements of Protocols' Assessment. The results of our "Essential Elements of Protocols" assessment are shown in Table 4. A bar graph displaying a summary of the Essential Element assessment of the combined protocol documents is shown in Figure 1.

Recommended Protocols and Glossary of Terms. The recommended protocols are shown in Table 5; a concise explanation of why they were recommended is offered in the associated comments section. A Glossary of Terms, that includes the descriptions of *Project Types* and *Focus Types*, and a general glossary is included in Appendix I.

Additional terminology of aquatic habitat inventories can be found in Armantrout (1998).

Recipients of the Data. A substantial weakness in our regional efforts for consistent salmon habitat data is related to data management. Once the data has been collected, support for the maintenance and long-term storage of the data has been difficult for most organizations because of limited and irregular funding investments and a rapidly changing technological environment. Some organizations are accepting data at this time. A list of data recipients is shown in Table 6.

Full Listing of Protocols Evaluated in this document. We identified 77 types of projects affecting salmonid habitat, and have cross-linked these projects to specific protocols to guide their respective data collection (Table 5).

We offer the full array of protocols examined in this project, arranged by *Project Type* and *Focus Type*, in Appendix II.

Index. An Index to the contents of this publication is offered in Appendix III.

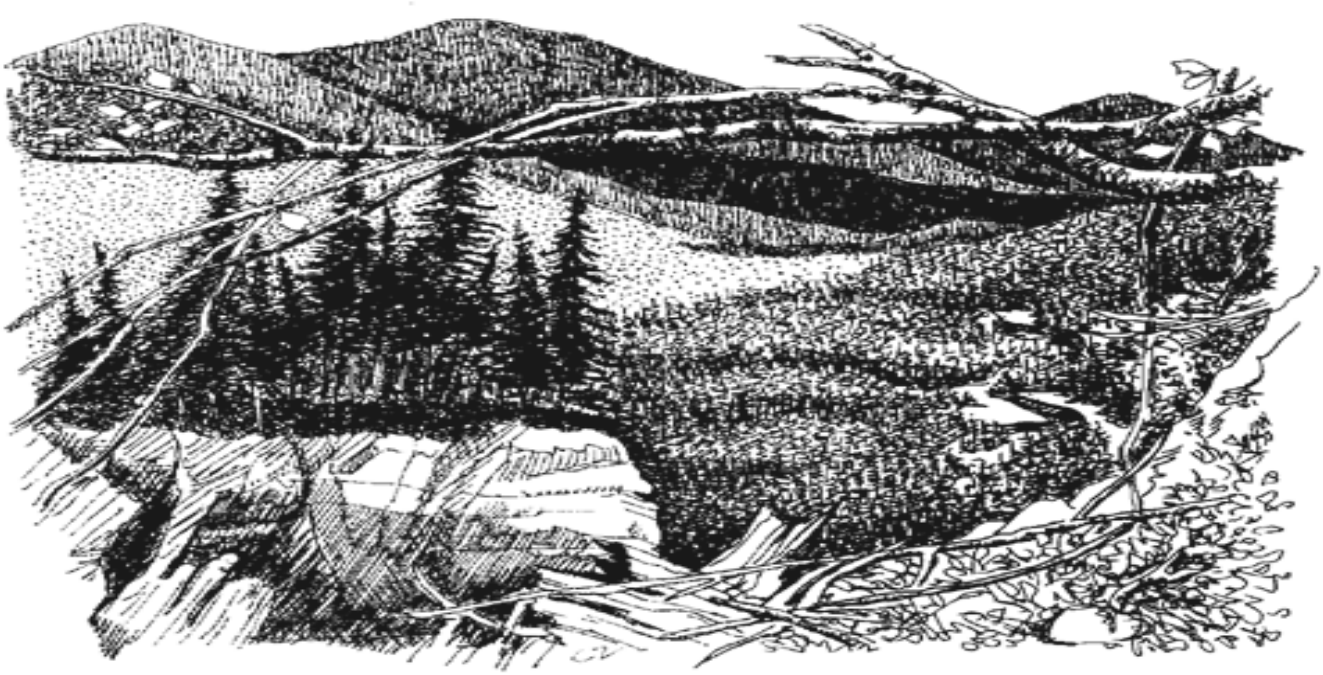


Table 4. Essential Elements of Protocols - Assessment

Table 4. Essential Elements (see Table 2) of the 112 documents. An “X” and “+” indicate full or partial inclusion of protocols elements in the document, respectively. An “Na” indicates that this particular element is not applicable.

Document Number	Background and Rationale			Sampling Design		Methods				Data Handling, Analysis and Reporting							Personnel Requirements and Training			Operational Requirements			References
	Background	Rationale	Objectives	Site Selection	Sampling Frequency	Setup	Events Sequence	Measurement Details	Sample Processing	Metadata	Database Design	Data Entry	Data Summaries	Report Format	Trend Analysis	Archival Processes	Responsibilities	Qualifications	Training	Workload	Equipment Needs	Budget Considerations	
1	X	X	X	+	+	X	X	X	Na	+	X	X	X	X		+			X		X		X
2	X	X	X	+	+	X	X	X	Na	+	X	X	X	X		+		+	X		X		X
3	X	X	X	X	X	X	X	X	+	+	X	X	X	X		+	X	+	X		X		X
4	X	X	X	X	X	X	X	X	Na	+	X	X	X	Na		+			X	+	X		X
5	X	X	X	X	X	X	X	X	Na	+	X	X	X	X		+		+	X		X		X
6	X	X	X	X		X	X	X	Na	+	X	X		X	Na	+	X	+	X		X		X
7			X	X		X	X	X	Na		+	X					+	+			X		X
8	X	X	X	X	X	X	X	X	X	+	X	X	X	X		+	+	+	X		X		X
9	X	X	X	Na	Na	X	X	X	N a	+	X	X	X	X		+	+				X		X
10	X	X	X	X	X		X	X				X									X		X
11	X	X	X	X		X	X	X			+		X	X	Na	+		X			X		X
12				Na	X	X	X		X			X				+	X			X	X	+	X
13	X	X	X	Na	Na	X	X	X	Na	+		+	+	X					X		X		
14	X	X	X	X	X	X		X		X	X	+	+	+				+	X		X	X	
15	X	X	X	X	X	X	X	X	X			X	X	X			X		X		X		X
16	X	X	X	X	X	X	X	X	X	+	X	X	X				X	+	X		X		X

		17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
References		X	X	X	X	X	X	+	X	X	X	X	X		X	X	X	X	
Operational Requirements	Budget Considerations		X			X		X		Na								X	
	Equipment Needs	X	X	X	X	X	X			X	X	X	X		Na	X	X		
	Workload					X	+			Na			+					X	
Personnel Requirements and Training	Training	X	X		+					X			X	X	Na				
	Qualifications				X					Na		X			+				
	Responsibilities				X					Na			X		+			X	
Data Handling, Analysis and Reporting	Archival Processes	+			X	+	X	X	X	Na			+	X	Na			Na	
	Trend Analysis				X					Na		Na			Na	X		X	
	Report Format	X		X		+		X	+	X	+	+			X	X			
	Data Summaries	X		X	X	X		X		Na	+			X	X	X	X	X	
	Data Entry	X	X	X	X	X	X	X		X	X	+	X	X	X	X	X	Na	X
	Database Design	+		X	X	+		X	+	Na				X	Na	X		Na	
	Metadata		X		+		X	X	+	Na				+	Na	X	X	Na	
Methods	Sampling Frequency	X	+	X	X	X		Na	X	X		Na	Na	Na	Na			Na	
	Measurement Details	X		X		X	X	X		X	X	Na	X	X	Na	X	X	X	+
	Eve nts Sequence	X	X	X		X	X			X		X			X	X	X	X	+
	Setup	X		X	X	X	X		+	Na		X	X		X	X	X	X	+
Sampling Design	Sampling Frequency		X	X		X		X	X	Na		Na	X		Na	X		X	
	Site Selection		X	X	X	X	X	X	X	X	X	Na	X		Na	X		X	
Background and Rationale	Objectives	X	X	X	X	X	X	X	X	X	X	+	X	X	X	X	X	X	X
	Rationale	X		X		X	X	X	X	X	X	+		X	X	X	X	X	
	Background	X	X	X	X	X	X	X	X	X	X	+	X	X	X	X	X	X	+
Document Number		17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34

		35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
References		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Operational Requirements	Budget Considerations		+			X													
	Equipment Needs	X		X	Na	X	X	X	X	X	X	X		X	X		X		X
	Workload			X		X						+		Na					
Personnel Requirements and Training	Training			X	Na	X					X								
	Qualifications		+	+	+	+										X		+	
	Responsibilities			X	+		+		X					Na		+			
Data Handling, Analysis and Reporting	Archival Processes	X	Na	+	Na	+				+			+	X	+	X		X	
	Trend Analysis		Na		Na									Na					
	Report Format	X		+	X					+			+	Na				+	
	Data Summaries	X	Na	X	X	X				+	+			Na		X			X
	Data Entry	X	Na	X	X	X	X			X	X		+	Na		X	X	+	
	Database Design	X	Na	+	Na									Na		X			
	Metadata	X	Na	+	Na							Na		Na		X		X	
Methods	Sampling Frequency	Na	X	Na	Na		X	X	X	X				Na	+		X	+	
	Measurement Details	X	X	X	Na	X	X	X	X		X		X	Na		X	X		
	Eve nts Sequence	X	X	X	X	X	X	X	X	X	X		X	Na	X	X	X	X	X
	Setup	X	X	X	X	+	X		+	X	X	+	X	X	X	X	X	X	X
Sampling Design	Sampling Frequency			X	Na	+		X	X	+		+		Na					Na
	Site Selection	X	Na	X	Na	X	+	X	X	X	+	X	X	Na		+	X	X	Na
Background and Rationale	Objectives	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Rationale	X		X	X	+	+	X		X	X	X	X	X		X	X	X	X
	Background	X	X	X	X	X	+	X	X	X	X		X	X	X	X	X	X	X
Document Number		35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52

		53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
References		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Operational Requirements	Budget Considerations					X		+			X											
	Equipment Needs	+		X		X	X	X	X	X	X	Na		X		X		X	X	Na		X
	Workload					X								+			X		X			
Personnel Requirements and Training	Training					X				X				+	X	X			X			
	Qualifications					X				X	+					X		X	X			
	Responsibilities					X								X	X	X		X	X			
Data Handling, Analysis and Reporting	Archival Processes		X	Na	Na	X				X	Na	X		X	X	X					Na	
	Trend Analysis	X	Na	X				X	X		Na	Na				X	+	+	X	Na		
	Report Format	X				X			X	X	Na	X		X	X	X			X		X	
	Data Summaries	X	X	X		X			X		Na	X				X	+		X	X	X	X
	Data Entry		X		X		X				Na	X		X	X	X	+	+	X	X	Na	
	Database Design										Na	+			X	X					Na	
	Metadata				X	X		X	X	X	Na	Na	X			X			X		Na	
Methods	Sampling Frequency	+	Na	X	Na	X	X	X	X		Na	Na			X	X			X	Na	+	
	Measurement Details	X	Na	X	X	X	X	X	X		Na	Na	X		X	X			X	Na		X
	Events Sequence	X		X	X	X		X	X	X	X			X	X	X	X	+	X	X		X
	Setup	+	X		X	X	X	X	X		X	X		X	X	X	X	X	X	X		X
Sampling Design	Sampling Frequency	X	X	X		X	+	X			Na	Na	Na	X		X	X	X	X	Na	X	
	Site Selection	X	X		X	X	X	X	X		X	Na	Na	X		X		X	X	X	X	
Background and Rationale	Objectives	X	X	X	X	X	X	X	X	X	X	X	X		X	X	+	X	X	X	X	X
	Rationale	X	X	X		X	X	X	X	X	X	X	X			X	X	X	X	X	X	X
	Background	X	X	X	X		X	X	X	X	X	X	X	+		X	X	X	X	X	X	X
Document Number		53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73

Document Number	Background and Rationale			Sampling Design		Methods				Data Handling, Analysis and Reporting							Personnel Requirements and Training			Operational Requirements			References
	Background	Rationale	Objectives	Site Selection	Sampling Frequency	Setup	Events Sequence	Measurement Details	Sampling Frequency	Metadata	Database Design	Data Entry	Data Summaries	Report Format	Trend Analysis	Archival Processes	Responsibilities	Qualifications	Training	Workload	Equipment Needs	Budget Considerations	
74	X		X		X	X	X	X					X										X
75	X	X	X	X	X	X	X	X		X						X	X	X	X		X		X
76	X	X	X	X			X	X	+			X							X		X		X
77	X	X	X		X	X	X		X			+									X		X
78	X	X	X	+			X			X			Na	Na	Na	Na	X						
79		X								X	X	X											X
80	X	X	X	X	Na			X		X			X		X								X
81	X	X	X			X	X			X													X
82	X	X	+	+	+							X									X		X
83	X	X	X	+	X	X	X	X	X	X							X	X	X		X		X
84	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X	X	X		X		X
85	X	X	X	X	Na	Na	Na	Na	Na	Na	Na	Na	X	X	X	Na	Na	Na	Na		Na		X
86	X	X	X	X	X			X				+	X	X			X			+			X
87	X	X	X	X	X							X	X	X	+								X
88	X	X	X	Na	Na				Na														X
89	X			X	+			+	Na		X	X	X	X			+		X		X		
90			X	Na	Na	X	X	X	X	Na	Na	Na	Na	Na	Na	Na		X			Na		X
91	X		X	X	X	X	X	+				X	X	X				X					X

Document Number	Background and Rationale			Sampling Design		Methods				Data Handling, Analysis, and Reporting							Personnel Requirements and Training			Operational Requirements			References
	Background	Rationale	Objectives	Site Selection	Sampling Frequency	Setup	Events Sequence	Measurement Details	Sample Processing	Metadata	Database Design	Data Entry	Data Summaries	Report Format	Trend Analysis	Archival Processes	Responsibilities	Qualifications	Training	Workload	Equipment Needs	Budget Considerations	
92	X	X	X	X	X		X		Na	Na	Na	Na	Na	Na	Na	Na							X
93	X	X	X	X		X	X	Na	Na	Na	Na	Na	Na	X	Na	Na	X	X	Na				X
94	X	X	X	X		X	X	X				X	X	X									X
95	X	X	X	X	X	Na	Na	X	X	Na	Na	Na	Na	Na	X		X	X				Na	X
96	X	X	X	X		X		X		Na	Na	Na	Na	X		Na	Na	X			X	X	X
97	+		+	Na	Na	X	X	X	Na									X			X		X
98	X	X	X	Na	Na	+	X	X				X						X				+	X
99	X		X	Na	Na	X			Na	X	X	X	X	X	+	X	X				X		X
100			X	Na	Na	X	X	Na	Na	X	X	X	X	X	X	X					Na		
101	X	X			X	X	X	X		X	X	X	X	X	X	X	X		X	X	X		X
102	X	X		Na	Na	Na	Na	Na	Na	X	X	X		X		X	X		+				X
103	X	X	X	Na	Na			X	Na			X						X				X	X
104	X	X	X	X				Na	Na	Na	Na	Na	Na			Na	Na	X					X
105	X	X	X	X	X		X	X	X										X		X		X
106	X	Na	Na	Na	Na	Na	Na	Na	Na	X	X	Na		Na		X	Na	Na	Na	Na	Na	Na	
107	X	X	X		X			X	Na														X
108	X	X	X	X	+	X	X	X	Na	Na	Na	Na	Na	Na	Na	Na	X	X	X	Na	X	+	X
109	X	X	X	X	X	X	X	X	X												X		X
110	X	X	X	X	Na		X	X	Na			X	X	X		X		X					X
111	X	X	X	X				X	Na	Na	Na	Na	Na								Na		X
112	X	X	X	Na	Na	X	X	X	Na	X	X	+	X	X		+							X

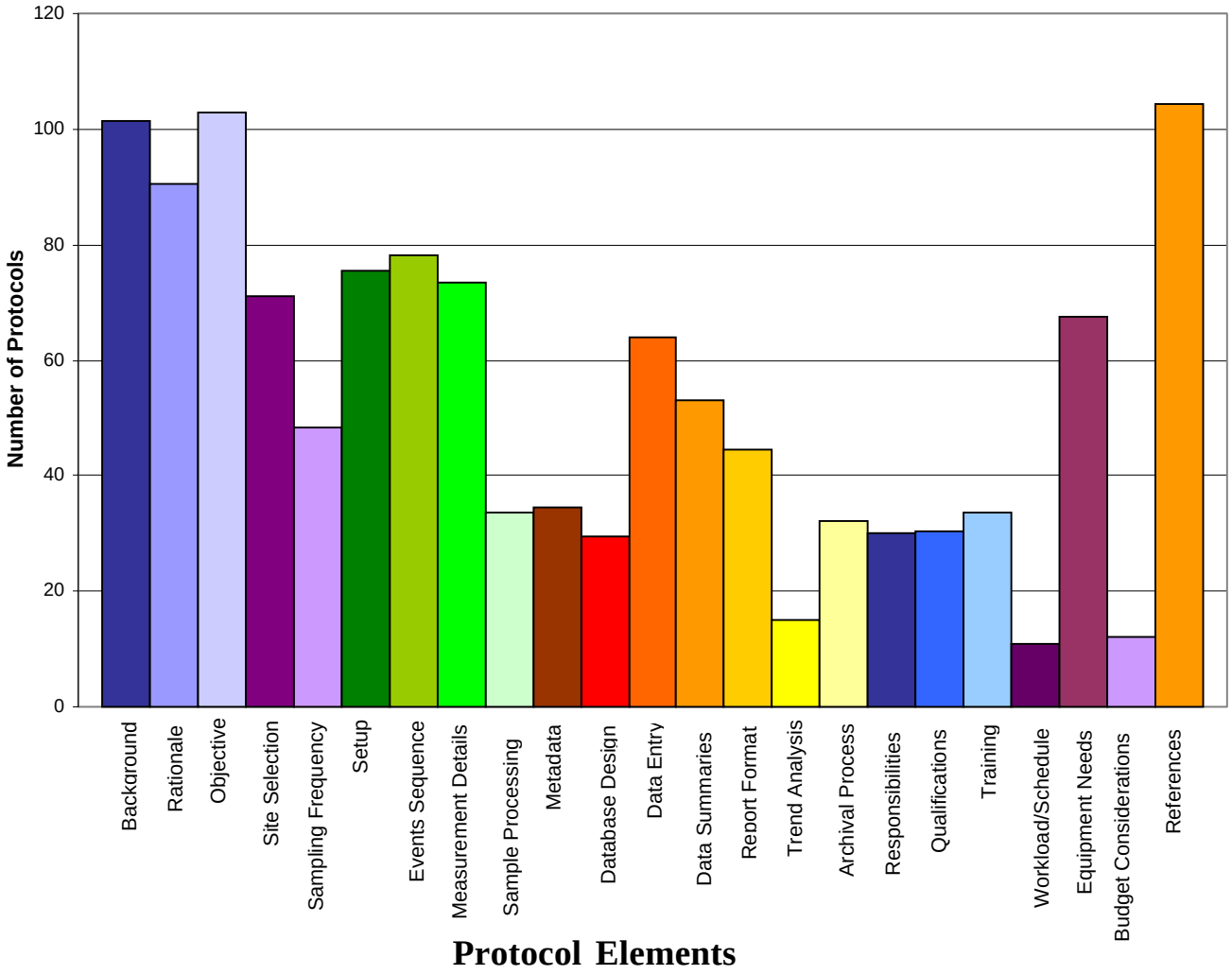


Figure 1. Summary of Essential Element Assessment of the 112 documents.

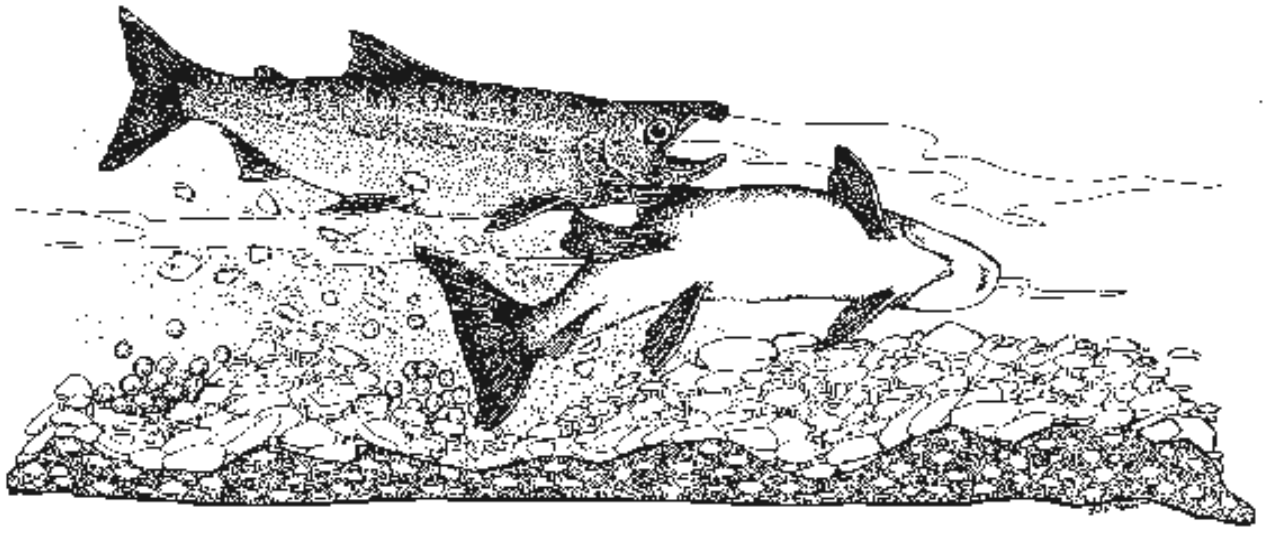


Table 5. Protocols Recommended for Use in the Pacific Northwest

Table 5. Protocols Recommended for Use in the Pacific Northwest. Protocols are arranged in alphabetical order by Project Type and their monitoring focus. ** This table contains a listing of the recommended protocols only. For a comprehensive list of all the documents assessed in this report, see Appendix II.*

Project Type	Focus Type	Recommended Protocols (by document Number)			
		Doc #	Volunteers	Management/Research	
			Comments	Doc #	Comments
• Bank Stabilization • Channel Connectivity • Channel Reconfiguration **Freshwater**	Bank and Shoreline Cover	46		31	
	Bank Shape	56		56	
				76	Work plan for lakes and reservoirs
	Bank Stability	56		75	
	Biomonitoring Fish Community	16	Recommended for spawning salmon survey	16	Recommended for spawning salmon survey
		105	Should be used as supplementary document	105	Should be used as supplemental document
				45	Recommended for bull trout monitoring
				55	Recommended for alevin and egg survival
				37	Recommended for snorkeling surveys
	Biomonitoring Macroinvertebrates	21		61	
		44	Recommended for students and teachers	60	Monitoring macroinvertebrates as indicators of water quality for salmon use
		105	Should be used as a supplementary document	87	Monitoring macorinvertebrates as general indicators of water quality
		19		83	Recommended on a regional scale
	Biomonitoring Periphyton	19		76	Work plan for lakes and reservoirs
				19	
	Biomonitoring Phytoplankton	90		90	

Freshwater

Project Type	Focus Type	Recommended Protocol (by document #)			
		Volunteers		Management/Research	
		Doc #	Comments	Doc #	Comments
• Bank Stabilization • Channel Connectivity • Channel Reconfiguration (cont'd)	Cover Composition and Abundance	46		31	
	Cover Density	46		46	
	Macrohabitat Classification	2	Recommended for habitat unit survey	63	Historical changes in stream characteristics
		44	Recommended for students	14, 37	The two protocols will be combined into one, with national database for data management and storage
		9	Recommended for segment delineation		
		1	Recommended for LWD surveys	1	Recommended for LWD surveys
				99	
		101		76	Work plan for lakes and reservoirs
	Gravel Composition	105	Should be used as a supplemental document	105	Should be used as a supplemental document
		3		3	
	Gravel Embededness	73		81	
		105	Should be used as a supplemental document	105	Should be used as a supplemental document
	Gravel Scour	4		4	
	Nutrient Subsidy	62		62	
	Photodocumentation	47		47	
	Rearing Habitat Availability	56		33	
	Spawning Habitat Availability			76	Work plan for lakes and reservoirs
		5		5	
	Stream Discharge	15		63	Historical changes in stream characteristics
				31	
	Structural Complexity	62		111	Recommended for LWD including performance and balasting needs
				62	
	Turbidity	21			
	Water Temperature	8		8, 65	

Freshwater

Project Type	Focus Type	Recommended Protocol (by document #)			
		Volunteers		Management/Research	
		Doc #	Comments	Doc #	Comments
• Bridge • Headgate • Roughened Channel • Pipes and Ditches	Bank Stability	56		75	
	Hydromodifications	108		108	
	Photodocumentation	47		47	
	Restoring Habitat	62		62	
	Turbidity	21		21	
• Carcass Placement	Biomonitoring Fish Community	16	Recommenced for biomonitoring spawning salmon	16	Recommenced for biomonitoring spawning salmon
				105	Should be used as a supplemental document
				45	Recommended for bull trout monitoring
				55	Recommended for monitoring allevin & egg survival
		105	Should be used as a supplemental document	37	Recommended for snorkeling
				67	
	Biomonitoring Periphyton			76	Work plan for lakes and reservoirs
		19		19	
	Nutrient Subsidy	62		62	
	Photodocumentation	47		47	
	Turbidity	21		21	
	Water Temperature	8		8, 65	
• Culvert Installation • Culvert Removal • Dam Removal • Debris Removal • Dike Removal • Deflectors/Barbs	Bank Stability	56		75	
	Bank Shape	56		31	
	Hydromodifications	108		108	
	Photodocumentation	47		47	
	Rearing Habitat Availability	56		33	
	Turbidity	21		21	
	Water Temperature	8		8, 65	

Freshwater

Project Type	Focus Type	Recommended Protocol (by document #)			
		Volunteers		Management/Research	
		Doc #	Comments	Doc #	Comments
• Diversion Dam	Photodocumentation	47		47	
	Stream Discharge	15		31	
				63	Historical changes in stream characteristics
	Turbidity	21		21	
• Fish By-Pass • Fish Screen • Fishways	Barrier Assessment	23		98	
	Biomonitoring Fish Community	16	Recommended for spawning salmon survey	10	Recommended for spawning salmon survey
		105	Should be used as a supplemental document	105	Should be used as a supplemental document
				45	Recommended for bull trout monitoring
				55	Recommended for egg and alevin survival
				37	Recommended for snorkling
				67	
	Photodocumentation	47		47	
	Stream Discharge	15		63	Historical changes in stream characteristics
				31	
	Rearing Habitat Availability			33	
	Turbidity	21			
• In Channel Hydromodifications	Biomonitoring Phytoplankton			90	
	Freshwater Macrohabitat Classification	2	Recommended for Habitat Unit Survey	63	Historical changes in stream characteristics
		9	Recommended for segment delineation	14, 37	The two protocols will be combined into one, with national database for data management
		1	Recommended for LWD	1	Recommended for LWD surveys
				76	Work plan for lakes and reservoirs
		44	Recommended for students	105	Should be used as a supplemental document

Freshwater

Project Type	Focus Type	Recommended Protocol (by document #)			
		Volunteers		Management/Research	
		Doc #	Comments	Doc #	Comments
• In Channel Hydromodifications (cont'd)	Hydromodifications	108		108	
	Photodocumentation	47		47	
	Water Temperature	8, 35		8	
• Log or Rock Control (weir)	Bank Stability	56		75	
	Fish Passage	23		110	
	Photodocumentation	47		47	
	Stream Channel Rehabilitation	62		62, 93	
				111	Recommended for LWD restoration with balasting and performance requirements
	Turbidity	21		21	
	Water Temperature	8		65	
• Off-Channel Habitat	Biomonitoring Fish Community	16	Recommended for spawning salmon surveys	16	Recommended for spawning salmon surveys
		105	Should be used as a supplemental document	105	Should be used as a supplemental document
				45	Recommended for bull trout monitoring
				55	Recommended for monitoring allevin & egg survival
				37	Recommended for snorkeling surveys
				67	
	Biomonitoring Macroinvertebrates	21		61	
		105	Should be used as a supplemental document	60	Monitoring macroinvertebrates as indicators of water quality for salmon
		44	Recommended for students and teachers	87	Monitoring macroinvertebrates as general indicators of water quality
				83	Recommended on a regional scale
				105	Should be used as a supplemental document
				57	Recommended on a watershed scale
				76	Work plan for lakes and reservoirs

Freshwater

Project Type	Focus Type	Recommended Protocol (by document #)			
		Volunteers		Management/Research	
		Doc #	Comments	Doc #	Comments
• Off-Channel Habitat (cont'd)	Gravel Embededness	73		81	
		105	Should be used as a supplemental document	105	Should be used as a supplemental document
	Photodocumentation	47		47	
	Rearing Habitat Availability	56		99	
	Turbidity	21		21	
	Water Temperature	8		8, 65	
• Project Success Monitoring	Habitat Function	24		24	
	Photodocumentation	47		47	
• Plant Removal/Control • Revegetation	Bank and Shoreline Cover	46		31	
	Bank Stability	56		75	
	Bank Stabilization	29, 62		62	
	Cover Composition and Abundance	46		31	
	Cover Density	46		46	
	Effectiveness Monitoring	10		10	
	General Freshwater Vegetation	27	Historical conditions	27	Historical conditions
				94	Riparian vegetation restoration
		44	Recommended for students and teachers	105	Should be used as a supplemental document
		10	Recommended for riparian stand survey	10	Recommended for riparian stand survey
		101	Riparian vegetation survey	96	Recommended for Properly Functioning Conditions component
				26	Recommended for greenline composition method
				81	Guide for assessing effects of forestry activities on riparian vegetation
				32	Recommended to be used on a watershed scale

Freshwater

Project Type	Focus Type	Recommended Protocol (by document #)			
		Volunteers		Management/Research	
		Doc #	Comments	Doc #	Comments
• Plant Removal/Control • Revegetation (cont'd)	Structural Complexity	62		62	
				111	Recommended for LWD placement methods and performance and balasting requirements
	Photodocumentation	47		47	
	Turbidity	21		21	
	Water Temperature	8		8, 65	
• Spawning Gravel	Gravel Availability	5		5	
	Gravel Composition	105	Should be used as a supplemental document	105	Should be used as a supplemental document
		3		3	
	Gravel Embededness	73		81	
		105	Should be used as a supplemental document	105	Should be used as a supplemental document
	Gravel Rehabilitation	62		62	
	Gravel Scour	4		4	
	Photodocumentation	47		47	
	Turbidity	21		21	
• Beaver Populations restoring/maintaining Creating/maintaining Islands or Rafts • Traffic Control • Utility Crossing • Work Site Restoration • Signage • Site Maintenance (1 year or less)	Photodocumentation	47		47	

Freshwater

Project Type	Focus Type	Recommended Protocol (by document #)			
		Volunteers		Management/Research	
		Doc #	Comments	Doc #	Comments
• Woody Debris Structures and Complex Log Jams	Bank Stability	56		75	
	Channel Classification	97	Recommended for gradient & confinement methods	97	Recommended for gradient and confinement methods
		105	Should be used as a supplemental document	105	Should be used as a supplemental document
				100	Recommended for dynamic segmentation methodology
		108	Recommended for bankfull width measurement method	64	
				108	Recommended for bankfull width measurement method
		101		1	
	Photodocumentation	47		47	
	Rearing Habitat Availability	101		99	
				33	
	Reference Points	11		11	
	Stream Morphology	44	Recommended for students and teachers	45	Recommended for bull trout monitoring
				63	Historical changes in stream characteristics
		16	Recommended for channel cross-section measurement	46	
	Substrate/pebble count	101		37	
	Turbidity	21		21	
	Water Temperature	8		8	
				65	Automated Water Quality Monitoring

Riparian/Upslope

Project Type	Focus Type	Recommended protocols (by document number)			
		Volunteers		Management/Research	
		Doc #	Comments	Doc #	Comments
• Erosion Control (Road) • Erosion Control (Slope) • Impervious Surface Removal	Bank Stability	56		59	
	Bank Stabilization	29		62	
	Gravel Embededness	73		81	
		105	Should be used as a supplementary documents	105	Should be used as a supplementary document
	Photodocumentation	47		47	
	Turbidity	21		21	
	Water Temperature	8		8, 65	
• Floodplain Restoration • Low/No Till • Road Abandonment and/or Decommissioning • Silvicultural Manipulation of Existing Trees • Site Maintenance (1year or less) • Utility Crossing	Photodocumentation	47		47	
• Freshwater Plant Removal and • Removal/Control • Revegetation	Bank and Shoreline Cover	46		31	
	Band Stability	56		59	
	Bank Stabilization	29, 62		62	
	Cover Composition and Abundance	59		59	
	Cover Density	59		59	
	General Freshwater Vegetation	27	Historical conditions of riparian vegetation	27	Historical Conditions of riparian vegetation
		44	Recommended for students and teachers	38	Recommended for Properly Functioning Conditions methods
		56		59	
		10	Recommended for riparian stand survey	81	Assessment of forestry activities on riparian vegetation

Riparian/Upslope

Project Type	Focus Type	Recommended protocols (by document number)			
		Volunteers		Management/Research	
		Doc #	Comments	Doc #	Comments
• Freshwater Plant Removal/Control • Revegetation (cont'd)	General Freshwater Vegetation			94	Riparian vegetation restoration
				32	Recommended on a watershed scale
	Effectiveness Monitoring	10		10	
	Photodocumentation	47		47	
	Structural Complexity	62		62	
				111	Recommended for LWD and performance analysis
	Turbidity	21		21	
	Water Temperature	8		8, 65	
• Livestock Fencing • Livestock Stream Crossing • Livestock Water Supply	Bank Stability	56		59	
	Biomonitoring - Freshwater Macroinvertebrates	59	Effects of grazing on macroinvertebrates	59	Effects of grazing on macroinvertebrates
		21		61	
		44	Recommended for students and teachers	60	Macroinvertebrates as indicators of water quality for salmon use.
		105	Should be used as a supplementary document	105	Should be used as a supplementary document
				83	Recommended on a regional scale
				57	Recommended on a watershed scale

Riparian/Upslope

Project Type	Focus Type	Recommended protocols (by document number)			
		Volunteers		Management/Research	
		Doc #	Comments	Doc #	Comments
• Livestock Fencing • Livestock Stream Crossing • Livestock Water Supply (cont'd)	Biomonitoring - Freshwater Periphyton	19		19	
	Gravel Embededness	73		81	
		105	Should be used as a supplemental document	105	Should be used as a supplemental document
	Photodocumentation	47		47	
	Shoreline Animal Damage	105	Should be used as a supplemental document	105	Should be used as a supplemental document
		46		46	
	Soil Compaction	56		56	
	Turbidity	21		21	
• Pipes and Ditches	Biomonitoring Fish Community	16	Recommended for spawning salmon survey	16	Recommended for spawning salmon survey
		59	Effects of grazing on fish community	59	Effects of grazing on fish community
				67	
				45	Recommended for bull trout
					Recommended for alevin and egg survival
				105	Should be used as a supplemental document
				37	Recommended for snorkeling techniques
	Hydromodifications	108		108	
	Photodocumentation	47		47	
	Restoring Habitat	62		94	
	Turbidity	21		21	

Riparian/Upslope

Project Type	Focus Type	Recommended protocols (by document number)			
		Volunteers		Management/Research	
		Doc #	Comments	Doc #	Comments
• Wetland Creation/Enhancement	Biomonitoring - Freshwater Fish Community			59	Effects of grazing on fish community
				67	
				45	Recommended for bull trout
				55	Recommended for alevin and egg survival
		105	Should be used as a supplemental document	105	Should be used as a supplemental document
				37	Recommended for snorkling
		16	Recommended fro spawning salmon surveys	16	Recommended for spawning salmon surveys
	Biomonitoring - Freshwater Macroinvertebrates			59	Effects grazing on macroinvertebrates
		21		61	
		44	Recommended for students and teachers	60	Macroinvertebrates as indicators of water quality for salmon use
				83	Recommended on a regional scale
				57	Recommended on a watershed scale
		105	Should be used as a supplemental document	105	Should be used as a supplemental document
	Photodocumentation	47		47	
	Rearing Habitat Availability	56		56	
	Turbidity	21			

Estuary/Nearshore Marine

Project Type	Focus Type	Recommended Protocols (by document number)			
		Volunteers		Management/Research	
		Doc #	Comments	Doc #	Comments
• Aquaculture • Armoring (Shoreline) • Beach Nourishment • Beach Restoration • Bulkhead Removal • Culverts in Levees, Installation • Dike Breeching/Removal • Dredging and Filling (marine) • Eel Grass, Kelp, or Other Native Vegetation Planting • Estuary Plant Removal/Control • Flushing/Partial Passage • Harbor, Marina, and Ferry Development • Landfill Removal • Nearshore Subtidal Enhancement • Residential Docks in Marine and Freshwater • Tidal Channel Reconstruction • Tide Gate Removal/Modification • Toxic Spills in fresh and saltwater • Underwater Marine Structures	Biomonitoring Fish Community	24		24	
	Biomonitoring Phytoplankton	25			
	Biomonitoring Macroinvertebrates	39		36	
	Photodocumentation	47		47	
	Turbidity	21		21	
		25	Recommended for the estuarine emphasis		
	Water Chemistry	25		65	Recommended for automated water quality
				50	Recommended for effluent sampling procedures
				83	Recommended on a watershed scale
				60	Recommended for its focus on water quality based on biological communities in relation to salmon
• Armoring (Shoreline) • Beach Nourishment • Bulkhead Removal • Culverts in Levees, Installation • Dike Breaching/Removal • Dredging and Filling (marine) • Eel Grass, Kelp, or Other Native Vegetation Planting • Flushing/Partial Passage • Harbor, Marina, and Ferry Development • Nearshore Subtidal Enhancement • Removal of Overwater Structures • Residential Docks in Marine and Freshwater	Biomonitoring Fish Community	24		24	
	Estuary Macrohabitat Classification	29	Recommended for surveying man-made structures	71	
		39		24	Recommended for Puget Sound
	General Estuary Vegetation	25		24	
	Habitat Function	24		24	
	Photodocumentation	47		47	
	Turbidity	21		21	

Estuary/Nearshore Marine

Project Type	Focus Type	Recommended Protocols (by document number)			
		Volunteers		Management/Research	
		Doc #	Comments	Doc #	Comments
• Beach Nourishment • Culverts in Leeves, Installation • Dike Breaching/Removal • Dredging and Filling (marine) • Eel Grass, Kelp, or Other Native Vegetation Planting • Estuary Plant Removal/Control • Nearshore Subtidal Enhancement • Residential Docks in Marine and Freshwater • Tidal Channel Reconstruction • Tide Gate Removal/Modification	General Estuary Vegetation	25		24	
	Photodocumentation	47		47	
	Water Temperature	8, 25		8, 24	
				65	Automated water quality monitoring
• Ghost Net Removal • Soft Shore Protection	Biomonitoring - Estuary Fish Community	24		24	
	Habitat Function	24		24	
	Macrohabitat Classification	29	Recommended for surveying man-made structures	24	Recommended for Puget Sound
		39		71	
	Photodocumentation	47		47	

Water Quality

Project Type	Focus Type	Recommended Protocols (by document number)			
		Volunteers		Management/Research	
		Doc #	Comments	Doc#	Comments
• Nutrient Loading (remove, reduce or modify sources • Toxic Loading (remove or reduce sources of) • Toxic Spills in fresh and saltwater • Wastewater	Total Suspended Solids	17		95	
	Turbidity	21		21	
		25	Recommended for its estuarine emphasis		
	Water Chemistry	48	Recommended for lake sediments sampling methods	40	
		44	Recommended for students and teachers	95	Recommended for the Quality Control/Quality Assurance aspects
		25	Recommended for its estuarine emphasis	55	Recommended for the dissolved oxygen methods
		21		65	Recommended for automated water quality measurements methods
				50	Recommended for effluent sampling procedures
				83	Recommended on a watershed scale
				60	Water quality based on biological communities with salmon emphasis
	Water Temperature	8		8	
				65	Automated procedures
• Sediment Collection Ponds	Photodocumentation	47		47	
	Total Suspended Solids	17		95	
• Thermal Loading (remove or reduce sources of)	Water Temperature	8		8	
				35	

Table 6. Data Pipeline - Destination of Collected Data

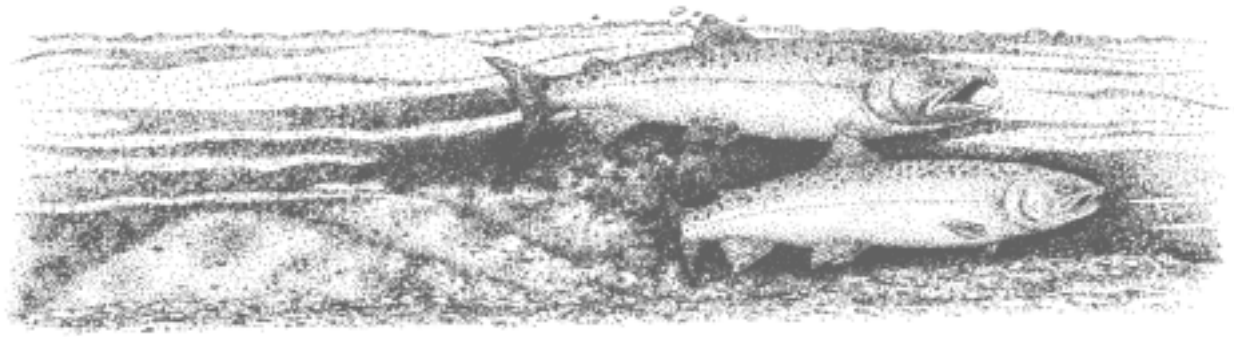
Table 6: Data Pipeline - Destination of Data Collected Under Specific Protocols.

State, Region or Province	Document Number	Organization	Database/ System
WA	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	TFW Monitoring Program – Northwest Indian Fisheries Commission. 6730 Martin Way E. Olympia, WA. 98516 Phone: (360)-438-1181 www.nwifc.wa.gov	ORACLE
WA	1, 2, 7, 8, 14, 24, 25, 29, 37, 63, 112, 108	SSHIAP – Washington Dept. Fish & Wildlife (Data accepted statewide) 600 Capitol Way N Olympia, WA. 98501-1091 Phone: (360)-902-2200; Internet: http://www.dfw.wa.gov Northwest Indian Fisheries Commission (Data accepted in WRIAs 1-23) 6730 Martin Way E. Olympia, WA. 98516 Phone: (360)-438-1181; Internet: http://www.nwifc.wa.gov	ACCESS
WA	20, 40, 57, 60, 61, 68, 69, 70, 86, 87,	Washington Dept. of Ecology PO Box 47600 Olympia, WA. 98504-7600 Phone: (360)-407-6000 www.ecy.wa.gov	EIM SYBASE
WA	95	Washington Dept. of Ecology Ambient Monitoring Section Po Box 7710 Olympia, WA 98504-7710	STORET
WA	16	Clallam County Dept. of Community Development 223 East 4th Street Port Angeles Washington 98362 (360) 417-2321; FAX: (360) 417-2443 http://www.clallam.net/dcd/	ACCESS
WA	18	Salmonweb http://www.salmonweb.org	EXCEL
WA	22	The Nature Mapping Program http://www.cbr.washington.edu/naturemapping	PARADOX
WA	23, 103	SSHEAR – Washington Dept. Fish & Wildlife 600 Capitol Way N. Olympia, WA. 98501-1091 Phone: (360)-902-2200	PARADOX
WA	28	People for Puget Sound 1402 Third Ave. Suite 1200 Seattle, WA. 98101 Phone: (206)-382-7007 http://www.pugetsound.org	Not Specified
WA	29	Puget Sound Water Quality Action Team P.O. Box 40900 Olympia, Washington 98504-0900 Phone: (360)-407-7300 Toll free in WA: 1-800-54-SOUND http://www.wa.gov/puget_sound	Filemaker Pro & EXCEL

State, Region, or Province	Document Number	Organization	Database/ System
WA	89	King County Department of Natural Resources King County Courthouse 516 Third Ave, Seattle, WA. 98104 Phone: 206-296-0100 Toll Free: 800-325-6165 http://www.metrokc.gov	EXCEL
OR	21	Oregon Dept. Fish & Wildlife 2501 SW 1st Ave, PO Box 59 Portland, OR 97207 Information: (503) 872-5268 http://www.dfw.state.or.us Oregon Dept. of Environmental Quality 811 SW Sixth Avenue Portland, Oregon 97204-1390 Phone: (503) 229-5696 Toll Free in Oregon: (800) 452-4011 http://www.deq.state.or.us	LASAR
OR	12	Oregon Dept. of Environmental Quality 811 SW Sixth Avenue Portland, Oregon 97204-1390 Phone: (503) 229-5696; Toll Free in Oregon: (800) 452-4011 http://www.deq.state.or.us	LASAR
OR	44	Student Watershed Research Project Saturday Academy/OGI 20000 NW Walker Road Beaverton, OR 97006 Fax 503-748-1388 http://www.swrp.org	Not Specified
AK	34	Alaska Dept. Fish & Game P.O. Box 25526 Juneau, Alaska 99802-5526 Phone: (907) 465-4100 http://www.state.ak.us/local/akpages/FISH.GAME/adfghome.htm	Not Specified
ID	35	Idaho Division of Environmental Quality 1410 N. Hilton Boise, ID 83706 Phone: (208) 373-0502 http://www2.state.id.us/deq	Lotus 123 v. 5.0
ID	52, 54, 55, 56, 72, 73, 74, 75, 76, 78, 79, 82, 85	Idaho Division of Environmental Quality 1410 N. Hilton Boise, ID 83706 Phone: (208) 373-0502 http://www2.state.id.us/deq	Not Specified
BC	13	Department of Fisheries and Oceans Canada 360 555 West Hastings St. Vancouver, B. C. V6B 5G3 http://www.dfo-mpo.gc.ca	Not Specified
BC	39, 71	Department of Fisheries and Oceans Canada Pacific Biological Station Nanaimo, B. C. V9R 5K6 http://www.pac.dfo-mpo.gc.ca/sci/protocol/shorekeepers/Database/default.htm	ACCESS

State, Region, or Province	Document Number	Organization	Database/ System
BC	65, 90, 48, 50	Ministry of Environment, Lands and Parks PO Box 9360 STN PROV GOVT Victoria BC V8W 9M2 Phone (250) 387-9422 http://www.gov.bc.ca/elp/cont/	EXCEL, WQDMS
BC	47, 91, 92, 93, 94	Ministry of Environment, Lands and Parks PO Box 9360 STN PROV GOVT Victoria BC V8W 9M2 Phone: (250) 387-9422 http://www.gov.bc.ca/elp/cont/	Not Specified
BC	49	Ministry of Environment, Lands and Parks PO Box 9360 STN PROV GOVT Victoria BC V8W 9M2 Phone: (250) 387-9422 http://www.gov.bc.ca/elp/cont/	ARC/INFO
BC	51	Ministry of Agriculture, Food and Fisheries BC Fisheries PO BOX 9043 STN PROV GOVT Victoria V8W9E2 Phone: (250) 387-1023 http://www.gov.bc.ca/fish/	ORACLE, ACCESS
EPA region 10	81, 59	US Environmental Protection Agency Region 10, NPS Section, WD-139 A200 Sixth Ave. Seattle, WA. 98101 http://www.epa.gov	PASSSFA
All US	84, 67, 15, 25, 17	US Environmental Protection Agency Environmental Monitoring System Laboratory Cincinnati, Ohio 45268	Not Specified
All US	19, 80	US Environmental Protection Agency Agency Office of Water 401 M St., NW Washington, D. C. 20460 http://www.epa.gov	STORET
All US	31, 43, 58, 66	US Geological Survey National Water-Quality Assessment Program http://water.usgs.gov/nawqa/nawqa_home.html	Not Specified
All US	33	US Geological Survey Biological Resources Division http://biology.usgs.gov/	Not Specified
All US	32	US Department of the Interior Bureau of Land Management National Applied Resource Science Center P.O. Box 25047 Denver, CO. 80225-0047 http://www.blm.gov/nstc/new_site_location.html	Not Specified
USDA Forest Service Region 6	14	USDA Forest Service - Pacific Northwest Region 333 SW First Avenue, Portland, Oregon 97204-3440; P.O. Box 3623, Portland, OR 97208-3623 http://www.fs.fed.us/r6/	USFS SMART

State, Region, or Province	Document Number	Organization	Database/ System
USDA Forest Service Regions 1 & 4	37	USDA Forest Service Northern Region 200 E. Broadway, PO Box 7669, Missoula, MT 59807 Phone: 406-329-3511 http://www.fs.fed.us/r1/ USDA Forest Service Intermountain Region Federal Building 324, 25th Street, Ogden, UT 84401 http://www.fs.fed.us/r4/	FBASE 3.0
All US	24	USDA Forest Service Pacific Northwest Regional Office Po Box 3523 Portland, OR, 97208 Contact: Deborah Konnoff – Fish Habitats Relationship Coordinator Phone: (503) 808-2973 E-mail: dkonnoff@fs.fed.us	SMART – being folded into the national Water Module database (inter-agency accessible) Data from outside sources will be accepted starting Spring of 2002
All US	11, 26, 109, 30, 38, 53, 62, 63, 64, 77, 88, 96	Not Specified	Not Specified
WA	104	Washington State Department of Fish and Wildlife 1111 Washington St SE Olympia, WA 98501-1091 Contact: Hal Michael (360) 902-2659	Not applicable
ID	106	Intermountain Research Station 324 25th Street Ogden, UT 84401	DBASE IV
CA	107	California Department of Forestry and Fire Protection's Fire and Resource Assessment Program (FRAP) 1920 Twentieth Street Sacramento, CA 95814 Phone: (916) 227-2651; FAX: (916) 227-2672 http://frap.cdf.ca.gov/data/frapgisdata/select.asp	ArcInfo



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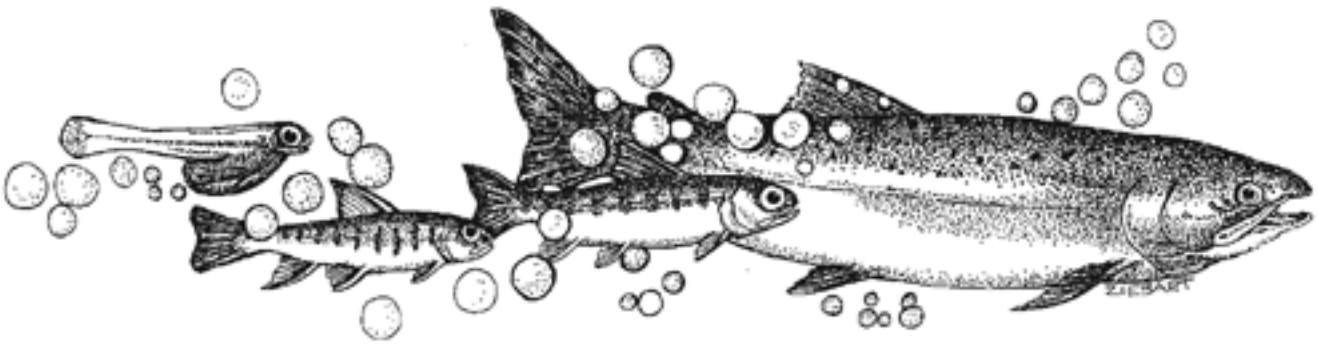
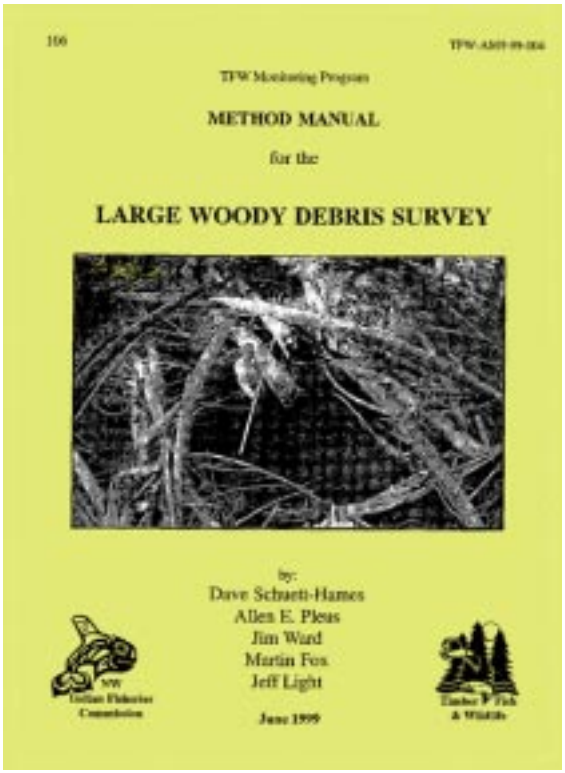


Document No.: 1

Timber-Fish-Wildlife (TFW)Method Manual for the Large Woody Debris Survey

Citation: Shuett-Hames, D., A. E. Pleus, J. Ward, M. Fox, and J. Light. 1999. TFW Monitoring Program method manual for the large woody debris survey. Prepared for the Washington State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-99-004. DNR #106. March. 33 pp.



Source: TFW Monitoring Program
Northwest Indian Fisheries Commission
6730 Martin Way East
Olympia, WA 98516
Phone: (360)-438-1180
Fax: (360)-753-8659
Internet: www.nwifc.wa.gov
Cost: No charge

Abstract: Provides two levels of standard methods for assessing and monitoring the quantity and quality of LWD at the TFW stream segment scale.

Pre-monitoring requirements include the TFW Stream Segment Identification Method (Protocol # 9) and the TFW Reference Point Survey Method (Protocol #6).

The relatively quick Level I method quantifies the number of pieces in each of several size class categories and by bankfull channel zone.

The Level 2 Method collects more detailed information on individual pieces including piece count, volume by bankfull channel zone, whether it is deciduous or conifer, and stability. LWD jam information is collected for both Level I and Level 2 Surveys. The Jam method collects information on jam and piece count, number of jams by bankfull channel zone, and number of pieces per jam in each of several size class categories.

Association with a Reference Point Survey provides information on piece and jam distribution. Optional key piece information can be collected for the Level I and II methods and is calculated in the database for Level 2 pieces. TFW data management services provide basic analysis of LWD data at 100 meter (except Level I) and stream segment scales. Standard calculations include the number of pieces and jams per channel width and kilometer.

Sections are presented in order of survey application including: study design, pre-survey preparation, stream discharge measurement, survey method, post-survey documentation, data management, and references. An extensive appendix is also provided that includes: copy masters of field forms; examples of completed field forms; a field criteria and code sheet; a standard field and vehicle gear checklist, and data management examples.

Target Application: Management

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Recommended: Yes

Available? Not at this time

Monitoring Focus:

Large woody debris quantity and quality:

1) Provide a means of accurately documenting the current abundance, characteristics, and function of large woody debris in stream channels.
2) Provide a repeatable methodology that can be used to monitor changes in the status of large woody debris over time.
3) Improve knowledge of the distribution, characteristics, and function of large woody debris in Pacific Northwest streams.

Geographic Scale: Basin, sub-basin, stream reach, or project site

Methods: Office **&** Field

Level of Data Quality: Level 3

Equipment and Tools: Appendix D of the document

Data Forms: Appendix A and C of the document

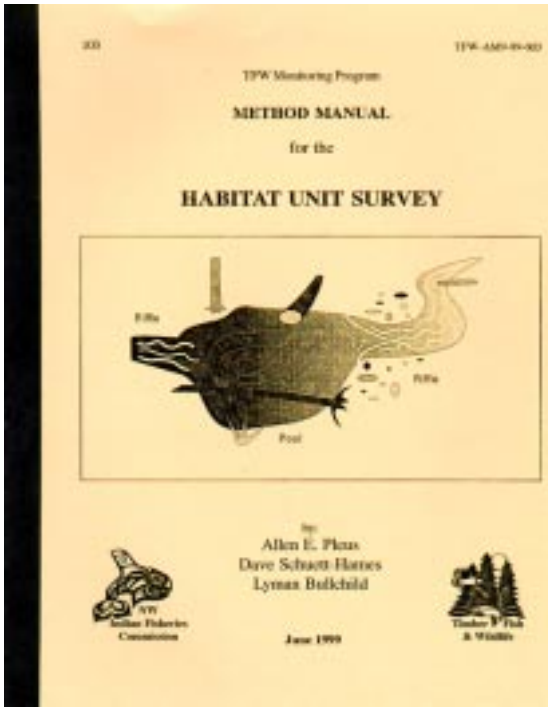
Examples of filled-in data forms: Appendix B of the document

Key References: Page 32 the document

Document No.: 2

Timber-Fish-Wildlife (TFW) Method Manual for the Habitat Unit Survey

Citation: Pleus, A. E., D. Shuett-Hames, and L. Bullchild. 1999. TFW Monitoring Program method manual for the habitat unit survey. Prepared for the WA State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-99-003. DNR #105. June. 31 pp.



Source: TFW Monitoring Program
Northwest Indian Fisheries Commission
6730 Martin Way East
Olympia, WA 98516
Phone: (360)-438-1180
Fax: (360)-753-8659
Internet: www.nwifc.wa.gov

Abstract: The TFW Monitoring Program method manual for the Habitat Unit Survey provides a standard method for assessing and monitoring the quantity and quality of habitat in wadable streams.

Pre-monitoring requirements include the TFW Stream Segment Identification Method (Protocol #) and the TFW Reference Point Survey Method (Protocol #).

The core Habitat Unit Survey collects information on the frequency and distribution of riffle and pool habitat units. Quantitative criteria are used to distinguish and identify habitat units to ensure consistency between observers. The unit's channel location is identified as either primary, secondary, side, or tributary channel. Wetland, sub-surface flow, and obscured unit types are also used to characterize portions of the stream that are either flowing through wetland systems, have gone subsurface, or cannot be identified because visibility is obscured. Additional information is collected on the maximum and outlet depths of pools, and on features associated with pool formation. Guidance is provided for optional collection of sub-unit habitat types.

The TFW Monitoring Program database accepts data collected using the Habitat Unit Survey method, performs standard calculations, and generated data summary reports of habitat unit data at 100 meter and stream segment scales.

Sections are presented in order of survey application including: study design, pre-survey preparation, methods, post-survey documentation, data management, and references.

Target Application: Management

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Recommended: Yes
Available? Not at this time.

Monitoring Focus:
- Stream morphology
- Freshwater Macrohabitat Classification

Geographic Scale: Basin, sub-basin, stream reach, or project site

Methods: Office **&** Field

Level of Data Quality: Level 3

Equipment and Tools (*list*): Appendix D of the document

Data Forms: Appendix A and C of the document

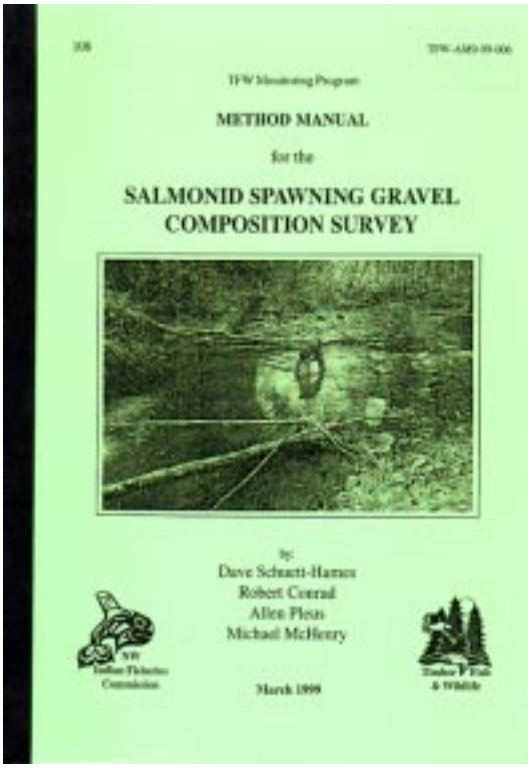
Examples of Filled-in Data Forms: Appendix B of the document

Key References: Page 30 of the document

Document No.: 3

Timber-Fish-Wildlife (TFW) Method Manual for the Salmonid Spawning Gravel Composition Survey

Citation: Shuett-Hames, D., R. Conrad, A. Pleus and M. McHenry. 1999. TFW Monitoring Program method manual for the salmonid spawning gravel composition survey. Prepared for the WA State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW AM9-99-001. DNR #101. March. 48 pp.



Source: TFW Monitoring Program
Northwest Indian Fisheries Commission
6730 Martin Way East
Olympia, WA 98516
Phone: (360)-438-1180
Fax: (360)-753-8659
Internet: www.nwifc.wa.gov

Abstract: A standard method for the assessment and monitoring of salmonid spawning gravel composition. The method is divided into sample inventory, collection, and processing sections. The inventory process ensures that samples from either riffle crests or gravel patch features are representative of spawning gravel composition on a stream segment scale.

The McNeil sampler is used to collect samples on inventory sites. There are two options for processing samples through a standard set of sieves. The relatively quicker volumetric method measures the volume (millimeters of water displced by), and the gravimetric method measures the weight (grams), of sample particles by size class. TFW data management services provide basic data analysis for spawning gravel samples such as calculating the percentage of particles less than 0.85 millimeters ("fine sediments" – volumetric equivalent) and the geometric mean (gravimetric equivalent).

The survey is designed for use on streams where there is no prior data available on variation in gravel composition to guide sample design. For streams with existing data, it may be preferable to develop custom sampling strategies based on segment-specific variation. The survey does not attempt to document or predict actual survival to emergence, nor is it oriented towards the requirements of any particular salmonid species.

If the stream has not already been segmented, pre-monitoring recommendations include the TFW Stream Segment Identification Method (Document No. 9).

Sections are presented in order of survey application including: study design, sample inventory, sample collection, sample processing, survey documentation, data management, and references. An extensive appendix is also provided that includes: field forms, examples of completed field forms, a field and vehicle gear checklist, sample bucket data tracking slips, data management examples, and a random number table.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Recommended: Yes
Available? Not at this time.

Monitoring Focus:

1) Evaluating and monitoring the composition and characteristics of spawning gravel;
2) Estimating the percentage of fine sediments less than 0.85 mm;
3) Comparing spawning gravel composition among stream segments, watersheds, and ecoregions;
4) Monitoring trends in spawning gravel composi tion over time.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

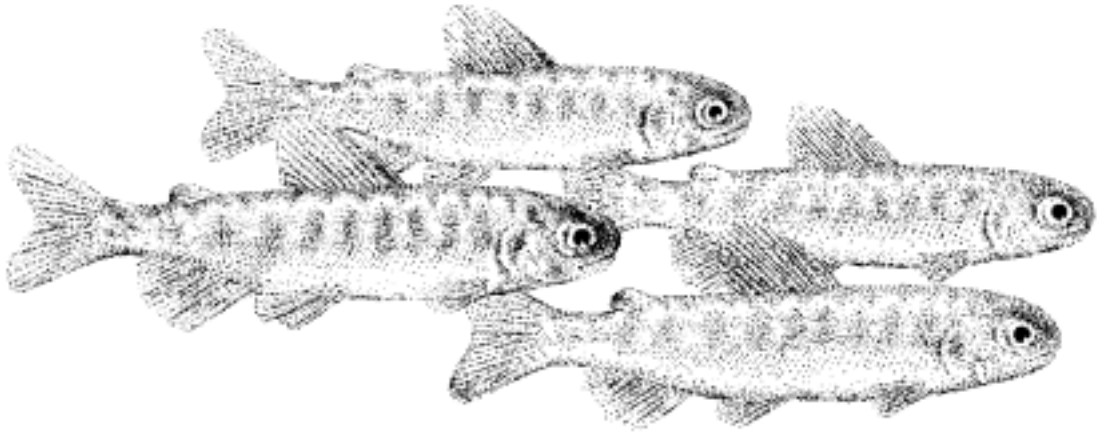
Level of Data Quality: Level 3

Equipment and Tools (*list*): Appendix C of the document

Data Forms: Appendix A of the document

Examples of Filled-in Data Forms: Appendix B of the document

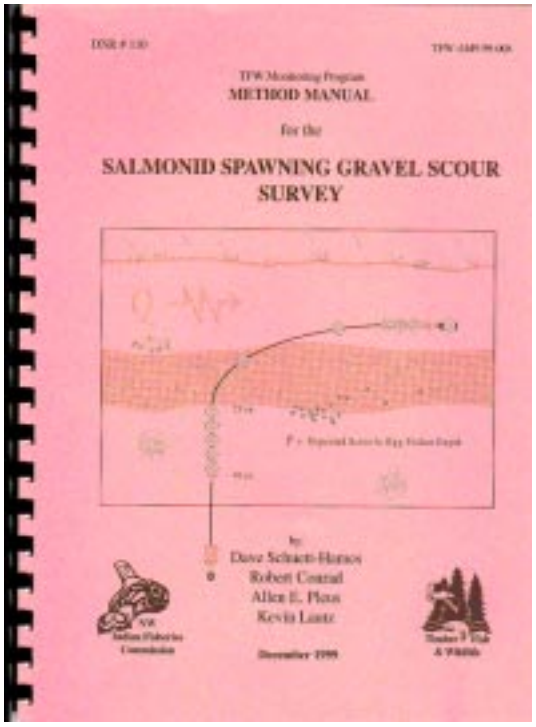
Key References: Page 46 of the document



Document No.: 4

Timber-Fish-Wildlife (TFW) Method Manual for the Salmonid Spawning Gravel Scour Survey

Citation: Shuett-Hames, D., A. E. Pleus, and D. Smith. 1999. TFW Monitoring Program method manual for the salmonid spawning gravel scour survey. Prepared for the Washington State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-99-008. DNR #110. December. 41 pp.



Source: TFW Monitoring Program
Northwest Indian Fisheries Commission
6730 Martin Way East
Olympia, WA 98516
Phone: (360)-438-1180
Fax: (360)-753-8659
Internet: www.nwifc.wa.gov
Cost: No charge

Abstract: Provides a standard method for the assessing and monitoring changes in the depth, frequency and distribution of scour on a stream segment scale. Segments for monitoring scour are selected on the basis of one of three monitoring objectives. Information on frequency and depth of scour is useful when there is a need to evaluate the effect of scour on salmonid incubation. It is also useful for evaluating the response of stream channels to changes in peak flow discharge, sediment input, or large woody debris loading.

The relative abundance of spawning habitat is used as an indicator of resource condition for individual monitoring projects and in the Watershed Analysis Fish Habitat Assessment process (WFPB, 1996). In segments where spawning habitat is scarce, information on hydrology, sediment supply, channel conditions, and human activities is examined to determine why.

The survey does not attempt to document or predict actual survival to emergence, nor is it oriented towards the requirements of any particular salmonid species.

If the stream has not already been segmented, pre-monitoring requirements include the TFW Stream Segment Identification Method (Document No. 9).

Once objectives are identified and segments have been selected, the spawning gravel is inventoried and categorized by spawning habitat type. Then cross sections are established in a sub-sample of randomly selected spawning gravel areas representing each habitat type. Scour monitors are inserted in potential spawning gravel along each cross -section, elevations are surveyed and substrate particle size are collected after each storm event during the monitoring period. Peak flow discharge is documented.

Scour data are analyzed in the TFW Monitoring database, which generates reports that characterize the depth, frequency and distribution of scour by cross section and spawning habitat type. Scour data are interpreted in the context of peak discharge events.

Sections are presented in order of survey application including: study design, pre-survey documentation, survey method, post-survey documentation, data management, and references. An extensive appendix is also provided that includes: copy masters of field forms, examples of completed field forms, scour monitor and inserter size and construction detail instruction, a sample size

calculation matrix, a sample site selection worksheet example, a standard field and vehicle gear checklist, and a data management example.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Recommended: Yes
Available? Not at this time.
Where? NWIFC at the address above.

Monitoring Focus: Changes and trends in stream channel morphology and scour characteristics:

1) Assess scour depth, frequency and distribution patterns in salmonid spawning gravel;
2) Detect and monitor changes in scour depth, frequency and distribution patterns over time on a stream segment scale; and
3) Provide information on peak discharge and physical channel characteristics to interpret scour in the context of physical channel processes.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

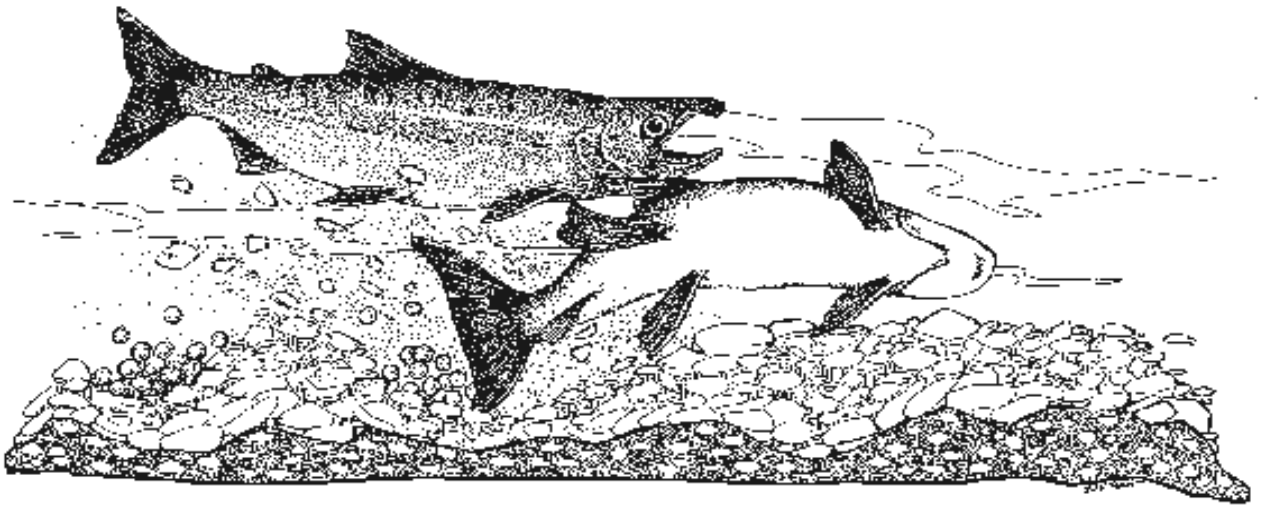
Level of Data Quality: Level 3

Equipment and Tools (*list*): Page 8 (Survey Equipment) and Appendix F of the document

Data Forms: Appendix A of the document

Examples of Filled-in Data Forms: Appendix B of the document

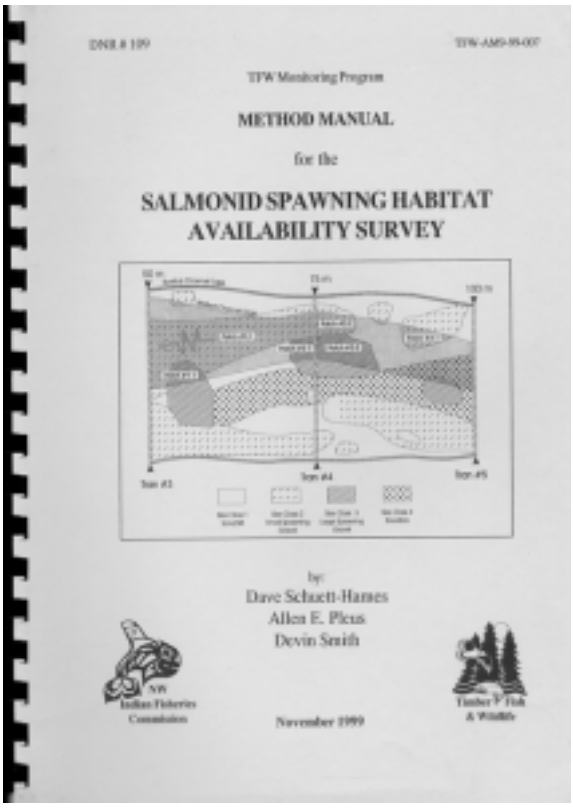
Key References: Page 37 of the document



Document No.: 5

Timber-Fish-Wildlife (TFW) Method Manual for the Salmonid Spawning Habitat Availability Survey

Citation: Shuett-Hames, D., A. E. Pleus, and D. Smith. 1999. TFW Monitoring Program method manual for the salmonid spawning habitat availability survey. Prepared for the Washington State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW AM9-99-007. DNR #119. November. 32 pp.



Source: TFW Monitoring Program
Northwest Indian Fisheries Commission
6730 Martin Way East
Olympia, WA 98516
Phone: (360)-438-1180
Fax: (360)-753-8659
Internet: www.nwifc.wa.gov
Cost: No charge

Abstract: Provides a standard method for assessing and monitoring changes in the depth, frequency and distribution of scour on a stream segment scale. The criteria used to determine spawning habitat includes substrate particle size, substrate depth, water depth, water velocity, and surface area coverage. A background section provides a review of scientific literature used as the basis for the Survey method, including a discussion of the distribution of spawning habitat within watersheds and stream segments and characteristics used by salmonids to select spawning habitat.

The Survey provides two methods for estimating the amount of spawning habitat on the TFW stream segment scale; transect and patch. The transect method uses dominant substrate information collected along systematically placed transects to estimate the total surface area of potential spawning habitat within the bankfull and wetted channels. The patch method provides detailed information on the surface area and distribution of individual spawning habitat patches within the wetted channel. Monitoring objectives and timing of surveys are used to select whether one or both survey methods are applied.

The relative abundance of spawning habitat is used as an indicator of resource condition for individual monitoring projects and in the Watershed Analysis Fish Habitat Assessment process (WFPB, 1996). In segments where spawning habitat is scarce, information on hydrology, sediment supply, channel conditions, and human activities is examined to determine why. The survey does not attempt to document or predict actual survival to emergence, nor is it oriented towards the requirements of any particular salmonid species.

Sections are presented in order of survey application including: study design, pre-survey documentation, stream discharge, survey methods, post-survey documentation, data management, and references. An extensive appendix is also provided that includes: copy masters of field forms, examples of completed field forms, a field code sheet, data management examples, and a standard field and vehicle gear checklist.

Note: *If the stream has not already been segmented, pre-monitoring requirements include*

the TFW Stream Segment Identification Method (see Document No. 9). Discharge methods are to the TFW Wadable Discharge Method (see Document No. 7).

Target Application: Management **&** Research

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Recommended: Yes

Available? Not at this time.
Where? Northwest Indian Fisheries Commission at above address.

Monitoring Focus: Changes and trends in salmonid spawning habitat availability:

1) Assess and monitor the availability of potential spawning habitat within the bankfull channel;
2) Assess and monitor the availability of actual spawning habitat in the wetted channel at a discharge representative of the spawning season;
3) Interpret spawning habitat availability in the context of channel conditions and watershed.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

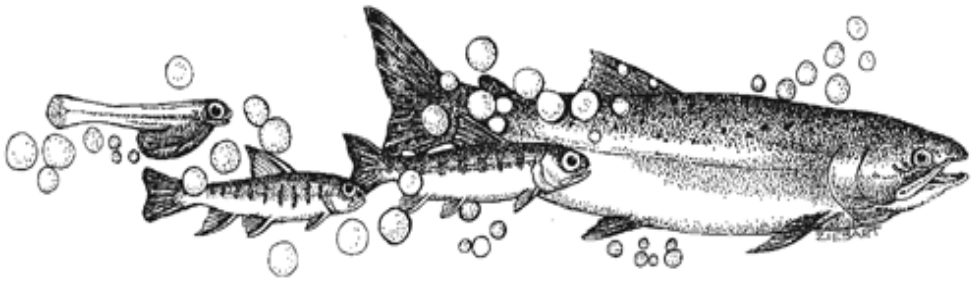
Level of Data Quality: Level 3

Equipment and Tools (*list*): Page 8 (Survey Equipment) and Appendix F of the document

Data Forms: Appendix A of the document

Examples of Filled-in Data Forms: Appendix B of the document

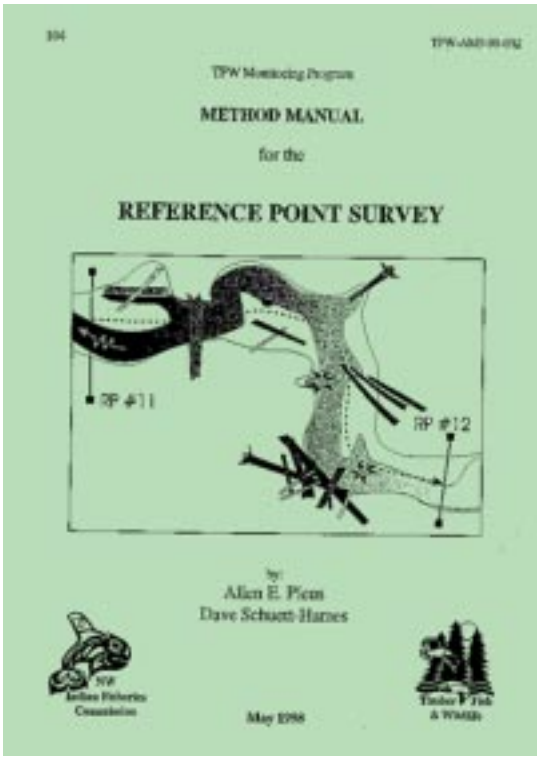
Key References: Page 30 of the document



Document No.: 6

Timber-Fish-Wildlife (TFW) Method Manual for the Reference Point Survey

Citation: Pleus, A. E., D. Shuett-Hames. 1998. TFW Monitoring Program method manual for the reference point survey. Prepared for the WA State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9 99-008. DNR #002. May. 31 pp



Source: TFW Monitoring Program
Northwest Indian Fisheries Commission
6730 Martin Way East
Olympia, WA 98516
Phone: (360)-438-1180
Fax: (360)-753-8659
Internet: www.nwifc.wa.gov
Cost: No charge

Abstract: A standard method for establishing stable reference point sites for monitoring stream segments over time. Reference points are established at regular intervals along a previously defined stream segment and monumented to be easily relocated. Stream parameters collected during this survey include: 1) segment length; 2) bankfull width; 3) bankfull depth; 4) canopy closure; and 5) optional reference photographs.

The manual is divided into pre-survey preparation, field methods, post-field documentation, and data management sections. An extensive appendix section includes a survey task checklist copy master, a materials and equipment source list, field form copy masters, examples of completed field forms, a data report example, and a glossary of terms.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Recommended: Yes
Available? Not at this time.

Monitoring Focus: Reference point establishment for monitoring stream segments over time. Stream parameters include:

1) segment length;
2) bankfull width;
3) bankfull depth;
4) canopy closure;
5) optional reference photographs.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

Level of Data Quality: Level 3

Equipment and Tools (*list*): Appendix B and D of the document

Data Forms: Appendix A of the document

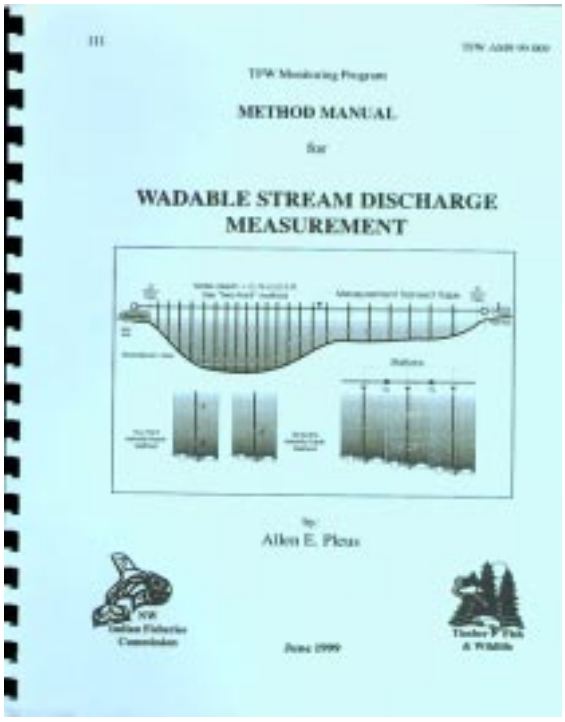
Examples of Filled-in Data Forms: Appendix E of the document

Key References: Page 30 of the document

Document No.: 7

TFW Method Manual for Wadable Stream Discharge Measurement

Citation: Pleus, A. E. 1999. TFW Monitoring Program method manual for wadable stream discharge measurement. Prepared for the Washing ton State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9 99-009. DNR #111. June. 13 pp.



Source: TFW Monitoring Program
Northwest Indian Fisheries Commission
6730 Martin Way East
Olympia, WA 98516
Phone: (360)-438-1180
Fax: (360)-753-8659
Internet: www.nwifc.wa.gov
Cost: No charge

Abstract: A standard method for the assessment and monitoring of stream discharge on wadable streams. The TFW method follows the USGS protocols (Rantz and others, 1982) with minor modifications for smaller stream systems. Discharge measurements are required for the TFW Habitat Unit Survey (*Document No. 2)* and Large Woody Debris Surveys *(Document No. 1)* and when conducting portions of the Spawning Habitat Availability *(Document No. 5)* and Stream Temperature Surveys *(Document No. 8)*.

The manual is divided into pre-survey preparation, methods, post-survey documentation, and data management, and reference sections. An appendix section includes copy masters of field forms, examples of completed field forms, a standard field and vehicle gear checklist, and USGS procedures for float and volumetric discharge measurements.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Recommended: Yes
Available? Not at this time.

Monitoring Focus: The purpose of the WSDM method is to:

1) Determine discharge at the time of the monitoring survey; and/or
2) Determine appropriate flows for repeat surveys.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

Level of Data Quality: Level 3

Equipment and Tools (*list*): Appendix C of the document

Data Forms: Appendix A of the document

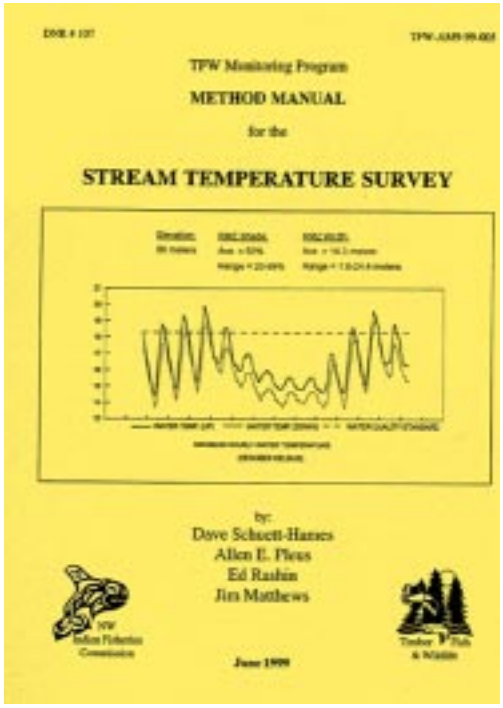
Examples of Filled-in Data Forms: Appendix B of the document

Key References: Page 12 of the document

Document No.: 8

Timber-Fish-Wildlife (TFW) Method Manual for the Stream Temperature Survey

Citation: Pleus, A. E. 1999. TFW Monitoring Program method manual for the stream temperature survey. Prepared for the Washington State Department of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9 99-005. DNR #107. June. 35 pp.



Source: TFW Monitoring Program
Northwest Indian Fisheries Commission
6730 Martin Way East
Olympia, WA 98516
Phone: (360)-438-1180
Fax: (360)-753-8659
Internet: www.nwifc.wa.gov

Abstract: A standard method for the assessment and monitoring of stream temperature and thermal reach characteristics. The TEMP survey provides a standard method for conducting annual maximum temperature monitoring studies to accomplish a variety of objectives, including assessment and monitoring of water temperature changes associated with land management activities, characterization and monitoring of stream reaches of special interest due to their importance for salmonid habitat or water quality, or characterization of temperature regimes throughout a watershed.

The monitoring approach involves collection of water temperature data at temperature stations, and optional characterization of channel and riparian conditions in thermal reaches immediately upstream of the temperature stations to identify factors affecting water temperature. Procedures cover the use of data logger and maximum/minimum temperature instruments for collecting water temperature data. Water temperature data are analyzed in the TFW Monitoring Program database and reports are generated that characterize the temperature regime for each temperature station on a daily, weekly, monthly and project basis. Cases where water quality standards have been exceeded are identified. Additional information can be collected on factors that affect the maximum water temperature regime, including air temperature, canopy closure (shade), reach, elevation, stream width and depth, gradient, channel morphology and groundwater inflow.

The manual is divided into study design, pre-survey preparation, survey methods, post-survey documentation, and data management and reference sections

Target Application: Management **&** Research

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Recommended: Yes
Available? Not at this time.

Monitoring Focus: Stream temperature: maximum and changes over time. Includes maximum and minimum water temperatures and air temperatures.

Geographic Scale: All scales

Methods: Office **&** Field

Level of Data Quality: Level 3

Equipment and Tools (*list*): Appendix C

Data Forms: Appendix A of the document

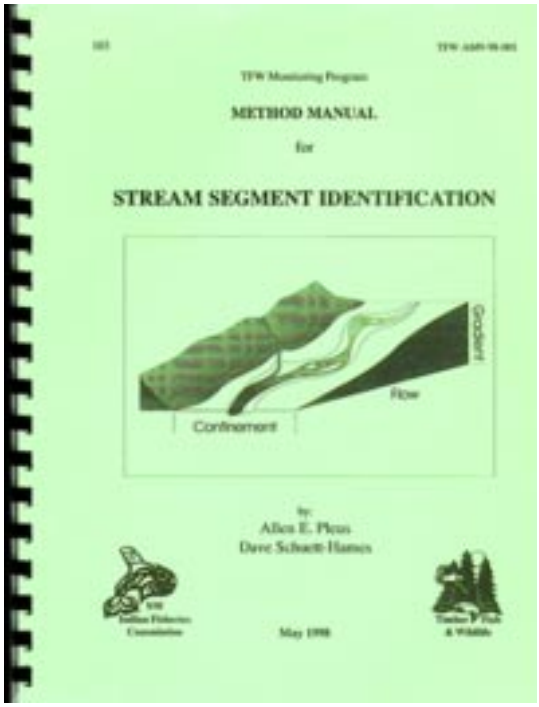
Examples of Filled-in Data Forms: Appendix B

Key References: Page 33 of the document

Document No.: 9

Timber-Fish-Wildlife (TFW) Method Manual for Stream Segment Identification

Citation: Pleus, A. E., D. Schuett-Hames. 1998. TFW Monitoring Program method manual for stream segment identification. Prepared for the] Washington State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW AM9-98-001. DNR #103. 39 pp.



Source: TFW Monitoring Program
Northwest Indian Fisheries Commission
6730 Martin Way East
Olympia, WA 98516
Phone: (360)-438-1180
Fax: (360)-753-8659
Internet: www.nwifc.wa.gov
Cost: No charge

Abstract: A standard method for systematically identifying stream segments on the basin of channel morphology and floodplain characteristics. These segments are used as the basic framework for designing monitoring study plans and conducting monitoring surveys for the TFW Monitoring Program, Watershed Analysis, and the Salmon and Steelhead Habitat Inventory and Assessment (SSHIAP) process.

The primary stream segment characteristics are: 1) stream order/relative basin drainage area; 2) channel gradient; and 3) channel confinement. The manual provides basic segmenting techniques with clear, step-by-step explanations and examples that illustrate the application of the methods in various stream situations.

The manual is divided into office methods, field verification, post-field documentation, and data management sections. A sub-segmenting process is included to provide flexibility to address the specific needs of individual studies and as a linkage to other stream classification systems.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Recommended: Yes
Available? Not at this time.

Monitoring Focus: The products produced by this method include:

- A stream system or watershed map delineating stream segments based on stream/drainage basin
- size, gradient, and confinement;
- Segment boundary location information;
- Segment characteristic information based on maps
- and field verification.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

Level of Data Quality: Level 3

Equipment and Tools (*list*): Appendices A and J of the document

Data Forms: Appendices B, C, G of the document

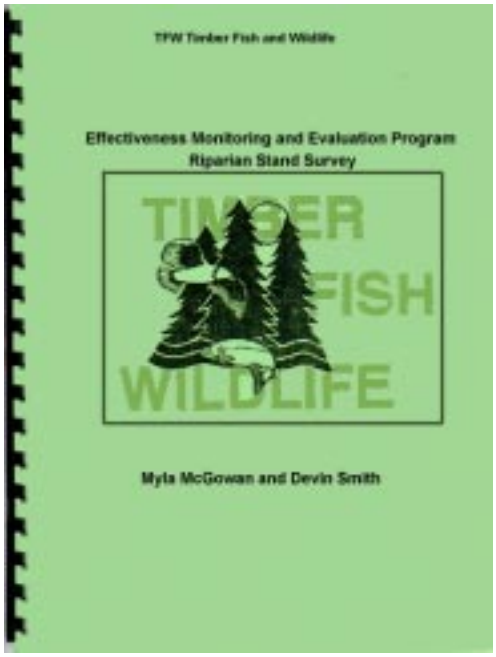
Examples of Filled-in Data Forms: Appendix E of the document

Key References: Page 38 of the document

Document No.: 10

Timber-Fish-Wildlife (TFW) Effectiveness Monitoring and Evaluation Program Riparian Stand Survey

Citation: Smith, D. 1998. TFW effectiveness monitoring and evaluation program: riparian stand survey. Final draft. 9 pages plus appendices.



Source: TFW Monitoring Program
Northwest Indian Fisheries Commission
6730 Martin Way E
Olympia, WA 98516
Phone: (360) 438-1180
Fax: (360) 753-8659
Internet: http://nwifc/TFW

Abstract: This protocol provides a sampling method to monitor riparian stand conditions and stream channel characteristics on a site scale. The methods track changes in stand density, composition, diameter and height, and relate those parameters to riparian buffer condition and the potential recruitment of large woody debris to the stream channel.

This sampling method may be used to evaluate the effectiveness of riparian forest practices in providing large woody debris (LWD) to stream channels as well as to quantify rates and processes related to LWD recruitment and function in order to improve the interpretation of monitoring results and Survey reaches may be delineated with one of two methods, depending on the objectives of the monitoring projects. To evaluate the effectiveness of forest practices, sampling takes place within survey reaches defined by the harvest boundaries at each site. To assess specific stand or channel types, sampling occurs in survey reaches defined by riparian stand and stream channel characteristics of interest.

Procedure descriptions include sections pertaining to:

- necessary equipment
- site selection
- sampling strategy
- sampling plots
- standing trees
- downed wood
- stand regeneration
- stand height and age
- channel characteristics

Appendices to this document provide a coding system for coniferous and deciduous tree species, instructions for measurement of tree diameter and height, and copies of field forms needed for the survey. Three levels of related protocols were developed by cooperators to answer questions about the success and failures of riparian revegetation projects.

Variables of failure include:

- site preparation
- soil type
- rodent, deer, and beaver activity
- tree species and size
- competition from invasive plant species

Riparian Vegetation Level I Monitoring Protocol: Established to determine what sites are in need of immediate action. This protocol provides no data of the overall effectiveness of a restoration project. Includes a data form.

Riparian Vegetation Level II Monitoring Protocols (2 protocols). The two protocols designed to measure the height, health and/or mortality of plants, requiring different investments of time Forms provided include: Data forms, “How-to” guides, and a form for noting the location of benchmarks.

Level II a (Nooksack Salmon Enhancement Association): This method samples the entire site and produces the most comprehensive data set. It is most appropriate for monitoring small restoration sites.

Level II b (Skagit Fisheries Enhancement Group): This method uses plots to sample a portion of the site no less than 5% of the total area. The method is appropriate for larger restoration projects, and provides information on soil, site characteristics, and shade availability.

Riparian Vegetation Level III Monitoring Protocols: Two additional protocols developed to be consistent and repeatable over time, and specifically focused on the success of riparian restoration projects.

Level III a - Riparian Zone Restoration Protocol (Lummi Natural Resources): This methodology tracks the growth and survival of young plants and is recommended for projects involving planting and revegetation such as riparian restoration projects where the goal is to replant native species, decrease understory competition, minimize browsing and grazing effects.

Level III b – Riparian Buffer Establishment Protocol (Lummi Natural Resources): A method developed and recommended for projects that restore riparian areas grazed by livestock.

(Level III c is Protocol # 10 outlined above).

Target Application: Management & Research

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Required: Yes
Available? Yes
Where? People for Salmon
P.O. Box 1106
North Bend, WA 98045
Phone: 425-831-2426
FAX: 425-961-2100 x 3221
E-mail: info@peopleforsalmon.org
Internet: http://www.peopleforsalmon.org/

See also: Lummi Natural Resources Riparian Zone Restoration Project. University of Washington Center for Streamside Studies at: http://depts.washington.edu/cssuw/Research/Lummi/lummi.html

or:

Skagit Fisheries Enhancement Group
Monitoring Programs
PO Box 2497
Mount Vernon, WA 98273
www.skagitfisheries.org

Monitoring Focus: Method(s) to monitor riparian stand conditions and stream channel characteristics on a site scale. Can be used to evaluate the effectiveness in providing LWD to stream channels or rates of recruitment over time.

Geographic Scale: Project site

Methods: Office **&** Field

Level of Data Quality: Level 1, 2, or 3

Equipment and Tools (*list*): Provided in the document

Data Forms: Provided in the document

Examples of Filled-in Data Forms: Not provided

Key References:

Smith and Schuett-Hames, 1998. LWD Recruitment Study Design Guidelines.

TFW Large Woody Debris Survey (Protocol # 1)
TFW Reference Point Survey (Protocol # 6)

Document No.: 11

Stream Channel Reference Sites: An Illustrated Guide to Field Techniques

Citation: Harrelson, C. C, Rawlins, C.L. and Potyondy, J. P. 1994. Stream channel reference sites: an illustrated guide to field technique. Gen. Tech. Rep. RM-245. Fort Collins, CO. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 pp.

Source: USDA Forest Service
Rocky Mountain Forest and Range
Experimental Station
40 West Prospect Road
Fort Collins, CO 80526-2098
Phone: (970)-498-1100
Internet: http://stream.rsl.psw.fs.fed.us:80/streamnt/oct99/oct99.a3.htm

Abstract: This document is a guide to establishing permanent reference sites for gathering a basic minimum set of data about the existing physical characteristics of streams and rivers. Developed by hydrologists, it presents techniques from a variety of published sources in a single compact field manual. It is recommended for entry-level hydrologists, biologists, and others directly responsible for managing streams and riparian areas. The minimum procedure consists of the following:

1) select a site
2) map the site and location
3) measure the channel cross-section
4) survey a longitudinal profile of the channel
5) measure stream flow
6) measure bed material
7) file the information

The guide includes instruction in basic surveying techniques, provides guidelines for identifying bankfull indicators and measuring other important stream characteristics. With a baseline foundation, changes in the character of streams can be quantified for monitoring purposes or to support other management decisions.

Target Application: Management

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Monitoring Focus: Baseline information for existing physical conditions of stream channels. Parameters include: 1) cross section measurement, 2) longitudinal profile measurement, 3) bed and bank characterization, and 4) discharge measurement. Stream classification systems are presented, based primarily on Rosgen (1994). Good instructions on mapping techniques and survey basics are included. ***Note:*** The section on indicators of bankfull stage is developed for the interior western states.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

Level of Data Quality: Level 2 **&** 3

Equipment and Tools (*list*): See Equipment List for Instream and Upland Protocols

Data Forms: Not provided

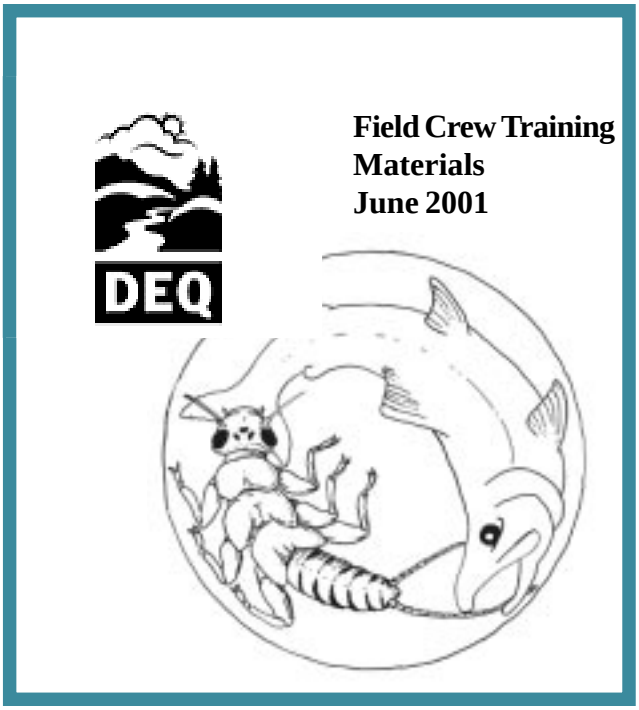
Examples of Filled-in Data Forms: Page 54 of the document

Key References: Page 55 of the document

Document No.: 12

Physical Habitat, Water Chemistry, Macroinvertebrates, and Aquatic Invertebrates

Citation: Oregon Department of Environmental Quality. 1999. Field methods – Regional environmental monitoring and assessment program: physical habitat, water chemistry, macroinvertebrates, aquatic insects, Version 2.5. Oregon Department of Environmental Quality, Laboratory Division, Biological Monitoring Section, Portland, OR.



Source: Oregon Department of Environmental Quality Laboratory Division
Biological Monitoring Section
2020 SW Fourth Avenue, Suite 400
Portland, OR 97201
Phone: (503) 229-5983
Fax: (503) 229-6924
Internet: http://www.deq.state.or.us

Abstract: This manual contains the field procedures used by the Oregon Department of Environmental Quality (DEQ) for monitoring streams as part of the Regional Environmental Monitoring and Assessment Program. This is a United States Environmental Protection Agency (USEPA) sponsored program.

The purpose of this monitoring is to document the current status, changes, and trends of aquatic natural resources in the Western Cascades, Ecoregions 4a and 4b. The protocols have five main parts:

- Aquatic vertebrate assemblage survey that includes the number, length, and health
- Macroinvertebrate sampling to evaluate biological integrity
- Periphyton assessment
- Habitat quality evaluation
- Chemical water quality measurements

These protocols have evolved from the Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP) protocols of June 1997. DEQ has conducted EPA funded Regional EMAP studies since 1994, including three years in the Coast Range (1994-1996) and two years in the Upper Deschutes River Basin (1997-1998).

Target Application: Management **&** Research

Suitable for Volunteers: No

Monitoring Focus: The current status, changes, and trends of aquatic natural resources in the Western Cascades, Ecoregions 4a and 4b. The protocol focuses on the following:

- Biomonitoring Macroinvertebrates
- Macrohabitat Classification
- Water Chemistry

Geographic Scale: Basin, sub-basin, stream reach, and project site.

Methods: Field **&**Laboratory

Level of Data Quality: Levels 3 **&** 4

Equipment and Tools (*list*): Identified per protocol

Data Forms: http://waterquality.deq.state.or.us/wq/303dlist/DataRptFormat.htm

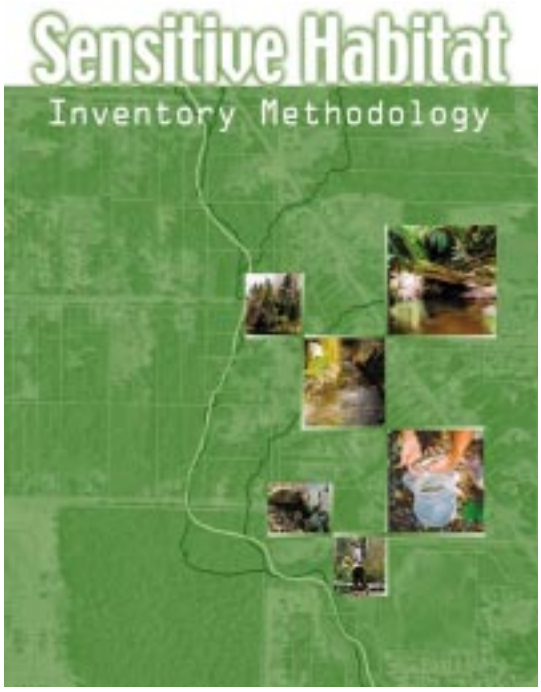
Examples of Filled-in Data Forms: http://waterquality.deq.state.or.us/wq/303dlist/qappexample.htm

Key References: Section 5.7 of the document lists Taxonomic References

Document No.: 13

Sensitive Habitat Inventory and Mapping: Aquatic and Riparian Habitat Mapping

Citation: Mason, B.C. and R. Knight. In preparation Sensitive Habitat Inventory and Mapping: Aquatic and Riparian Habitat Mapping Procedures for Communities in B.C. Module 4 – Crossections and Riparian Areas. Module 8 – Impervious Surfaces BC Ministry of Fisheries and BC Ministry of Environment, Lands and Parks. Victoria, B.C.



Source: Habitat Inventory Coordinator
Information Management Unit
Habitat and Enhancement Branch
Department of Fisheries & Oceans
360 555 West Hastings Street,
Vancouver, B.C. Canada V6B 5G3
Internet: www.shim.bc.ca
Contact: Brad Mason
Phone: (604)-666-7015
Fax: (604)-666-0417
E-mail: masonb@dfo-mpo.gc.ca

Abstract: Methods incorporating TFW monitoring methods for standardized fish, habitat and riparian baseline inventories in urban and rural watersheds. Objective is to identify, inventory, and map all water, fish presence, riparian habitat, sensitive habitats, and important features. Includes field surveying and mapping techniques to allow data to be incorporated into a provincial multi-agency GIS system. Included is a method for measuring imperviousness, used as an indicator of cumulative water resource impacts. Basic GIS skills and equipment (ArcView) are assumed. The methods do not address issues related to evaluating restoration and enhancement potential. These methods are being used in B.C. s interim procdedures while a standard is developed through the Resource Inventory Committee, a multi-discipline, multi-agency committee of inventory specialists.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Required: Yes
Available? Yes,
Where? Being developed
Note: A basic understanding of stream ecology and ecological principles are recommended. For the aquatic and riparian modules recommended by the authors and agencies are: B.C. – based RIC training, certification in Global Positioning Systems use, fish habitat field procedures and data compilation.

Monitoring Focus: Fish, habitat and riparian baseline inventories in urban and rural watersheds. Objective is to identify, inventory, and map all water, fish presence, riparian habitat, sensitive habitats, and other important features. Includes an impervious surface module, methods to monitor gravel composition, gravel scour, and photodocumentation techniques.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

Level of Data Quality: Level 3, potentially Level 4

Equipment and Tools (*list*): Included in each module

Data Forms: No, however, data dictionary is provided in the document.

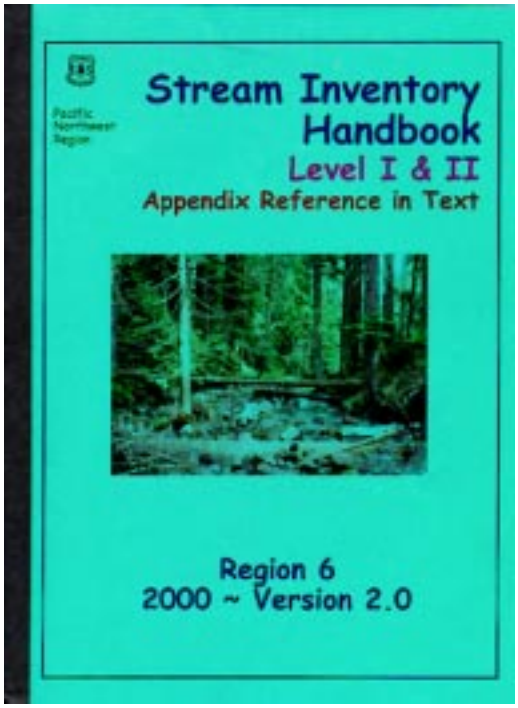
Examples of Filled-in Data Forms: Not provided

Key references: Provided in the document

Document No.: 14

Stream Inventory Handbook: Level I & II

Citation: USDA Forest Service, 2000. Version 2.0. Stream Inventory Handbook: Level I & II. USDA Forest Service, Pacific Northwest Region. Portland. OR. 84 pp.



Source: USDA Forest Service
Pacific Northwest Regional Office
PO Box 3623
Portland, OR 97208
Contact: Deborah Konnoff, Fish Habitat Relationship Coordinator
Phone: (503)-808-2676
Fax: (503)-808-2973
Internet: http://www.fs.fed.us/r1
E-mail: dkonnoff@fs.fed.us

Abstract: The level I and II inventories contain data attributes that were identified by an interagency interdisciplinary team as the most critical for defining steam channel, riparian vegetation, and aquatic resource condition (based on physical characteristics). The protocol seeks to provide a statistically defensible method for evaluating and minimizing the observer bias. Quantitative measures for streamflow; bankfull channel dimensions, bank instability, and substrate are intended to reduce surveyor bias and sampling error. Level I is a prerequisite for Level II, and is intended to familiarize users with the historical use and natural history of the landscape drained by the inventoried stream. Forms are provided for the delineation of preliminary stream reaches and to create a field map, which includes access points for the field inventory.

Level II utilizes field data and supplied forms to gather and catalog information on the stream physical attributes. Additional forms catalog data on fish and amphibians, stream discharge, and streambed substrate in riffles. The stream classification is based on Rosgen.

Regional differences are incorporated to some degree. Two ranges of size characterization of Large Woody Debris are provided for forests east and west of the Cascade Mountains in Washington. The average cost to the Forest Service complete the survey is $1,000 per mile.

The Stream Inventory Handbook is updated annually.

Target Application: Management

Suitable for Volunteers: Yes, if supervised by experienced personnel

Training Required: Yes
Available? No

Monitoring Focus: The protocol identifies core attributes necessary to evaluate the condition of a stream. It contains methods for monitoring stream habitat conditions (flow, water quality, historical land use, valley-channel parameters, streambed substrate, flood-prone dimensions, and riparian habitat dimensions).

Geographic Scale: Basin **&** sub-basin.

Methods: Office **&** Field

Level of Data Quality: Level 3

Equipment and Tools (*list*): See Instream and Water Quality Equipment Lists

Data Forms: Provided

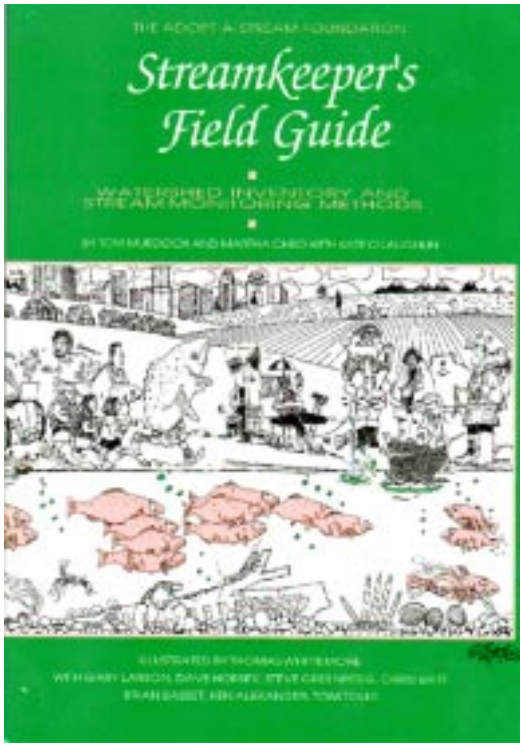
Examples of Filled-in Data Forms: Not provided

Key References: Page 64 of the document

Document No.: 15

Watershed Inventory and Stream Monitoring Methods

Citation: Murdoch, Tom and M. Cheo. 1999. The streamkeeper's field guide: watershed inventory and stream monitoring methods. Adopt a-Stream Foundation. ISBN: 0-9652109-0-1



Source: Adopt-a-Stream Foundation
600 – 128th Street SE
Everett, WA 98208
Phone: (425)-316-8592
Fax: (425)-338-1423
E-mail: aasf@streamkeeper.org
Internet: www.streamkeeper.org
Cost: $29.95 + shipping and handling; discounts of 40% for 25+ copies

Abstract: This volunteer-friendly guidebook provides background information on how streams and their surrounding watersheds function, detailed methods on watershed inventory and stream monitoring for volunteers, tips on presenting data, and stories about Streamkeepers putting watershed inventory and stream monitoring information to use in the protection and restoration of our nation's streams. Includes instructions on constructing equipment: stadia rods and collecting nets among others.

While the target audience is volunteers, this guide is a great overview for resource managers, as well.

Target Application: General

Suitable for Volunteers: Yes

Training Required: No
Available? Yes
Where? Adopt-a-Stream Foundation
600 – 128th Street SE
Everett, WA 98208
Phone: (425)-316-859
Fax: (425)-338-1423
E-mail: aasf@streamkeeper.org

Monitoring Focus: Volunteer monitoring protocols for mapping methods and physical inventories including cross sections, stream bottom, and flow. Stream reach surveys of fish, wildlife, macroinvertebrates, vegetation, canopy, gradient, sinuosity, cross section and stream banks, habitat, human alterations, and land use. Surveys of water quality include pH, dissolved oxygen, temperature, and other chemical parameters.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office & Field & Laboratory

Level of Data Quality: Levels 1 **&** 2, possibly 3

Equipment and Tools (*list*): Appendix D of protocol (Sources); Lists by chapter throughout the document

Data Forms: Appendix C of the document

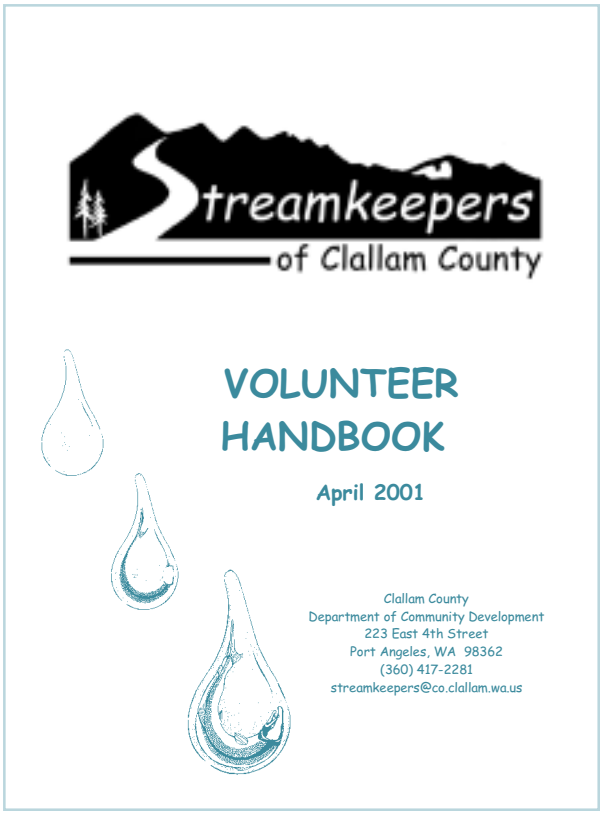
Examples of Filled-in Data Forms: Not provided

Key References: Provided in the document

Document No.: 16

Streamkeepers of Clallam County Volunteer Handbook

Citation: Baccus, J. T., E. A. Chadd. 2000. Clallam County Department of Community Development, Natural Resources Division. Second Edition.



Source: Clallam County Department of Community Development. Natural Resources Division
223 East Fourth Street
Port Angeles, WA 98362
Phone: (360)-417-2281
E-mail: streamkeepers@co.clallam.wa.us
Cost: No Charge

Abstract: Streamkeepers of Clallam County provides a suite of monitoring protocols and a body of trained data collectors to document the baseline, ambient, physical, chemical and biological conditions of surface water streams in Clallam County on a quarterly basis. The program's objective is to provide this data to assist in watershed and restoration planning adaptive management, and citizen involvement**.** The protocols are also applied to tracking the success of stream restoration and enhancement projects initiated by other entities. Several protocols are modified from TFW methods (flow, pools, LWD, and canopy closure). Over 20 additional protocols are performed using simplified methods to reduce the monitoring effort while maintaining meaningful and reliable data.

Protocols include: Reach map, compass use, fish and wildlife signs, flow, gradient, establishing cross section monuments, cross section survey, photos, large woody debris, erosion/revetment survey, pool survey, pebble count, canopy closure (single point), canopy type percentages (reach-wide), conifer stem count, water chemistry, benthic macroinvertebrates, noxious weeds, and grab sampling for bacteria and nitrates.

The program currently has over 50 volunteers monitoring 13 streams on a quarterly basis, plus a number of other special monitoring projects. A volunteer can learn the entire suite of protocols during a 24-hour training, and then perform in the field with a team of three or four in 1 to 3 hours per site depending on the monitoring season.

Target Application: General

Suitable for Volunteers: Yes, with training

Training Required: Yes
Available? Yes
Where? Clallam County Department of Community Development, Streamkeepers Program (address above)

Monitoring Focus: Guidance for volunteer teams monitoring streams and restoration projects in Clallam County tracking habitat, water quality, biota, and project performance over time. Protocols have been adapted from EPA, Timber/Fish/Wildlife, University of Washington Center for Urban Water Resources Management, SalmonWeb, Adopt-A-Stream Foundation, and other sources. Provides detailed guidance in all protocols, including basic field skills and data entry.

Protocols include:

- channel and riparian condition (gradient, cross section, substrate, pools, large woody debris (LWD), canopy closure, canopy type, conifer stems, erosion, revetment)

- water chemistry (temperature, dissolved oxygen, conductivity, pH, nitrate-nitrogen, turbidity)
- flow
- fish and wildlife
- benthic macroinvertebrates
- noxious weeds
- grab sampling for fecal coliform, *E. coli*, and nitrates
- reach establishment, mapping, and cross section monumenting
- photo-point photographs
- riparian condition
- Streamwalk rapid bio-assessment

Geographic Scale: Stream reach, project site

Methods: Office **&** Field **&** Laboratory

Level of Data Quality: Quality assurance and controls procedures are in place. Department of Ecology freshwater monitoring data quality levels 1 to 4 described for each activity.

Equipment and Tools (*list*):
See Equipment Lists by protocol:
Reach Map FP-7; Fish Use FP-17; Flow FP-19; Gradient FP-25; Cross Section Monuments FP-27; Cross Section Survey FP-31; Photos FP 35; Large Woody Debris FP-39; Erosion/Revetment FP-41; Pools FP-43; Pebble Count FP-45; Canopy Closure FP-47; Water Chemistry FP-53; Benthic Macroinvertebrates FP-61; Noxious Weeds FP 67; Bacteria and Nitrates FP-69.

Data Forms: Included for each protocol

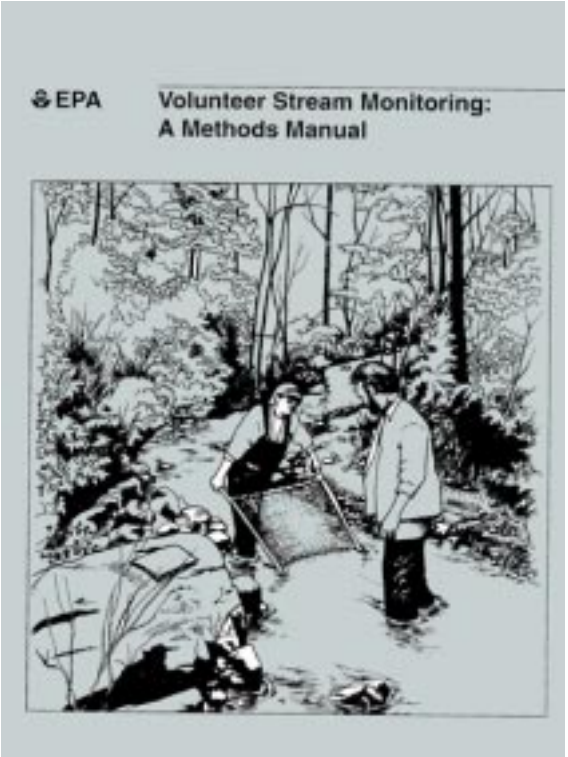
Examples of Filled-in Data Forms: Provided for each protocol

Key References: Appendix E of the document

Document No.: 17

Volunteer Stream Monitoring: A Methods Manual

Citation: Dohner, E. et al. 1997. Volunteer stream monitoring: a methods manual. U.S. Environmental Protection Agency Office of Water. EPA 841-B-97-003. November. 211 pp.



Source: U.S. Environmental Protection Agency
Office of Wetlands, Oceans, and Watersheds
Volunteer Monitoring (4503F)
401 M Street, SW
Washington, DC 20460
Internet: http://www.epa.gov/owow/monitoring/vol.html

Copies can be obtained at:
USEPA Publications
Phone: 1-800-424-4372
or in pdf format at: http://www.epa.gov/owow/monitoring/volunteer/stream/

Abstract: This manual presents methods that have been adapted from those used by successful volunteer monitoring programs throughout the United States, and provides volunteers with an integrated approach to the design and implementation of a stream monitoring program.

A combination of physical, chemical, and biological monitoring methods are presented that are intended to assist in the assessment of land uses in a watershed and their influence on the health of the aquatic system.

Chapters include:

- Elements of a Stream Study: The concept of the stream environment; information on the leading sources of pollution affecting streams in the United States; ten questions to guide the development of an effective stream study; and training, safety, and equipment considerations.
- Watershed Survey Methods: How to conduct a watershed survey or inventory; how to conduct a background investigation of a watershed.
- Macroinvertebrates and Habitat: Three survey methods for monitoring the biology of streams; (1) Streamwalk: a simple method that requires little training or preparation (Level 1 Data Quality); (2) Streamside Biosurvey: a widely-used macroinvertebrate that yields a basic stream rating while monitors are still at the stream (Level 2 Data Quality; and (3) Intensive Streamside Biosurvey : a macroinvertebrate sampling and advanced habitat assessment approach that requires professional and laboratory support by can yield data on comparatively subtle impacts (Level 3 Data Quality).
- Water Quality Conditions: Summarizes techniques for monitoring ten different water quality parameters: dissolved oxygen/biochemical oxygen demand, temperature, pH, turbidity, phosphorus, nitrates, total solids, conductivity, total alkalinity, and fecal bacteria. Stream flow measurement techniques and basic steps for collecting samples are included.
- Managing and Presenting Monitoring Data: Outlines basic principles of data management
- with an emphasis on quality assurance and quality control procedures. Discusses spreadsheets, databases, and mapping software.

Instructions in each chapter walk the user through filling out data forms, defining and identifying habitat characteristics, and creating maps and

sketches of sites.

Target Application: Management

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Required: Yes
Available? No

Monitoring Focus: A comprehensive guide to developing a stream monitoring program. Includes watershed survey methods, macroinvertebrates and their substrate habitat components, water chemistry and temperature, streamflow, physical channel measurements and more.

Geographic Scale: Basin, sub-basin, stream reach, project site?

Methods: Office **&** Field & Laboratory

Level of Data Quality: Levels 1**,** 2, and 3 can be achieved depending on the level of protocols chosen to implement.

Where does the data go? The Environmental Protection Agency does not have the capability to incorporate volunteer data at this time.
Potential data users might include: state, county, or local water quality analysts; the volunteers them selves; fisheries biologists; universities; school teach ers; environmental organizations; parks and recre ation staff; local planning and zoning agencies; state environmental agencies; state and local health departments; soil and water conservation districts; federal agencies.

Equipment and Tools (*list*): Provided in the document; refer to Instream Equipment List

Data Forms: Provided in the document

Examples of Filled-in Data Forms: Not provided

Key References: Provided in the document at the end of each chapter.

Document No.: 18

Sampling Protocol for the Benthic Index of Biotic Integrity (B-IBI)

Citation: Karr, J. R., and W. Chu. 1999. Sampling Protocol for the Benthic Index of Biotic Integrity (B-IBI). Restoring Life in Running Waters: Better Biological Monitoring. Island Press, Washington DC.

Source: Salmonweb
Puget Sound Plaza
1325 4th Ave., Suite 1820
Seattle, WA 98101-2509
Phone: (206)-297-7918
Contact: Cici Kelling, Science Director
Email: cici@cbr.washington.edu
Internet: www.salmonweb.org
Cost: No Charge
Available in pdf format at: http://www.salmonweb.org/index.html

Abstract: The sampling protocol for the benthic index of biotic integrity is a standard method used to obtain a quantitative sample of benthic macroinvertebrates. The collected sample can be used to assess stream condition using a benthic index of biotic integrity (B-IBI). The sampling protocol and an overview of B-IBI analysis are included in these materials. The sampling protocol may be used in wadeable streams, in a riffle representative of the stream reach. A surber sampler is used to take three replicates from a single riffle. The replicates are not composited, but archived separately.

Because the protocol is designed to investigate changes from year to year, sampling occurs once a year. A fall sampling season, from mid-August to mid-October, allows monitors to sample when stream levels are at their lowest and before most salmon runs occur. Salmonweb recommends that samples be sent to professional labora tories for identification.

Indices of biotic integrity may be used for analysis of biological condition. These indices are developed for specific geographic areas and for specific sampling methodologies. An index of biotic integrity (IBI) is a synthesis of diverse biological information that numerically depicts associations between human influence and biological attributes. (Karr, 1998). It is composed of several biological attributes or 'metrics' that are sensitive to changes in biological integrity caused by human activities. The multi-metric (a compilation of metrics) approach compares what is found at a monitoring site to what is expected using a regional baseline condition that reflects little or no human impact (Karr and Chu, 1999).

The benthic index of biotic integrity (B-IBI) has been calibrated for data collected using the sampling protocol from streams lower in elevation than 3,000 feet in northwest Washington. Other indices of biotic integrity are being developed for other regions in the Pacific Northwest.

The sampling protocol for the benthic index of biotic integrity and B-IBI analysis have been used to examine and understand the effects of logging, recreation, point and non-point source pollution, agriculture, and the cumulative effects of many forms of human activity (Karr and Chu 1999, Karr 1998). A rapid decrease in the relative abundance of coho salmon (as compared with cutthroat trout) young of the year was also reflected by a decline in B-IBI when limited fish data from Puget Sound lowland streams was examined (May et al. 1997). B-IBI is used to monitor changes in streams encroached upon by urban development (Fore 1999, Karr and Chu 1999, Karr 1998) and restoration projects (Morley 2000). The sampling protocol and B-IBI are used by Seattle Metro, Seattle Public Utilities, Cities of Bellevue, Issaquah, and Kent; and

Kitsap, Pierce, Snohomish, and Thurston Counties for management and permitting purposes, and are used by academic institutions for research.

Salmonweb trains volunteers in the sampling protocol and assists with B-IBI data scoring and analysis. Rigorously trained citizen volunteers can collect reliable data that are comparable to data collected by professionals (Fore et. al. in press). Volunteers may develop their own monitoring projects or participate in Salmonweb monitoring projects.

Target Application: General **&** Management **&** Research

Suitable for Volunteers: Yes, with training

Training Required: Yes
Available? Yes
Where? Salmonweb workshops; Information available at: www.salmonweb.org

Monitoring Focus: A standard method for benthic macroinvertebrate sampling and analysis to assess the biological condition of streams and monitor changes to biological condition of streams over time. May be used for gathering baseline information.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Field

Level of Data Quality: Levels 3 **&** 4

Equipment and Tools (*list*): Listed on website; Refer to Water Quality Equipment List

Data Forms: Provided in the document

Examples of Filled-in Data Forms: Provided in the document

Key References:

Fore, L.S., J.R. Karr, R.W. Wisseman. 1996. Assessing invertebrate responses to human activities: evaluating alternative approaches. Journal of the North American Benthological Society 15: 212-231.

Fore, L. S. 1999. Measuring the Effects of Urbanization on Bellevue Streams. Final Report to City of Bellevue.

Fore, L. S., K. Paulsen, & K. O'Laughlin. (In press) Assessing the performance of volunteers in monitoring streams. Freshwater Biology.

Karr, J. R. 1998. Rivers as sentinels: using the biology of rivers to guide landscape management. River Ecology and Management: Lessons from the Pacific Coastal Ecosystem (eds. R. J. Naiman and R. E. Bilby), pp. 502-528. Springer, NY.

Karr, J. R. 1999. Defining and measuring river health. Freshwater Biology, 41, 221-234.

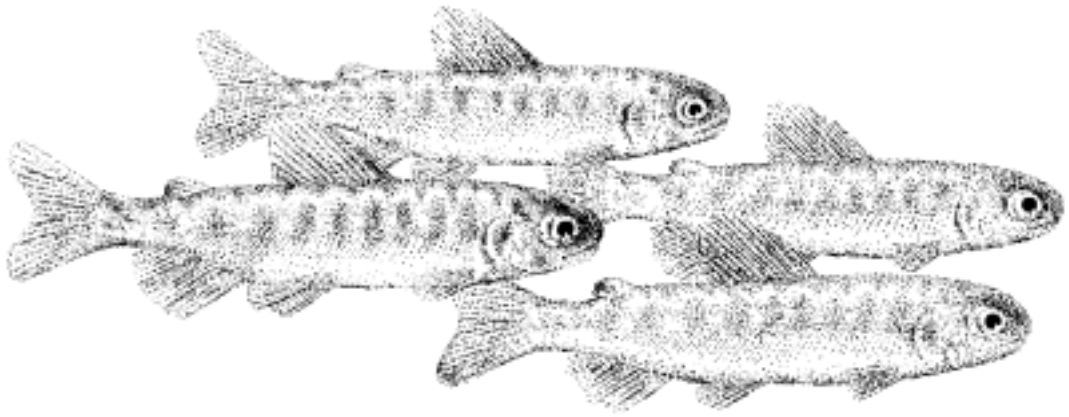
Karr, J. R. and E. W. Chu. 1999. Restoring Life In Running Waters: Better Biological Monitoring. Island Press, Washington, DC.

Karr, J. R. and E. W. Chu. 2000. Sustaining living rivers. Hydrobiologia 422/423: 1-14.

May, C.W., R.R. Horner, J.R. Karr, B.W. Mar & E.B. Welch. 1997. Effects of urbanization on small streams in the Puget Sound lowland ecoregion. Watershed Protection Techniques 2:483-494.

Morley, S.A. 2000. Effects of urbanization on the biological integrity of Puget Sound lowland streams: Restoration with a biological focus, Washington, USA. Thesis, University of Washington, Seattle, WA.

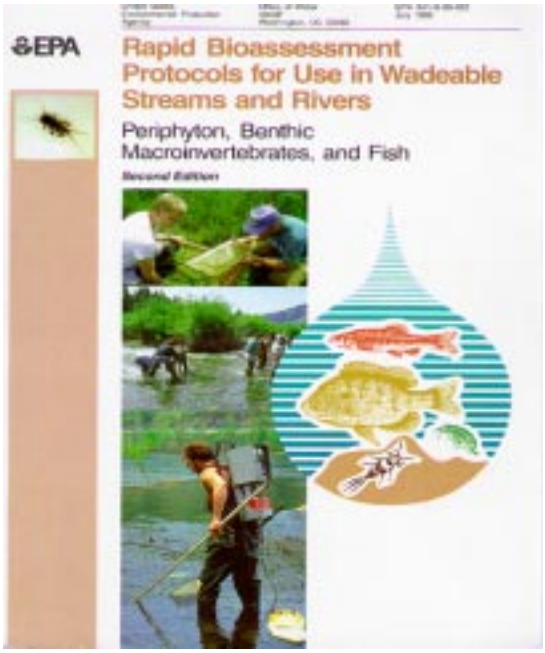
Simon, T. P., editor. 1999. Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities. Boca Raton, FL, CRC Press.



Document No.: 19

Rapid Bioassessment Protocols for use in Streams and Rivers; Periphyton, Benthic Macroinvertebrates and Fish

Citation: Barbour, M.T, J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid bioassessment protocols for use in streams and rivers: periphyton, benthic macroinvertebrates and fish. Second Edition. EPA 841-B-99-002. US Environmental Protection Agency, Office of Water; Washington D.C.



Source: United States Environmental Protection Agency Office of Water
401 M Street, NW
Washington, DC 20460
Project Officer: Chris Faulkner
Internet: http://www.epa.gov/OWOW/monitoring/techmon.html

Abstract: These protocols advocate an integrated assessment, comparing habitat (e.g., physical structure, flow regime), water quality and biological measures with reference conditions (via actual reference sites, historical data, and/or modeling or extrapolation). Each section has information on a range of monitoring parameters, monitoring methods, and different monitoring equipment.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, if supervised by experienced personnel

Training Required: Yes
Available? No

Monitoring Focus: Manual providing detailed methods for biological assessments (algae, fish, and macroinvertebrates) of surface waters to evaluate waterbody condition. The manual incorporates methodologies utilizing the Index of Biotic Integrity (IBI), developed in several states in the eastern and Midwest United States.

This document also includes several protocols for habitat assessment:

- physical stream characteristics,
- large woody debris (LWD)
- riparian vegetation

Note: The physical habitat assessment methods were developed in western states that may not reflect conditions in coastal Washington State, but will have good application in other parts of Washington. The document does not provide identification guidance, but includes extensive information on macroinvertebrate species and tolerances.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office & Field **&** Laboratory

Level of Data Quality: Level 3 **&**4

Equipment and Tools (*list*): Included in the document; see Water Quality equipment list

Data Forms: Appendix A of the document

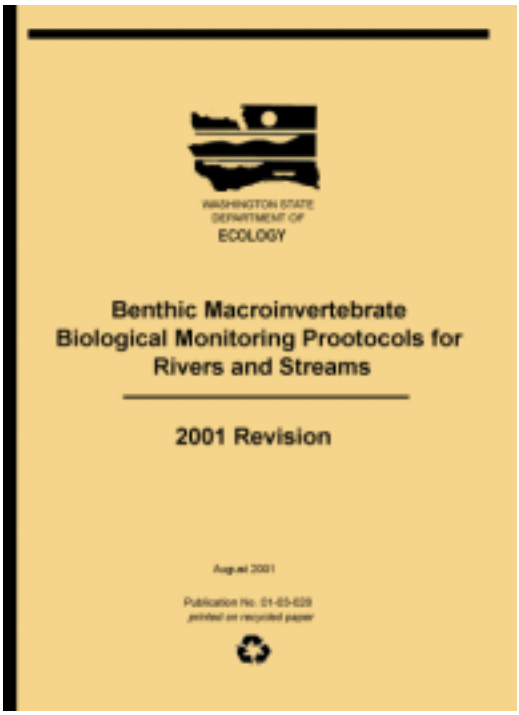
Examples of Filled-in Data Forms: Not provided

Key References: Extensive taxonomic references for fish, periphyton, and macroinvertebrates are included in each chapter of the manual. Also see: Chapter 11: pp. 11- 1 to 11- 22.

Document No.: 20

Benthic Macroinvertebrate Biological Monitoring Protocols for Rivers and Streams

Citation: Plotnikoff, R.W., and C. Wiseman. 2001. Benthic Macroinvertebrate Biological Monitoring Protocols for Rivers and Streams. Publication No. 01-03-028. Environmental Investigations and Laboratory Services Washington State Department of Ecology. Olympia, WA. 27 pp.



Source: Department of Ecology Publications
P.O. Box 47600
Olympia, WA 98504-7600
Phone: (360)-407-7472
Internet: http://www.ecy.wa.gov/pubs.shtm
URL: http://www.ecy.wa.gov/biblio/94113.html

Abstract: This document describes the Washington State Department of Ecology's Freshwater Ambient Biological Assessment Program. Outline within the document is:
1) the sampling design;
2) the site selection process;
3) field implementation;
4) laboratory processing of data, and
5) analysis and interpretation of data.

The document also includes all of the elements necessary to serve as a Quality Assurance Project Plan (QAPP) for biological monitoring. Field preparations remain consistent with previous work (Plotnikoff 1992; 1994; 1998. 1999, Plotnikoff and Ehinger 1997). Relative to the original protocols document (Plotnikoff 1994), this revision provides additional detail for field operations, sub-sampling procedures, and data analysis procedures.

Also see protocols: 57, 61, and 87

Target Application: Research

Suitable for Volunteers: Yes if supervised by experienced personnel

Training Required: Yes
Available: Yes
Where: The Xerces Society
4828 SE Hawthorne Blvd
Portland OR 97215-3252
Phone: (503) 232-6639
Fax: (503) 233-6794
General E-mail: xerces@teleport.com
Internet: http://www.xerces.org/people.htm

Monitoring Focus: In-depth technical reference on methods for "cost-effective" biological assessments (algae, macroinvertebrates and fish) of surface waters to evaluate waterbody condition. Protocols for habitat assessment including physical stream characteristics, LWD, riparian vegetation, and others. Extensive information on macroinvertebrate species and tolerances.

Geographic Scale: Basin, sub-basin, stream reach, project site.

Methods: Field **&** Laboratory

Level of Data Quality: Level 3 **&** 4

Equipment and Tools (*list*): Appendix A

Data Forms: Appendix A

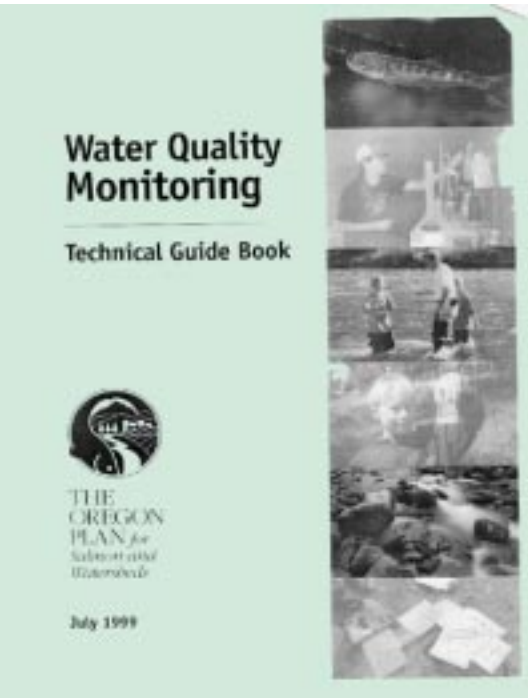
Examples of Filled-in Data Forms: Not provided

Key References: Pages 30-34 of the document

Document No.: 21

Water Quality Monitoring: Technical Guide Book

Citation: Oregon Plan for Salmon and Watersheds. 1999. Water Quality Monitoring Technical Guide Book.



Source: Oregon Plan Monitoring Team
Oregon Department of Fisheries
Contact: Liz Dent
Phone: (503)-945-7493
Fax: (503)-945-7490
E-mail: liz.f.dent@state.or.us
Internet: http://www.oregon-plan.org/status.html#wqguide
Cost: No Charge

Abstract: As a component of the Oregon Plan for Salmon and Watersheds and the Oregon Watershed Assessment Manual, the Guidebook provides a standardized set of water quality monitoring methods for use by the public in determining the status and trends of aquatic habitat and species. The first few chapters provide background information, monitoring strategies, and ways to develop a monitoring plan including criteria for selecting monitoring sites, data quality guidelines, and methods to store and analyze water quality data. References and Oregon State contacts are provided in each chapter to obtain more detailed information. The subsequent chapters provide protocols designed to be stand-alone documents on basic monitoring techniques for each:

- stream temperature
- dissolved oxygen
- pH, conductivity
- nitrogen/phosphorus concentration
- turbidity
- stream macroinvertebrates
- pesticides and toxic chemicals
- road sediment
- sediment deposition

Information on additional references is included in each chapter, as well as estimated time and labor requirements per technique, equipment lists and specifications, detailed instructions on using equipment for sampling and analysis, and equipment costs based on 1997 prices.

Two appendices provide detailed techniques for evaluating road-related erosion and hazards to aquatic systems (Appendix D of Guidebook: Road Hazard Inventory) and for assessing sediment deposition in streams (Appendix E of Guidebook: Sediment Deposition).

Target Application: General **&** Management **&** Research

Suitable for Volunteers: Yes

Training Required: No

Monitoring Focus: Guidance for the standard and consistent collection of field-based data on a range of water quality parameters. Chapters include detailed discussion of monitoring strategies and ways to develop a monitoring plan. Also explained are criteria for selecting monitoring sites, data quality guidelines, and methods to store and analyze water quality data.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field **&** Laboratory

Level of Data Quality: Levels 2, 3 **&** 4

Note: Oregon has a different Data Quality objective rating: Levels A-C. Level A is the highest, and can be used to assess compliance with water quality standards, permitting requirements and other regulatory activities. Level B is the next highest, is easier and less expensive, and can be used as an early warning of potential problems or as a screening tool.
Level C is the lowest, and is the easiest to collect, but because of its low accuracy and precision, Level C data is best used for educational purposes.

Equipment and Tools (*list*): Provided in each chapter of the document; see Water Quality Equipment List

Data Forms: Provided in document; also available from the internet at:
http://waterquality.deq.state.or.us/wq/303dlist/DataRptFormat.htm

Examples of Filled-in Data Forms: Provided in the document; also available from the internet at:
http://waterquality.deq.state.or.us/wq/303dlist/qappexample.htm

Key References: Included in each chapter of the document

Document No.: 22

A citizen's guide to stream monitoring and restoration

Citation: Washington Department of Fish and Wildlife and the University of Washington. 1996. Nature Mapping for fish and streams: A citizen's guide to stream monitoring and restoration.

Source: University of Washington
School of Aquatic and Fishery Sciences
Box 355020
Seattle, WA 98195
Contact: Karen M. Dvornich
Phone: (206)-616-2031
E-mail: kgap@fish.washington.edu
Internet: http://www.fish.washington.edu/naturemapping/index.html

Abstract: The Washington Department of Fish and Wildlife (WDFW) in partnership with the Washington Cooperative Fish and Wildlife Research Unit Gap Analysis Project at the University of Washington, initiated a pilot project in September, 1993. Teachers were asked to collect "real" wildlife data for a statewide biological database. The pilot has grown from 23 teachers to over 200 in two years! The Oregon Biodiversity Project used this model to begin a similar program in 1995. The *Nature Mapping* Program's vision is to create a national network that links natural resource agencies, academia and land planners with local communities primarily through schools. The program's goal is to keep common animals common and to maintain our quality of life. The approach is to train individuals to become aware of their natural resources and to provide the tools to inventory and monitor their resources. For a full description of the program, visit the Nature Mapping web site at the above address.

Target Application: General **&** Management

Suitable for Volunteers: Yes

Training Required: Yes

Available? Information about future training workshops can be obtained from Nature Mapping web site at: www.fish.washington.edu/naturemapping or contact Karen Dvornich University of Washington at: (206) 616-2031.

There are two levels of workshops available:
1) Wildlife and Habitat Data Collection,
2) What To Do With Your Data

Where? Monthly throughout the state

Monitoring Focus: To acquire broad data sets to map biodiversity including wildlife, fish, and Water Quality data including:

1) stream discharge; 2) water chemistry; 3) general vegetation; 4) biomonitoring - fish community, and 5) macrohabitat classification.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Field

Level of Data Quality: Level 1 **&** 2

Equipment and Tools (*list*): Provided

Data Forms: Available online at the Nature Mapping web site at: http://www.fish.washington.edu/naturemapping/joindata.html

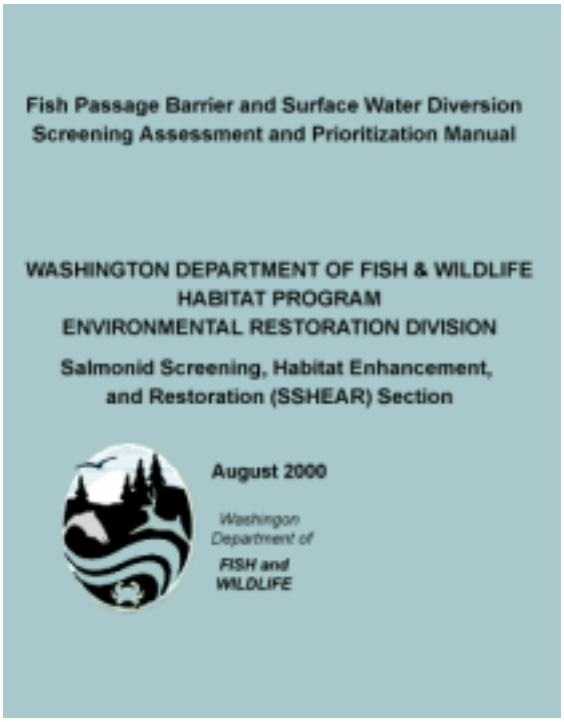
Examples of Filled-in Data Forms: Provided is an example of Orchard Prairie Nature Mapping School Project and a preliminary Report at: http://www.lsw.org/op/

Recommended References: There are links available to the Field Guides, General References, and curriculum sources from the Nature Mapping web site: http://www.fish.washington.edu/naturemapping/edresorc.html

Document No.: 23

Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual

Citation: Washington Department of Fish and Wildlife Habitat Program, Environmental Restoration Division, Salmonid Screening, Habitat Enhancement, and Restoration (SSHEAR) Section. August 2000, 81pp.



Source: Washington Department of Fish and Wildlife
Habitat Program
Environmental Restoration Division
SSHEAR Section
600 Capitol Way North
Olympia, WA 98501-1091
Contact: Mike Barber
Phone: (360)-902-2555
Fax: (360)-902-2946
E-mail: BARBEMRB@dfw.wa.gov
Internet: http://www.wa.gov/wdfw/hab/engineer/fishbarr.htm
Cost: No Charge

Abstract: A manual providing guidance and methods for the inventory and evaluation of potential fish passage barriers and surface water diversions. Methodologies are also provided to estimate the potential habitat gain above the barrier, allowing prioritization of restoration projects. Different levels of effort are described for varying inventory goals: locating culverts, dams, and fishways, determining barrier status of the structure, and prioritizing restoration habitat projects. The data is uploaded into the Washington Department of Fish and Wildlife SSHEAR Fish Passage and Water Diversion databases.

Target Application: General **&** Management

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Required: Yes
Available? Yes
Where? WDFW at the above address.

Monitoring Focus: This manual contains protocols for evaluating fish passage at culverts, dams, and fishways, evaluating water diversions for fish screens. It also describes the methodologies for conducting habitat assessments and prioritizing fish passage barriers and water diversions for correction.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

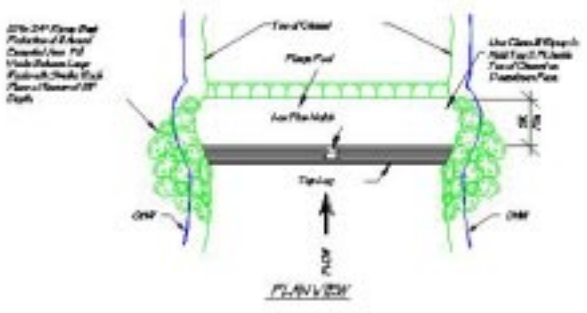
Level of Data Quality: Levels 2 **&** 3

Equipment and Tools (*list*): Included in the Manual; See also the Instream Equipment List

Data Forms: Appendix A of the document

Examples of Filled-in Data Forms: Not provided

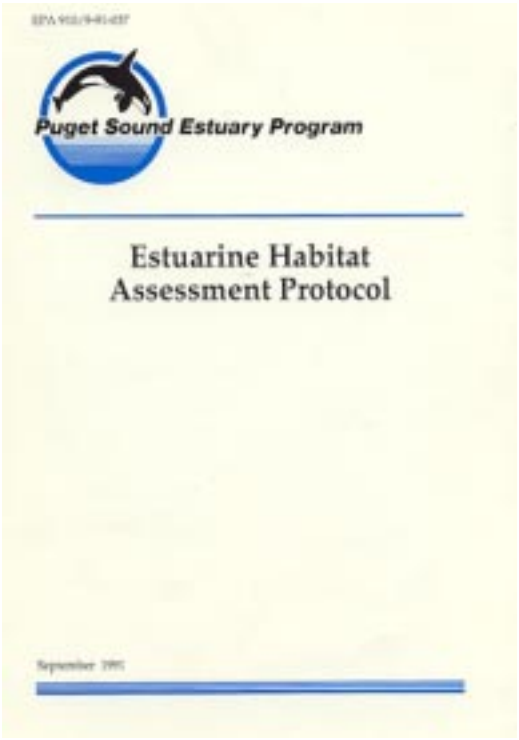
Recommended References: Provided in the document



Document No.: 24

Estuarine Habitat Assessment Protocol

Citation: Simenstad, C.A., C.D. Tanner, and R.M. Thom, and L. Conquest. 1991. Estuarine habitat assessment protocol. UW-FRI-8918/-8919, Report to United States Environmental Protection Agency, Region 10, Wetland Ecosystem Team, Fish. Res. Inst., University of Washington, Seattle, WA. Report. 191 pp., Appendices. EPA 910/9-91-037



Source: US EPA Region 10
1200 6th Avenue
Seattle, WA 98101
Phone: (206)-553-1200
Toll free: 1-800-424-4372
Internet: http://www.epa.gov/r10earth/

Abstract: The goal of the protocol is to initiate systematic, on-site measurement of estuarine wetland and nearshore habitat function for fish and wildlife utilization *by assessing the attributes of the habitats identified as being functionally important to fish and wildlife*. The protocol applies only to the functional assessment of fish and wildlife support in estuarine wetlands and certain adjacent habitats of the Puget Sound trough. The protocol can be used to monitor the comparative performance of the site after restoration or of a mitigation site.

The protocol is organized to answer questions from three perspectives: Habitat type, fish and wildlife assemblage species, and attribute. The habitat definitions, representative fish and wildlife species of each habitat and important habitat attributes are cross-referenced. The manual provides guidance on study design and recommends appropriate sampling methods. Extensive appendices list 1) habitat-specific assemblage of species, 2) habitat-specific attributes and associated habitat functions, and 3) physiochemical attributes identified as important to fish and wildlife utilization of estuarine habitats.

Target Application: Research

Suitable for Volunteers: Yes, with training or if supervised by experienced personnel.

Monitoring Focus:

- *Habitat classification:* Emergent Marsh, mudflat, sandflat, gravel/cobble, eelgrass, water column, subtidal soft bottom, and subtidal hard substrate.
- *Habitat Function:* Reproduction, feeding, refuge and physiological adaptation.
- *Physical:* Substrate, tidal elevation, light, sound, bathymetric features, vertical relief, horizontal edges, water movement.
- *Chemical:* Salinity, temperature, turbidity, water quality, sediment quality, nutrient inputs from natural freshwater and terrestrial sources.
- *Biological:* Benthic microbiota, benthic macroalgae, rooted vascular plants, demersal adhesive eggs, surface epifauna, sedentary infauna, active infauna, epibenthic plankton, pelagic zooplankton, neusonic and drift invertebrates, sedentary and motile fish, birds, mammals.

Minimum, recommended and preferred monitoring parameters are listed for different species or habitats. Minimums generally include presence or absence, percent cover, and density.

Geographic Scale: Basin, sub-basin, stream reach, project site (estuary or nearshore habitats).

Methods: Field **&** Laboratory

Level of Data Quality: Level 3 **&** 4

Equipment and Tools (*list*): Sixteen (16) sampling designs are given, each with equipment and lab items.

Data Forms: Not provided

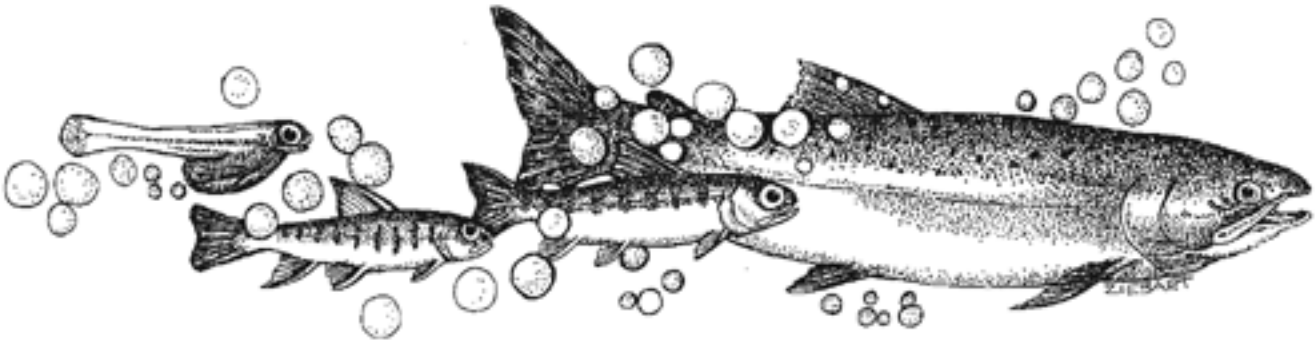
Examples of Filled-in Data Forms: Not provided

Key References: Pages 123-134 of the document

Recommended Reading:

A Field Guide for Characterizing Habitats using A Marine and Estuarine Habitat Classification System for Washington State* (*Associated publication)

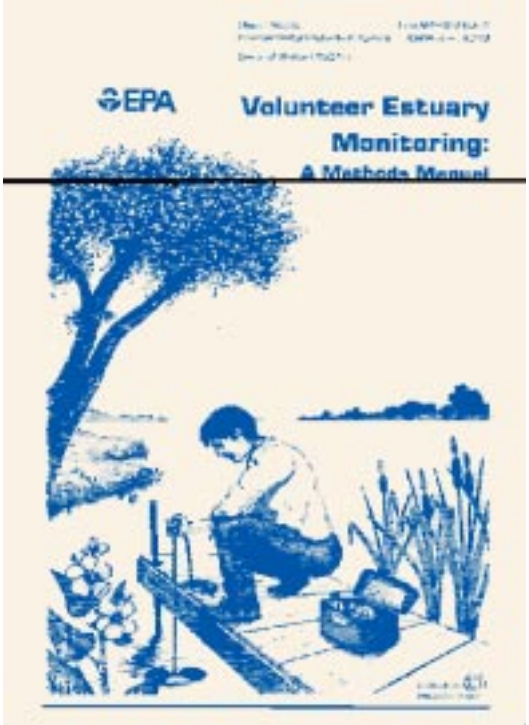
Bailey, A., K. Ward, T. Manning. 1993. Washington DNR, Division of Aquatic Lands. April. 10 pp.



Document No.: 25

Volunteer Estuary Monitoring: A Methods Manual

Citation: Fisher, Nina A. 1993. United States Protection Agency, Office of Water. EPA 842 B-93-004. December. 176 pp.



Source: US Environmental Protection Agency
Office of Water
Office of Wetlands,
Oceans, and Watersheds
Oceans and Coastal Protection Division
401 M Street SW
Washington, DC 20460
Internet: http://www.epa.gov/owow/estuaries/monitor
Copies can be obtained at:
USEPA Publications
Phone: 1-800-424-4372

Abstract: The manual's focus is the identification of those water quality parameters most important in determining an estuary's water quality. The significance of each parameter to estuarine health and specific methods for monitoring are detailed in step-by-step fashion. The manual stresses proper quality assurance and quality control techniques to ensure that the data are useful to state agencies and other data users.

The manual summarizes the process of planning and managing a volunteer monitoring program followed by a discussion of problems facing estuaries. Fundamental estuarine water quality parameters are used to describe the status of an estuary: dissolved oxygen, nutrients and phytoplankton, submerged aquatic vegetation, and bacteria. Additional estuarine conditions discussed include marine debris and the collection of shellfish for analysis of paralytic shellfish poisoning and toxicant contamination.

The chapters are presented with descriptions of the monitoring parameter and its importance and impact, sampling considerations, a task list on how to conduct the each monitoring protocol, and references.

Target Application: General

Suitable for Volunteers: Yes

Training Required: No
Available? No

Monitoring Focus: This methods manual provides a range of volunteer-oriented monitoring protocols for the identification of water quality parameters important for determining estuarine condition including water chemistry, phytoplankton, and submerged aquatic vegetation. Also discusses monitoring marine debris, and shellfish toxins.

Geographic Scale: Estuary and project site

Methods: Office & Field **&** Laboratory

Level of Data Quality: Levels 1, 2, and 3, depending on the level of protocols chosen to implement.

Equipment and Tools (*list*): Included in each chapter; Refer to Estuarine Equipment List

Data Forms: Provided are several sample data sheets for format and design

Examples of Filled-in Data Forms: Not provided

Key References: Provided in the document

Document No.: 26

Monitoring the Vegetation Resources in Riparian Areas

Citation: Winward, A. H. 2000. Monitoring the vegetation resources in riparian areas. Gen. Tech. Rep. RMRS-GTR-47. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 49 pp.

Source: Rocky Mountain Research Station
Publications Distribution
240 West Prospect Road
Fort Collins, CO 80526
Phone: (970)-498-1392
FAX: (970)-498-1396
Internet: http://www.fs.fed.us/rm
or:
Department of the Interior
Bureau of Land Management
NARCS, RS-130
PO Box 25047
Denver, CO 80225-0047
Phone: (303)-236-0162
FAX: (303)-236-3508
E-mail: dprichard@blm.gov

Abstract: This document provides information on three sampling procedures used to inventory and monitor the condition of vegetation resources in riparian areas to provide an evaluation of the health of all the vegetation in a given riparian area. These include: 1) the vegetation cross-section method designed to evaluate the health of vegetation across the valley floor; 2) the greenline method designed to provide a measurement of the stream side vegetation; 3) and the woody species regeneration method designed to measure the density and age class structure of any shrub or tree species that may be present in the sampling area.

Data analysis procedures designed to rate thestatus of an area have been included. This protocol further provides a terminology (glossary) section, excellent photographs and figures to aid with determination of scientific and monitoring parameters, and several appendices.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, if supervised by experienced personnel

Training Required: No

Monitoring Focus: The procedures outlined within this document are specifically intended to be used as follow-up methods to the USDA Riparian Proper Functioning (PFC) Assessment (1998) when more quantitative information is desired. Sampling focuses on riparian community composition, greenline* community composition and bank stability, and woody vegetation regeneration. Emphasis is placed within the USDA Forest Service Intermountain Region*.

*The Intermountain Region includes eastern Oregon and Washington, Idaho, Montana, south to Colorado between the Rocky Mountains and Cascade Mountains.

Geographic Scale: May be applied at all scales, however, this protocol may be best suited for small scale analysis such as stream reach or project site.

Methods: Field

Level of Data Quality: Level 3

Equipment and Tools (*list*): Provided in the document

Data Forms: Provided in the document

Examples of Filled-in Data Forms: Not provided

Recommended References:

Assessing Conditions of Riparian-Wetland Corridors at the Area-wide Level: Using Proper Function Condition (PFC) methodology – an interdisciplinary assessment tool. USDA Natural Resources Conservation Service, September 1999.

Stream Corridor Inventory and Assessment Techniques: a guide to site, project and landscape approaches suitable for local conservation programs. USDA Natural Resources Conservation Service, September 1999

http://www.geology.washington.edu/~nrcs-ws

Document No.: 27

Oregon Watershed Assessment Manual: Component II Historical Conditions Assessment

Citation: Watershed Professionals Network. 1999. Oregon Watershed Assessment Manual Component II Historical Conditions Assessment. June 1999. Prepared for the Governor's Watershed Enhancement Board. Salem, Oregon.

Source: Oregon Watershed Enhancement Board
775 Summer Street NE, Suite 360
Salem, OR 97301-1290
Phone: (503)-986-0178
Internet: http://www.watershednet.com/oweb.htm
(may be downloaded as a pdf file)
Cost: Hard copy of entire manual: Send $45.00 fee to Leilani Jennings at the address above.

Abstract: The intent of the protocol is to provide clues that can be used to develop an understanding of the condition of key watershed resources before settlement by Europeans. The protocol guides users to develop a set of critical questions regarding the characteristics of a watershed's resources at the time of European settlement, the historic trends and locations of land use, the historical accounts of fish populations and distributions, and the location and extent of historic modifications of the aquatic and riparian resources.

The final product is a concise report of the watershed's historical conditions that includes seven components:

1. A descriptive historical narrative
2. Historical conditions time line
3. Historical information referenced by stream and subwatershed location
4. Historical Channel and Riparian Modification Inventory and Map
5. A summary of historical information and trends, and conclusions on impacts on aquatic and riparian resources
6. A comprehensive listing of the sources of information
7. A Confidence Evaluation

A suggested outline is provided and forms are provided for tasks 4 and 7.

Target Application: General **&** Management

Suitable for Volunteers: Yes

Training Required: No

Note: The minimum necessary skills identified in the protocol include: (1) the ability and desire to search for and compile information from a variety of information sources and individuals, (2) the ability to summarize information in a report format. The ability to use aerial photographs will help protocol users to accomplish the assessment, but isn't required by the authors.

Monitoring Focus: This Assessment provides guidance to collect and develop a report on the collection of historical materials related to:

- Landscape condition
- Aquatic\riparian habitat
- Fish populations
- Water quality

Issues to be explored through investigation of historical information include:

- Settlement patterns
- Direct impacts to the stream channels including channel modification
- Natural and human-caused disturbance
- Riparian vegetation patterns and change

- Natural and human-caused disturbance such as floods and fire
- Fish presence and distribution

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office

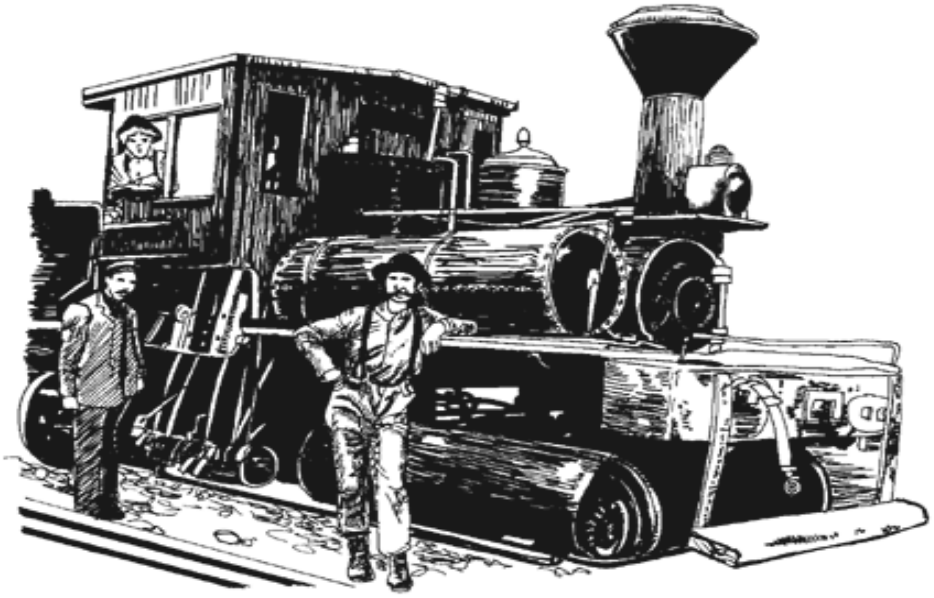
Level of Data Quality: Level 2

Equipment and Tools (*list*): Provided in the document; see Upland Equipment List

Data Forms: Included in the document

Examples of Filled-in Data Forms: Not provided

Key References: Page 11-8 of the document

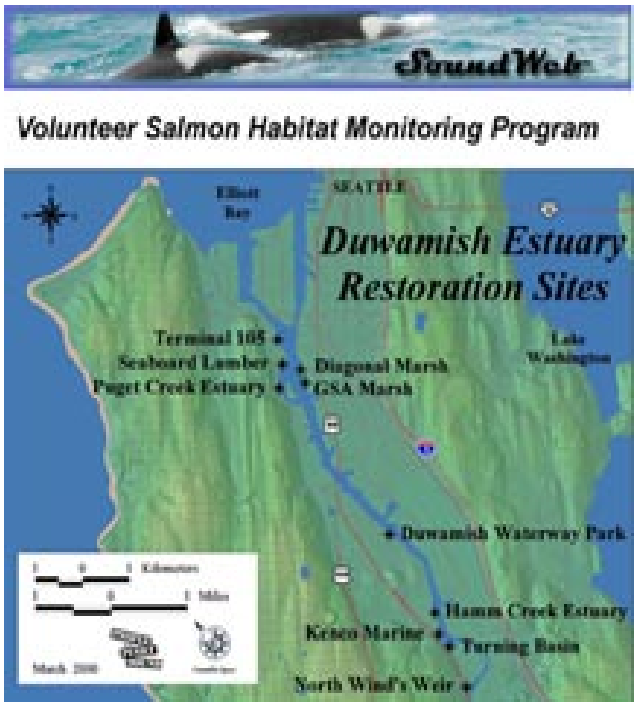


Document No.: 28

Volunteer Salmon Habitat Monitoring Program

Citation: People For Puget Sound. Volunteer Salmon Habitat Monitoring Program. DRAFT. June 2001.

Source: People for Puget Sound
1402 Third Avenue Suite 1200
Seattle, WA 98101
Phone: (206) 382-7007
Internet: www.pugetsound.org



Abstract: People for Puget Sound recruits volunteer stewards to restore salmon rearing habitat in Seattle's industrial Duwamish Waterway. The goal of the Volunteer Salmon Habitat Restoration and Monitoring Program is to involve citizens in assuring the long-term success of estuarine restoration projects. People for Puget Sound works with partners and volunteers to restore salmon rearing habitat in estuaries around Puget Sound. From planting to monitoring to stewardship, the goal of the Volunteer Salmon Habitat Restoration and Monitoring Program is to assure the long-term success of estuarine restoration projects. Puget Sound chinook salmon were placed on the endangered species list in 1999, and estuary habitats - especially salt marshes - are crucial for the survival of chinook and other Puget Sound salmon. For the past six years, People for Puget Sound have cooperated with agencies, tribes and other organizations to restore salt marsh habitat in Seattle's industrialized Duwamish estuary and other locations around the Sound.

Currently, People for Puget Sound directly manages all volunteers implementing this protocol and handles all data that is generated. As this program is expanded into additional areas around Puget Sound, building partnerships with local organization will be an effective means of managing volunteers and insuring that data is efficiently processed, analyzed, and utilized.

Data is collected at various times throughout the year, depending upon the type of data being collected

Target Application: General

Suitable for Volunteers: Yes, with training

Training Required: Yes
Available? Yes
Where? People for Puget Sound
Internet: www.pugetsound.org

Monitoring Focus: Monitoring estuarine vegetation and vegetation restoration project success

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Field

Level of Data Quality: Level 2

Equipment and Tools (*list*): Provided in the document and the web

Data Forms: Appendix B of the document and available on the web

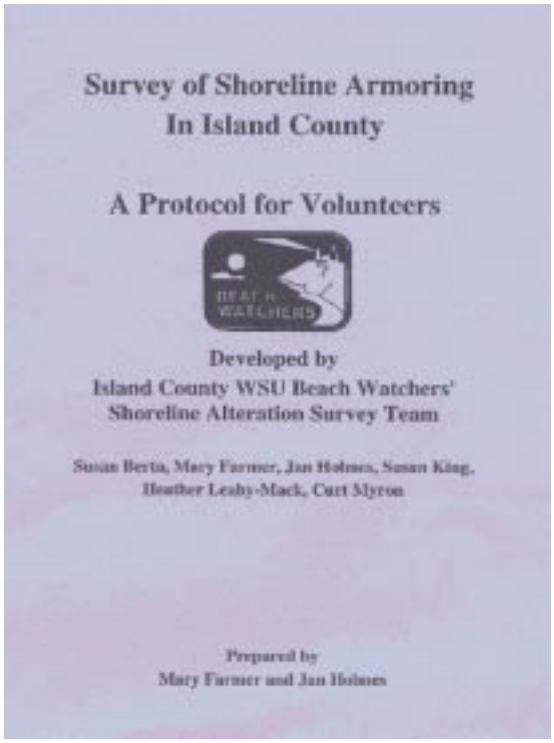
Examples of Filled-in Data Forms: Not provided

Recommended References: Not provided

Document No.: 29

Survey of Shoreline Armoring in Is land County: A Protocol for Volunteers

Citation: Berta, S., M. Farmer, J. Holmes, S. King, H. Leahy-Mack, C. Myron. 1999. Survey of shoreline armoring in Island County. Developed by Island County WSU Beach Watchers' Shoreline Alteration Survey Team. 30 pp. + appendices.



Source: Puget Sound Water Quality Action Team
Washington Department of Natural Re sources Division of Aquatic Resources
PO Box 47027
Olympia, 98504-7027
Contact: Thomas Mumford
Phone: (360)-902-1079
Email: mumford.tom@wadnr.gov
Internet (request a copy from staff): http://www.wa.gov/dnr/htdocs/aqr/nshr/contacts.html

Abstract: This report documents an inventory project developed in response to a growing concern about the impact of shoreline armoring in Puget Sound. The project was initiated by the Puget Sound Water Quality Action Team, and designed and implemented by a number of groups in the Puget Sound region. The methods measured amount of hardening in selected areas. The report describes survey methods, volunteer training, materials used for data collection and analysis, data collection forms, database design, and an analysis of the data gathered by the group of Island County and Washington State University Beachwalkers during the survey of Whidbey Island in 1999.

The authors note that the protocol lends itself to creating future inventories of significant nearshore parameters including substrate suitable for forage egg deposit, eel grass beds, and other parameters of interest.

Target Application: General **&** Management

Suitable for Volunteers: Yes, with training

Training Required: Yes
Available? Yes
Where? Adopt-a-Beach and People for Puget Sound

Monitoring Focus: The survey protocol provides a method to quantify the extent of man-made shoreline armoring structures including bulkheads, seawalls, docks, jetties, and groins:

- Location
- Type of structure
- Composition of structure
- Condition of structure

Length of structure. The locations of shoreline structures are documented with Geographic Positioning System equipment.

Geographic Scale: Shoreline reaches

Methods: Field

Level of Data Quality: Not applicable

Equipment and Tools (*list*): Included in protocol; See Estuary Equipment List

Data Forms: Included in the document

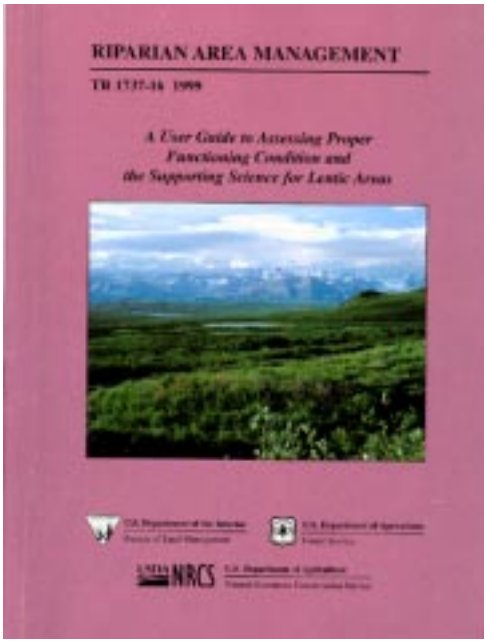
Examples of Filled-in Data Forms: Not provided

Key References: Not provided

Document No.: 30

A User Guide to Assessing Proper Functioning Conditions and the Supporting Science for Lentic Areas.

Citation: Prichard, D., et al. 1999. Riparian Area Management. U.S. Department of the Interior Bureau of Land Management. Technical Reference 1737-16. 109 pp.



Source: Bureau of Land Management
National Business Center.
BC-65-0B. P.P. Box 25047.
Denver, Colorado 80225-0047.

Abstract: The following publication provides guidance for assessing the physical functioning conditions of riparian-wetland areas. This assessment, referred as Properly Functioning Conditions assessments (PFC), is based on a consistent analysis of physical attributes and key physical processes pertinent to riparian-wetland areas, such as vegetation, hydrology, and erosion processes. The assessment of the PFC is qualitative, based on a checklist of attributes and processes defined for riparian wetlands. This checklist synthesizes information that is basic for determining a riparian-wetland area's health. Additionally, quantitative techniques are used in conjunction with the checklist, and especially when experience is limited.

Following the analysis of the checklist, the Interdisciplinary (ID) team makes the determination of the conditions and trends of a given riparian-wetland area. The process of assessing the PFC includes collection and analysis of existing documents: historical documents, aerial photographs, riparian-wetland vegetation classification, and other surveys relating to the attributes being analyzed. This method is at the minimum level of assessment for riparian wetlands. It may also be a useful starting point in determining and prioritizing the type and location of quantitative inventory or monitoring.

Note: This document should be used in conjunction with protocols contained in Document No. 96.

Target Application: Management

Suitable for Volunteers: No

Training Recommended: Yes
Available? Not specified

Monitoring Focus:

- A qualitative assessment of properly functioning conditions and apparent trends of riparian-wetland areas considering applicable attributes and processes.
- Current conditions are examined using existing data and field observations.
- Used as a tool for prioritizing inventory needs or restoration activities.

Geographic Scale: Project site, but can be used in watershed analysis if ratings are aggregated.

Methods: Office **&** Field

Level of Data Quality: Level 2

Where does the data go? U.S. Department of the Interior - Bureau of Land Management; U.S. Department of Agriculture - Forest Service and Natural Resources Conservation Service.

Equipment and Tools (*list*): Not applicable

Data Forms: Appendix A of the document

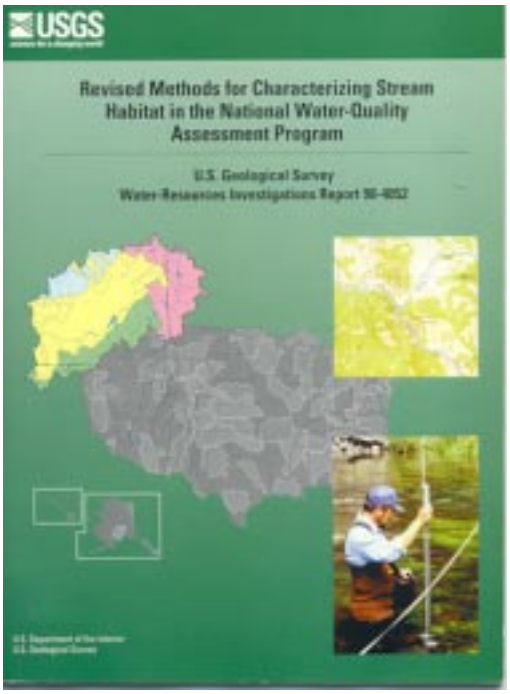
Examples of Filled-in Data Forms: Appendix B of the document

Key References: Page 103 of the document

Document No.: 31

Revised Methods for Characterizing Stream Habitat in the National Water Quality Assessment Program

Citation: Fitzpatrick, F. A., J. R. Waite, P. J. D'Arconte, M. R. Meador, M. A. Maupin, and M. E. Gurtz. 1998. Revised Methods for Characterizing Stream Habitat in the National Water Quality Assessment Program. U.S. Geological Survey Water Resources Investigations Report 98-4052. Raleigh, North Carolina.



Source: Copies can be purchased from:
U.S. Geological Survey Branch of Information Services
Box 25286, Federal Center
Denver, CO, 80225-0286

Abstract: Stream habitat is characterized in the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program as part of an integrated physical, chemical, and biological assessment of the Nation's water quality. The goal of stream habitat characterization is to relate habitat to other physical, chemical, and biological factors that describe water quality conditions. To accomplish this goal, environmental settings are described at sites selected for water-quality assessment. In addition, spatial and temporal patterns in habitat are examined at local, regional, and national scales.

This habitat protocol contains updated methods for evaluating habitat in NAWQA Study Units. Revisions are based on lessons learned after 6 years of applying the original NAWQA habitat protocol to NAWQA Study Unit ecological surveys. Similar to the original protocol, these revised methods for evaluating stream habitat are based on a spatially hierarchical framework that incorporates habitat data basin, segment, reach, and microhabitat scales. This framework provides a basis for national consistency in collection techniques while allowing flexibility in habitat assessment within individual Study Units.

Procedures are described for collecting habitat data basin and segment scale; these procedures include use of geographic information system database, topographic maps, and aerial photographs. Data collected at the reach scale include channel, bank, and riparian characteristics. Collected data include major natural and human factors (i.e., ecoregion, land use, stream size, hydrology, and geology) that are thought to control water quality. Habitat characteristics from each scale that are needed for NAWQA national data aggregation are distinguished from optional characteristics that might be important for specific study units. This protocol describes both qualitative and quantitative techniques for assessing habitat quality.

Target Application: Management

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Recommended: Yes
Available? No

Monitoring Focus: This document assesses the status and trends of riparian habitat quality focusing on:

- Bank and shoreline cover;
- Cover composition and abundance;
- Bank stability;
- General freshwater vegetation;
- Freshwater macrohabitat classification;
- Substrate (pebble count);
- Bank shape;

- Stream morphology;
- Stream discharge;
- Gravel embededness.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

Level of Data Quality: Level 2 **&** 3

Equipment and Tools (*list*): Page 47 of the document

Data Forms: Provided at the end of the document

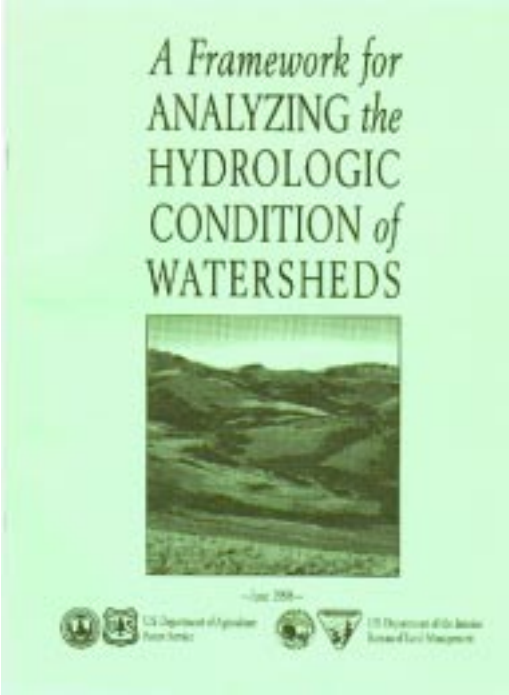
Examples of Filled-in Data Forms: No, but detailed instructions on filling out the data sheet corresponding to each geographic scale are included. Also included are two application examples.

Key References: Page 54-59 of the document

Document No.: 32

A Framework for Analyzing the Hydrologic Condition of Watersheds

Citation: McCammon, B., J. Rector, and K. Gebhardt. 1998. U.S. Department of the Interior. Bureau of Land Management. BLM Technical Note 405. Report No. 0704-0188.



Source: U.S. Department of the Interior
Bureau of Land Management
National Applied Resource Science Center
P.O. Box 25047
Denver, CO 80225-0047

Abstract: The Bureau of Land Management and the USDA Forest Service have developed a national framework for comprehensive interdisciplinary watershed analysis. Hydrologic condition analysis requires, among other things, obtaining information about precipitation, ground cover, vegetation soils, geology, runoff, channels, floodplains, and riparian areas for each watershed. The analysis result s in an understanding of the interrelationships among meteorological, surface- and ground water, and physical and biological factors that influence the flow, quality, and/or timing of water. This guidance outlines a process for identifying the essential factors needed to describe hydrologic condition, while still providing the flexibility to address site-specific outlines a process for identifying the essential factors needed to describe hydrologic condition, while still providing the flexibility to address site-specific characteristics.

The information assembled during the process enables those who conduct hydrologic analyses to participate effectively with other interdisciplinary team members in addressing ecosystem and resource management planning issues. The process helps to organize existing information about a watershed in the form of a watershed case file, which displays and interprets critical hydrologic information and supplements other resource information during decision-making process.

This document strives to develop an understanding of hydrologic condition of a watershed by examining the interrelationships among meteorological, surface and ground water, and physical and biological factors. The analysis follows a set of logical steps, where the products of one step provide information about the next step:

Step 1. Characterize the watershed – collecting all known information including past and current human use and development disturbance regimes, meteorological, hydrological, and biological factors. This step results in a broad overview of a watershed.

Step 2. Rate factors – Identify and qualitatively rate the factors that are most influential on the flow, quality, and timing.

Step 4. Establish current levels – quantify the current range and status of the factors identified in step 3.

Step 5. Establish reference levels – specify conditions that would be expected if the system were operating without significant human influence.
Step 6. Identify changes and interpret results – evaluate causes and significance of observed differences and project potential for recovery.

Target Application: Management

Note: This protocol was designed for land

use planning applications, but may be useful to other applications.

Suitable for Volunteers: No

Training Recommended: Yes
Available? No

Monitoring Focus: General freshwater vegetation and stream discharge.

Geographic Scale: Watershed

Methods: Office

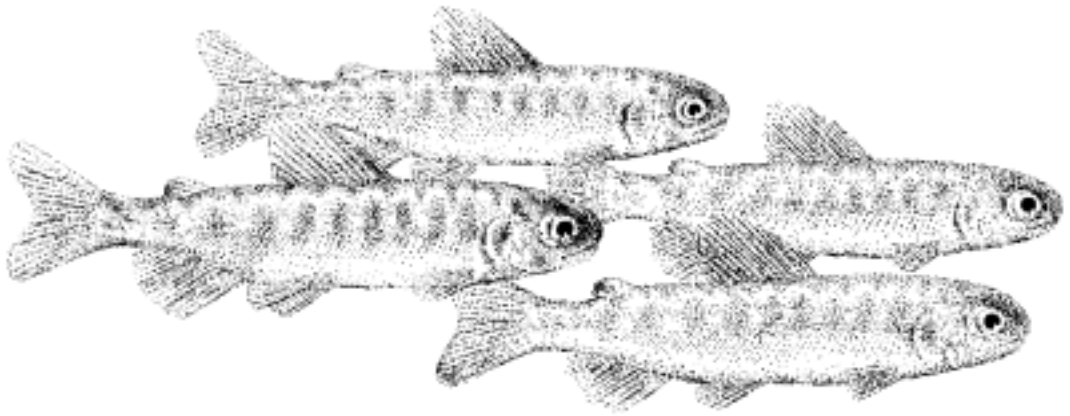
Level of Data Quality: Levels 2 through 4

Equipment and Tools (*list*): Provided is a list of data, recommended format, and procedures and/or sources for obtaining data (Appendix A of the document).

Data Forms: Can be adapted from the hypothetical example in the manual (see below).

Examples of Filled-in Data Forms: Throughout its contents, the manual provided is a complete and detailed (hypothetical) example of a characterization of a watershed. It guides a reader through a set of filled out data sheets, demonstrating the analysis process, and providing rationale for the qualitative ratings and data sources.

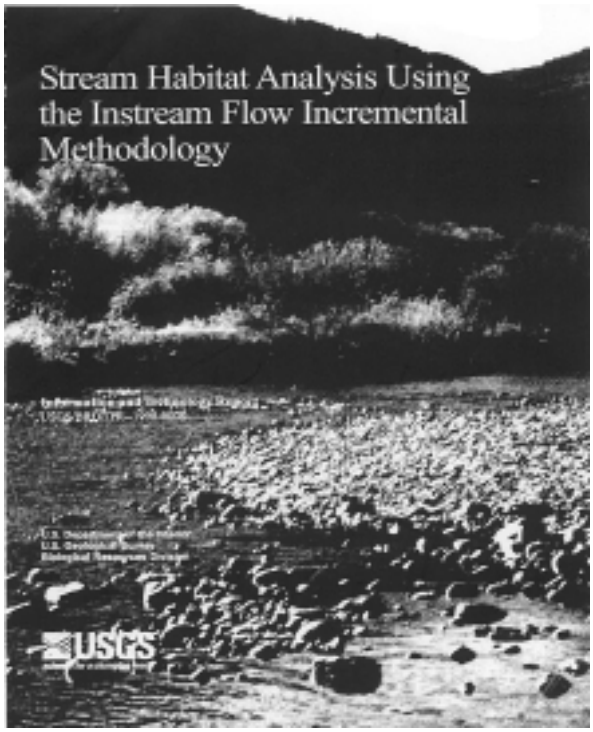
Key References: Page 37 of the document



Document No.: 33

Stream Habitat Analysis Using the Instream Flow Incremental Methodology

Citation: Bovee, K. D., B. L. Lamb, J. M. Bartholow, C. B. Stalnaker, J. Taylor, and J. Henriksen. 1998. Stream Habitat Analysis Using the Instream Flow Incremental Methodology. U.S. Geological Survey, Biological Resources Division Information and Technology Report USGS/BRD-1998-0004. viii + 131 pp.



Source: U.S. Geological Survey
Biological Resources Division
Midcontinent Ecological Science Center
4512McMurry Avenue
Fort Collins, CO 80525-3400

Copies are available at:
National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161
Phone:1-800-553-6847 or 703-487-4650
or:
Defense Technical Information Center
Attn: Help Desk
8725 Kingman Road, Suite 0944
Fort Belvoir, Virginia 22060-6218
Phone: 1-800-225-3842 or (703)-767-9050

Abstract: This document is intended to update the concepts and ideas first presented in Information Paper 12, the first attempt to describe the Instream Flow Incremental Methodology (IFIM) in its entirety in 1982. This publication serves as a comprehensive introductory textbook in IFIM for training courses. It contains the most complete and comprehensive description of IFIM in existence today.

This manual should also serve as an official guide to IFIM in publication to counteract the misconceptions about the methodology that have pervaded the professional aimed at the decisionmakers of management and allocation of natural resources in providing them an overview; and to those who design and implement studies to inform the decision mankers. There should be enough background on model concepts, data requirements, calibration techniques, and quality assurance to help the technical user design and implement a cost-effective application of IFIM that will provide policy-relevant information.

Some of the chapters deal with basic organization of IFIM, procedural sequence of applying IFIM starting with problem identification study planning and implementation, and problem resolution.

Target Application: Management

Suitable for Volunteers: No; authors strongly recommend an interdisciplinary team approach to the use of IFIM.

Training Recommended: Not applicable; interdisciplinary team approach.

Monitoring Focus: IFIM's modeling approach has been developed considering major human-induced impacts to river systems that fall into five major categories:

1) flow regime – description of habitat variability under baseline and alternative flow regimes

2) habitat structure – quantification of the amount of microhabitat available for a target species over a wide range of discharges, combining empirical descriptions of the structural features of the channel, simulated distributions of depth and velocity, and habitat suitability criteria for the target species.
3) water quality – IFIM studies generally incorporate water quality models in common use by the water resource or public health agency of the region.
4) food energy source – incorporates simulations of microhabitat area for use by benthic macroinvertebrates in streams inhabited by trout and salmon.
5) biotic interactions – examination of interspecific competition as a consequence of flow management. This pathway according to the authors has been most neglected and is in a need of further development. The authors offer a few new concepts that need to be sorted out and applied to IFIM modeling. Among them are simulated historical temperature and flow patterns, unfavorable temperature during spawning and incubation, or unfavorably high velocities during fry emergence.

Geographic Scale: Basin, sub-basin, stream reach, project site. The fundamental accounting habitat unit used in IFIM is a segment. How the component of IFIM are assembled and combined depends on the nature of the problem and the objectives of the study.

Methods: Office

Level of Data Quality: Level 3 **&** 4

Equipment and Tools (*list*): Data requirements, data collection strategies, sampling protocols descriptions and evaluations, and most widely available sources are listed under each pathway in chapter 3 and 4 of the report.

Data Forms: Not applicable

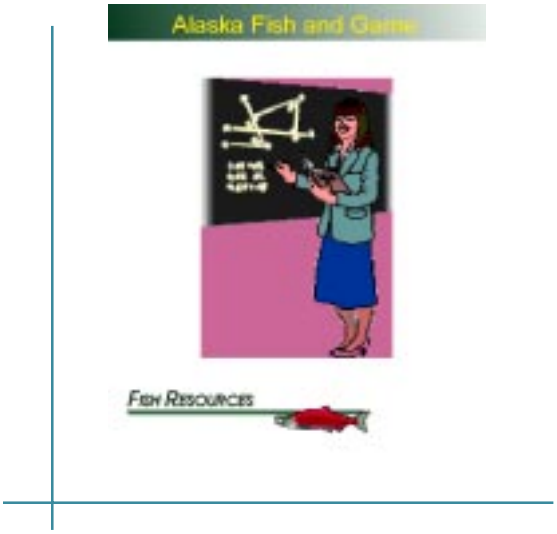
Examples of Filled-in Data Forms: Not applicable

Key References: Literature Cited section page 111, suggested reference materials at the end of each chapter.

Document No.: 34

Aquatic Education Stream Survey Manual

Citation: Alaska Fish and Game; http://www.state.ak.us/local/akpages/FISH.GAME/sportf/geninfo/aq_ed/awwstml/awwmn1.htm



Source: Alaska Fish and Game
Division of Sport Fish,
Aquatic Education Division
Contact: Mark Anderson
Department of Environmental Conservation
Phone: (907) 4565307
or:
Kent Patrick-Riley
Phone: (907) 269-7554
E-mail: kriley@einvirocon.state.ak.us

Abstract: AWW stream surveys are specifically designed to enhance students' and volunteers' knowledge of aquatic resources and ways of their protection. The AWW stream surveys have been in use by the volunteers and students for 6 years. The AWW is the state-wide umbrella organization for hands on aquatic stewardship programs. AWW's four themes are: aquatic education, monitoring, pollution prevention, and watershed rehabilitation and maintenance. The AWW stream survey includes instructions for annual, seasonal stream, and macroinvertebrate surveys.

Target Application: General

Suitable for Volunteers: Yes; specifically designed for volunteers and students.

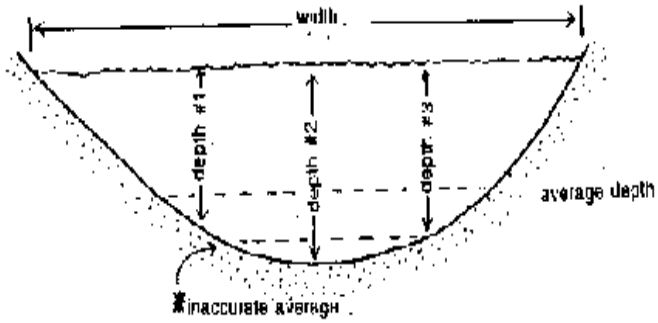
Training Recommended: No

Monitoring Focus: The AWW annual and seasonal stream surveys focus on general characteristics of surveyed streams. Among the features to be observed by the volunteers and students during an annual stream survey are:

- channel features (existence of culverts, dams, artificial banks, cover for fish, channel cross section, and bottom sediments),
- riparian features (surrounding vegetation types, percent canopy cover),
- and land use

During a seasonal stream surveys, the focus is on:

- weather (air temperature, precipitation)
- stream flow
- water quality (level, clarity, presence of algae, etc.)
- wildlife presence
- water chemistry (dissolved Oxygen, pH, turbidity)



Geographic Scale: Stream reach, project site

Methods: Field

Level of Data Quality: Level 1

Equipment and Tools (*list*): Not provided

Data Forms: Available online

Examples of Filled-in Data Forms: Not provided

Key References: Not provided

Document No.: 35

Protocol for placement and retrieval of temperature data loggers in Idaho streams

Citation: Zaroban, D. W. 1999. Protocol for placement and retrieval of temperature data loggers in Idaho streams. Idaho Division of Environmental Quality. Boise, ID.

Source: Idaho Division of Environmental Quality:
State Technical Services Office
1410 N. Hilton
Boise, ID 83706-1253
http://www2.state.id.us/deq/water/tlp.htm

Abstract: This protocol is intended to provide a standardized process for collection of temperature data using data loggers. The Introduction section provides background information relevant to the need for stream temperature data collection as well as a description of the scope of the protocol (i.e., its intended purpose and what information is provided). The methods section describes pre-placement procedures: *develop a monitoring plan, select logger, calibrate logger*; and placement procedures: *launch logger, site selection, logger placement, locality documentation*; and retrieval procedures. A bibliography and glossary are further provided. Appendices A-F include the Owyhee Mountains thermograph placement work plan, a temperature logger calibration form, a temperature logger metadata sheet, a field equipment list, a temperature logger field form, and procedures for temperature data handling respectively. This protocol does not cover lakes, reservoirs, and large non-wadable rivers.

This protocol is intended to supplement the Idaho Division of Environmental Quality (DEQ) technical procedures manual (Ralston and Browne 1976) in light of recent advances in temperature monitoring technology.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Recommended: No
Available? No

Monitoring Focus: Provides guidelines for the placement, retrieval and documentation of temperature data loggers at individual wadable stream sites and subsequent temperature data handling.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

Level of Data Quality: Level 3 **&** 4

Equipment and Tools (*list)*: Appendix D of the document

Data Forms: Appendices B, C, and D of the document

Examples of Filled-in Data Forms: Not provided

Key References: Page 7 of the document

Document No.: 36

Recommended Protocols for Sampling and Analyzing Subtidal Benthic Macroinvertebrate Assemblages in Puget Sound

Citation: Puget Sound Estuary Program. 1987. Recommended protocols for sampling and analyzing subtidal benthic macroinvertebrate assemblages in Puget Sound. Prepared by Tetra Tech, Inc. Recommended Protocols and Guidelines for measuring selected environmental variables in Puget Sound. Puget Sound Water Quality Action Team, Olympia, WA.

Source: U.S. Environmental Protection Agency
Region 10, Office of Puget Sound
1200 6th Avenue
Seattle, WA 98101
Also available in pdf format at
Puget Sound Water Quality Action
Team web site at:
http://www.wa.gov/puget_sound/Publications/protocols/protocol.html

Abstract: This protocol describes recommended methods for sampling and analyzing subtidal soft-bottom benthic macroinvertebrates assemblages in Puget Sound. The methods are based on the results of a workshop and written reviews by representatives from most organizations that fund or conduct environmental studies in Puget Sound. The purpose of developing these recommended protocols is to encourage all Puget Sound investigators conducting monitoring programs, baseline surveys, and intensive investigations to use standardized methods whenever possible.

The protocol includes a section on study design consideration. In this section, discussed are major elements of the design of subtidal benthic macroinvertebrate studies that were considered at the workshop but left unresolved.

Next sections include specification for the field, laboratory, quality assurance/quality control (QA/QC), and data reporting procedures that are recommended for most future benthic macroinvertebrate studies in Puget Sound.

Although these protocols are recommended for most studies conducted in Puget Sound, departures form these methods may be necessary to meet the special requirements of individual projects. If such departures are made, however, the funding agency or investigator should be aware that the resulting data may not be comparable with most other data of that kind. In some instances, data collected using different methods may be compared if the methods are intercalibrated adequately.

Target Application: Management **&** Research

Suitable for Volunteers: No

Monitoring Focus: Monitoring of subtidal soft-bottom benthic macroinvertebrate assemblages in Puget Sound.

Geographic Scale: Written specifically for use within Puget Sound

Methods: Field & Laboratory

Level of Data Quality: Level 4

Equipment and Tools (*list*): Not provided

Data Forms: Not provided

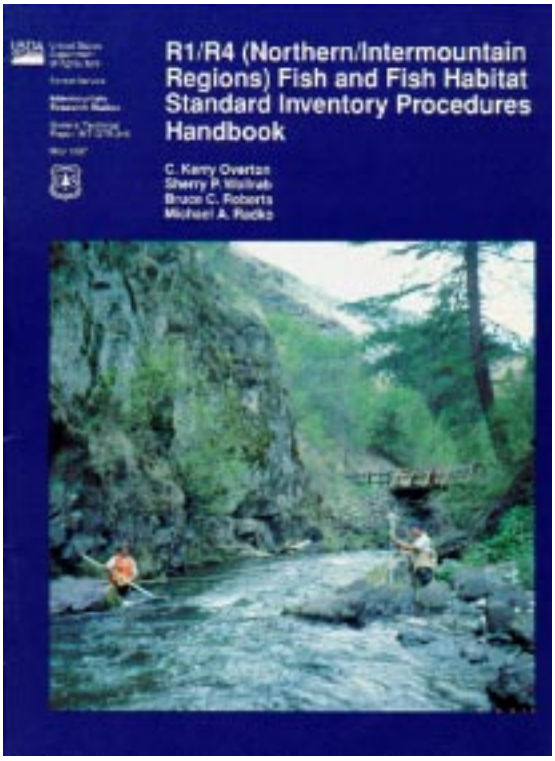
Examples of Filled-in Data Forms: Not provided

Key References: Page 33 of the document

Document No.: 37

R1/R4 (Northern/Intermountain Regions) Fish and Fish Habitat Standard Inventory Procedures Handbook

Citation: Overton, C. K., S. P Wollrab, B. C. Roberts, and M. A. Radko. 1997. RI/R4 (Northern/ Intermountain Regions) Fish and fish habitat standard inventory procedures handbook. Gen. Tech. Rep. INT-GTR-346. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 73 p.



Source: U.S.D.A Forest Service: Intermountain Research Station
324 25th Street
Ogden, Utah 84401

Abstract: This protocol is intended as a tool for U.S. Department of Agriculture Forest Service fisheries biologists to meet their requirements of assessing the direct, indirect, and cumulative effects of National Forest management activities on fish and fish habitat. This document provides a standard set of core variables and procedures designed to allow for the capability to observe and and contrast fish population and habitat status and condition across multiple landscape scales. The inventory procedure process is divided into five sections:

I. R1/R4 Fish Habitat Inventory Overview – briefly describes each sequential step of data collection and processing from start to inventory finish.

II. R1/R4 Fish Habitat Inventory Procedures – describes the variables collected and the methodology for the fish habitat inventory and fish population sampling.

III. Inventory Training – provides the procedures used to introduce inventory crews to the fish habitat inventory and the suggestions for conducting crew training sessions.

IV. Inventory Quality Control – describes techniques that crew supervisors can use to improve the inventory skills of their crews.

V. Inventory Sampling Schemes – describes the different inventory levels (Levels I to III) and subsampling frequencies (20 to 100 percent) in relation to common Forest objectives and outputs.

Appendix A provides data forms used in the inventory process, appendix B provides an example of completed inventory forms, appendix C is a glossary, appendix D lists equipment needed to complete the inventory, appendix E contains a key for identifying riparian community types, and appendix F displays summary variable outputs using a database management system (FBASE).

Target Application: Management **&** Research

Suitable for Volunteers: No

Training Recommended: Yes
Available? No, includes instructions for training.
Where? Page 40 of the document

Monitoring Focus: To assess the direct, indirect, and cumulative effects of National Forest management activities on fish and fish habitat. This inventory was designed to:

1) Define the structure (pool/riffle, forming features), pattern (sequence and

spacing), and dimensions (length, width, depth, area, volume, and so forth) of fish habitat.
2) Describe species composition, distribution, and relative abundance of salmonid species.
3) Facilitate the calculation of summary statistics for habitat descriptors.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

Level of Data Quality: Level 4

Equipment and Tools (*list*): Appendix D of the document

Data Forms: Appendix A of the document

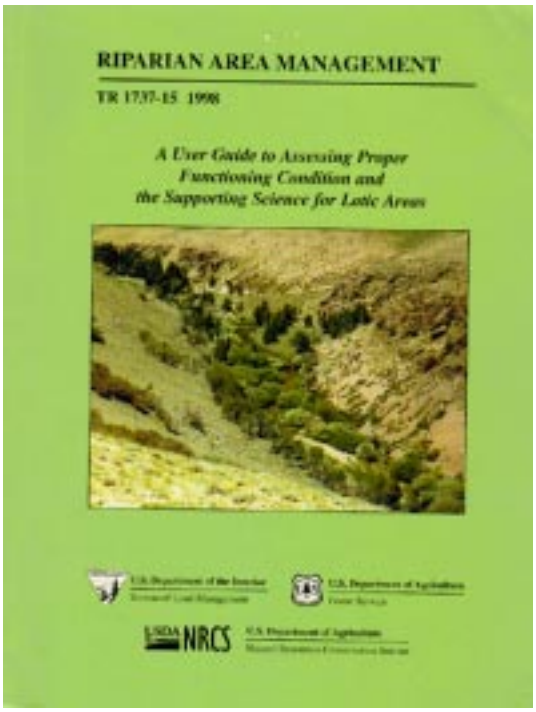
Examples of Filled-in Data Forms: Appendix B of the document

Key References: Page 44 of the document

Document No.: 38

A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas

Citation: Prichard, D., J. Anderson, C. Correll, J. Fogg, K Gebhardt, R. Krapf, S. Leonard, B. Mitchell, and J. Staats. 1998. Riparian area management: A user guide to assessing proper functioning condition and the supporting science for lotic areas. TR 1737-15. U. S. Department of the Interior, Bureau of Land Management. Denver, CO.



Source: Bureau of Land Management
National Business Center
BC-650B
P.O. Box 25047
Denver, Colorado 80225-0047

Abstract: This manual provides guidance in assessing the proper functioning condition (PFC) of riparian-wetlands areas. PFC is a qualitative method and refers to both the assessment process and defined, on the ground condition of a riparian area.

The PFC assessment refers to a consistent approach for considering hydrology, vegetation, and erosion/deposition (soils) attributes and processes to assess the condition of riparian-wetland areas. PFC is a qualitative assessment based on quantitative science. The PFC assessment is intended to be performed by an interdisciplinary team with local, on-the-ground experience in the kind of sampling techniques that support the PFC checklist.

PFC is also an appropriate starting point for determining and prioritizing the type and location of quantitative inventory or monitoring necessary.

PFC assessment has also proven to be an excellent communication tool for bringing a wide diversity of public to agreement. This process forms a "common vocabulary" for identifying the building blocks for the development of desired condition and resulting values.

Note: This document should be used in conjunction with protocols contained in Document No. 96.

Target Application: Management

Suitable for Volunteers: No

Training Recommended: Yes
Available? Yes
Where? Interdisciplinary teams consisting of Federal and State agencies were formed in 11 western states. These teams are currently providing training in each of the 11 states.

Monitoring Focus: Considers hydrology, vegetation, and erosion/deposition (soils) as attributes and processes to assess the condition of riparian-wetland areas.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

Level of Data Quality: Level 2

Equipment and Tools (*list*): Not provided

Data Forms: Page 63 of the document

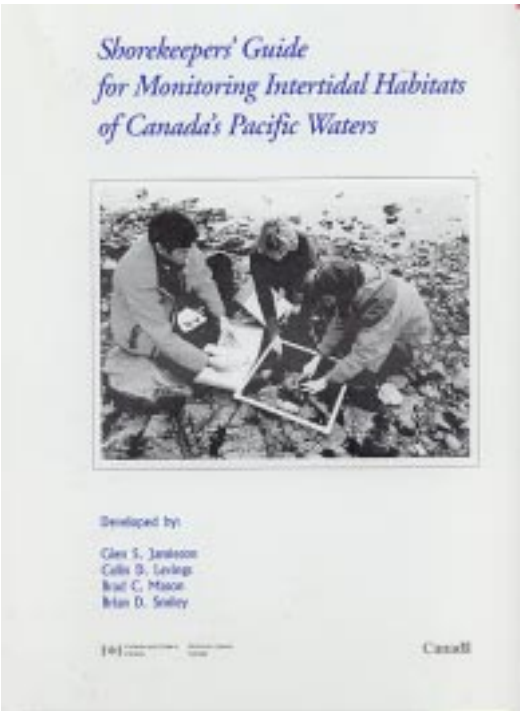
Examples of Filled-in Data Forms: Appendix B of the document

Key References: Page 119 of the document

Document No.: 39

The Shorekeeper's Guide for Monitoring Intertidal Habitats of Canada's Pacific Waters

Citation: Jamieson, G. S., C. D. Levings, B. C. Mason, and B. D. Smiley. 1999. The shorekeeper's guide for monitoring intertidal habitats of Canada's Pacific waters. Fisheries and Oceans Canada, Pacific Region. Modules 1, 2, and 3. Volume I. (Looseleaf).



Source: Fisheries and Oceans Canada
Pacific Biological Station
Nanaimo, B.C.
V9R 5K6
Internet: http://www.pac.dfo-mpo.gc.ca/sci/protocol/shorekeepers/

Abstract: The Shorekeeper's Guide is a protocol for nonprofessionals to map and survey the intertidal zone, and to produce data of sufficient quantity and quality for use by resource managers, environmental biologists, and marine researchers who are monitoring and assessing long-term changes in marine communities. The goal is to enable interested nonprofessional individuals and community groups to obtain standardized, credible data over time from a specific physical site – and from these data, to document and evaluate the nature of change, if any, that is occurring. The protocol uses both physical substrate characteristics (e.g. sand, mud, and rock boulders) and biological features (e.g. rockweed and eelgrass beds) to define and map habitats, which are then sampled for species diversity and abundance. The protocol can be used on both soft and hard intertidal substrates, and includes a descriptive method for backshore surveying within 20 m of the intertidal zone. The Guide is comprised of three modules: a mapping and survey procedure, a data management procedure, and a training curriculum to teach leaders about the survey protocol and data management procedures.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, with training

Training Recommended: Yes
Available? Yes
Where? Contact DFO Representatives:
Dr. Glen S. Jamieson, Pacific Biological Station, Namaimo
(250)-756-7223/Email: jamiesong@pac.dfo-mpo.gc.ca
Dr. Collin D. Levings
West Vancouver Laboratory
West Vancouver
Phone: (640)-666-7915
Email: levingsc@pac.dfo-mpo.gc.ca

Monitoring Focus: 1) Macrohabitat classification; 2) General vegetation; 3) Biomonitoring of macroinvertebrates.

Geographic Scale: Designed for use within intertidal habitats of varying size

Methods: Office **&** Field

Level of Data Quality: Levels 2 to 3

E**quipment and Tools (*list*):** Appendix C, supplemented within the text of the document

Data Forms: Appendix B of the document

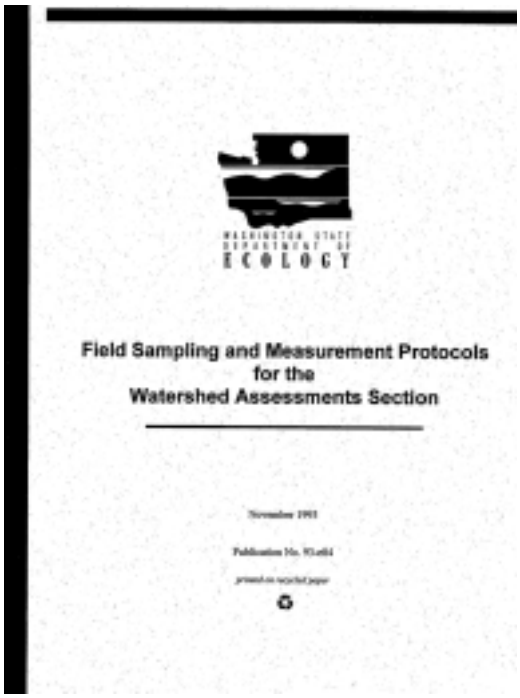
Examples of Filled-in Data Forms: Partial; pages 16-23 of the document

Key References: Page 100 of the document

Document No.: 40

Field Sampling and Measurement Protocols for the Watershed Assessment Section.

Citation: Cusimano, B. 1993. Field sampling and measurement protocols for the watershed assessments section. Pub. No. 93-e04. Washington State Department of Ecology. Olympia, WA.



Source: Washington Department of Ecology
Publications Distributions Office
P.O. Box 47600
Olympia, WA 98504-7600
(360) 407-7472

Abstract: This document provides a collection of field sampling and measurement protocols designed for the watershed assessments section of the Washington Department of Ecology. This collection of protocols relates primarily to the collection of parameters involving water quality and includes: bottle rinsing; nutrients (ammonia, nitrate-nitrite, total persulfate nitrogen, total phosphorous, and nutrients 3 [ammonia, nitrate-nitrite, and total phosphorous]); orthophosphate; fecal coliform; temperature; conductivity; pH; dissolved oxygen – Winkler titration; dissolved oxygen – YSI dissolved oxygen meter; free and total chlorine; oil and grease; flow measurement; and hydrolab calibration and deployment. Individual protocols within this document are clearly laid out in step-by-step fashion.

Target Application: Research

Suitable for Volunteers: No

Monitoring Focus: Monitoring water chemistry and water temperature.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Field

Level of Data Quality: Level 4

Equipment and Tools (*list*): Listed within each protocol

Data Forms: Not provided

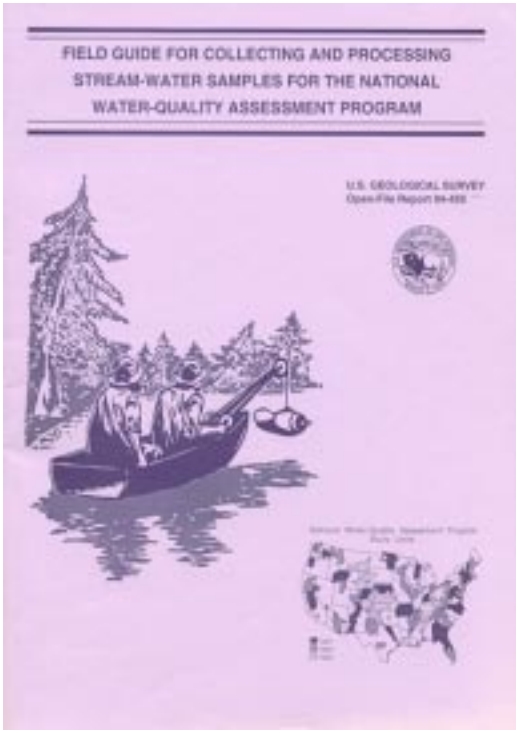
Examples of Filled-in Data Forms: Not provided

Key References: Listed within each protocol

Document No.: 41

Field Guide for Collecting and Processing Stream-Water Samples for the National Water-Quality Assessment Program

Citation: Cusimano, B. 1993. Field sampling and measurement protocols for the watershed assessments section. Pub. No. 93-e04. Washington Department of Ecology. Olympia, WA. 48 pp.



Source: U.S. Geological Survey
NAWQA Field Technical Support
Placer Hall
6000 J Street
Sacramento, CA 95819-6129
http://water.usgs.gov/pnsp/pest.rep/sw-t.html

Abstract: The U.S. Geological Survey's National Water-Quality Assessment program includes extensive data-collection efforts to assess the quality of the Nation's streams. These studies require analyses of stream samples to major ions, nutrients, sediments, and organic contaminants. For the information to be comparable among studies in different parts of the nation, consistent procedures specifically designed to produce uncontaminated samples for trace analysis in the laboratory are critical. This field guide describes the standard procedures for collecting and processing samples for major ions, nutrients, organic contaminants, sediment, and field analyses of conductivity, pH, alkalinity, and dissolved oxygen. Samples are collected and processed using modified and newly designed equipment make of Teflon to avoid contamination, including nonmetallic samplers (D-77 and DH-81) and a Teflon sample splitter. Field solid-phase extraction procedures developed to process samples for organic constituent analyses produce an extracted sample with stabilized compounds for more accurate results. Improvements to standard operational procedures include the use of processing chambers and capsule filtering systems. A modified collecting and processing procedure for organic carbon is designed to avoid contamination from equipment cleaned with methanol. Quality assurance is maintained by strict collecting and processing procedures, replicate sampling, equipment blank samples, and a rigid cleaning procedure using detergent, hydrochloric acid, and methanol.

Target Application: Management **&** Research

Suitable for Volunteers: No

Monitoring Focus: Stream-water quality sample collection and processing

Geographic Scale: Scaled to the USGS Study Unit – roughly equivalent to the basin scale

Methods: Field **&** Laboratory

Level of Data Quality: Level 4

Equipment and Tools (*list*): Page 10 of the document

Data Forms: Partial on page 43 of the document

Examples of Filled-in Data Forms: Not provided

Key References: Page 45 of the document

Document No.: 42

Guidelines for Collecting and Processing Samples of Stream Bed Sediment for Analysis of Trace Elements and Organic Contaminants for the National Water-Quality Assessment Program

Citation: Shelton, L. R. and P. D. Capel. 1994. Guidelines for collecting and processing samples of stream bed sediment for analysis of trace elements and organic contaminants for the National Water-Quality Assessment program. Open-File Report 94-458. U.S. Geological Survey, Sacramento, CA.

Source: U.S. Geological Survey
NAWQA Field Technical Support
Placer Hall
6000 J Street
Sacramento, CA 95819-6129
http://water.wr.usgs.gov/pnsp/pest.rep/bs-t.html

Abstract: A major component of the U.S. Geological Survey's National Water-Quality Assessment program is to characterize the geographic and seasonal distributions of water-quality conditions in relation to major contaminant sources. For streams, the assessment of trace elements and organic contaminants is accomplished through a two-phase assessment of stream bed sediments and tissues of aquatic organisms. The first phase of the strategy is to identify important constituents based on data collected from bed-sediment depositional zones. Fine-grained particles deposited in these zones are natural accumulators of trace elements and hydrophobic organic compounds. For the information to be comparable among studies in many different parts of the nation, strategies for selecting stream sites and depositional zones are critical. Fine-grained surficial sediments are obtained from several depositional zones within a stream reach and composited to yield a sample representing average conditions. Sample collection and processing must be done consistently and by procedures specifically designed to separate the fine material into fractions that yield uncontaminated samples for trace-level analytes in the laboratory. Special coring samplers and other instruments made of Teflon are used for collection. Samples are processed through a 2.0-millimeter stainless-steel mesh sieve for organic contaminant analysis and a 63-micrometer nylon-cloth sieve for trace-element analysis. Quality assurance is maintained by strict collection and processing procedures, duplicate sampling, and a rigid cleaning procedure.

Target Application: Management & Research

Suitable for Volunteers: No

Monitoring Focus: Water-quality – contamination of stream bed sediments by trace elements and hydrophobic organic compounds

Geographic Scale: Designed for the USGS Study Unit – roughly equivalent to the basin scale; sampling done at the stream reach scale.

Methods: Field

Level of Data Quality: Level 4

Equipment and Tools (*list*): Page 10 of the document

Data Forms: None, but mentioned on page 22 of the document

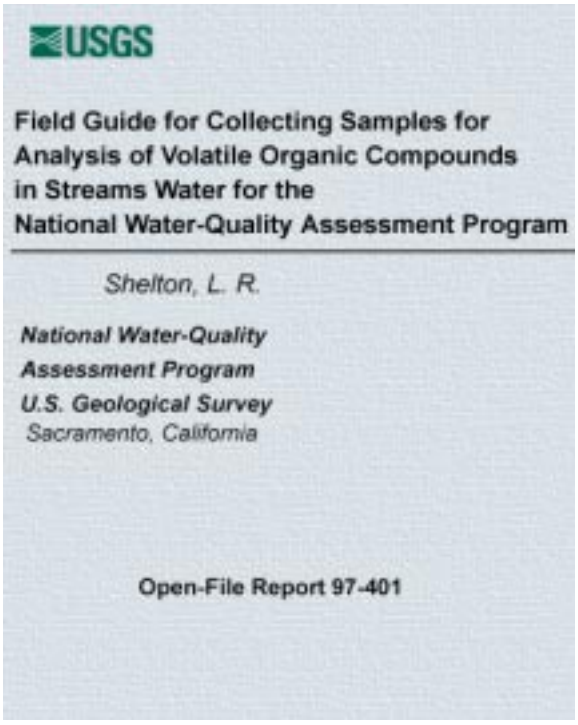
Examples of Filled-in Data Forms: Not provided

Key References: Page 23 of the document

Document No.: 43

Field Guide for Collecting Samples for Analysis of Volatile Organic Compounds in Stream Water for the National Water-Quality Assessment Program

Citation: Shelton. L. R. 1997. Field guide for collecting samples for analysis of volatile organic compounds in stream water for the National Water-Quality Assessment program. Open-File Report 97-401. U.S. Geological Survey, Sacramento, CA.



Source: U.S. Geological Survey
Field Technical Support, NAWQA
Placer Hall
6000 J Street
Sacramento, CA 95819
Internet: http://water.wr.usgs.gov/pnsp/pest.rep/voc.html#SC

Abstract: For many years, stream samples for analysis of volatile organic compounds have been collected without specific guidelines or a sampler designed to avoid analyte loss. In 1996, the U.S. Geological Survey's National Water-Quality Assessment Program began aggressively monitoring urban stream water for volatile organic compounds. To assure representative samples and consistency in collection procedures, a specific sampler was designed to collect samples for analysis of volatile organic compounds in stream water. This sampler, and the collection procedures, were tested in the laboratory and in the field for compound loss, contamination, sample reproducibility, and functional capabilities. This report describes that sampler and its use, and outlines field procedures specifically designed to provide contaminant-free, reproducible volatile organic compound data from stream water samples.

Target Application: Management **&** Research

Suitable for Volunteers: No

Monitoring Focus: Monitoring water chemistry with emphasis on contamination of stream water by volatile organic compounds

Geographic Scale: At sites within basins or sub-basins, located at or near streamflow gages.

Methods: Field

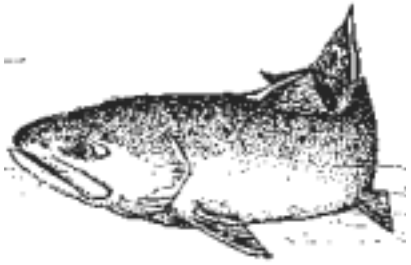
Level of Data Quality: Level 4

Equipment and Tools (*list*): Page 9 of the document

Data Forms: Not provided, although field notes are addressed on page 13 of the document

Examples of Filled-in Data Forms: Not provided

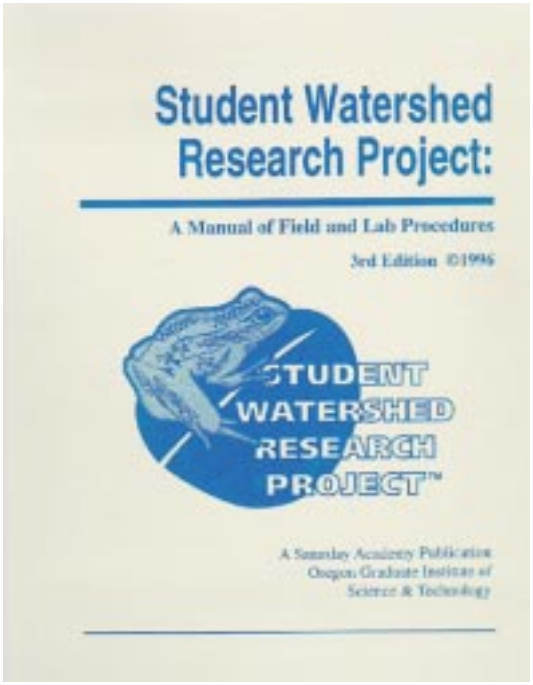
Key References: Page 15 of the document



Document No.: 44

Student Watershed Research Project: A Manual of Field and Lab Procedures – 3rd Edition

Citation: Andrews, S., V. Beeson, J. Blair, R. Carter, M. Goodrich, E. Harris, W. Jarrell, D. Lev, J. Miller, R. Peterson, R. Rodgers, R. Stockhouse, D. Wolf, L. Wolf. 1996. Student watershed research project: a manual of field and lab procedures – 3rd edition. Saturday Academy-Oregon Graduate Institute of Science and Technology, Portland, OR.



Source: http://www.swrp.org/Publications/publications.htm

Abstract: The Student Watershed Research Project (SWRP), a program of Saturday Academy, uses the cooperation of teachers, students, scientists, businesses, governmental agencies, and community groups to couple watershed education with the collection of high quality data. SWRP identifies 5 project goals, these include: collaboration between science teachers, students, and practicing scientists; provision of training, equipment, and materials for watershed monitoring; maintenance of a database of student-collected data that is reliable and of high quality; fostering stewardship of natural areas and resources by students. SWRP developed the *Riparian and Aquatic Ecosystem Monitoring: A Technical Training Workshop*, which partners scientists, SWRP staff, and local teachers. Within this intensive training workshop, teachers work alongside cooperating scientists and staff to acquire the skills and practice needed to use, and teach the use of, data collection equipment and techniques.

Procedures and criteria for high quality collection of watershed data were developed through the collaboration of scientists working in the Tualatin and Clackamas watersheds. These procedures are presented here to assist with instruction, data collection, and the reporting of results. The integration of SWRP into a science curriculum challenges students to study, interpret, and communicate site characteristics and existing water quality characteristics while collecting data on water chemistry, microbiology, vegetation, macroinvertebrates, wildlife, and stream habitat parameters at accessible sites along targeted tributaries. Field data collection occurs during October and April providing data for both high and low seasonal flows.

The implementation of a rigorous quality assurance/quality control (QA/QC) program is coordinated and supervised by SWRP staff. This plan includes high level technical training of teachers, synthetic sample analysis prior to field sampling by students, duplicate sample analysis by professional labs, ID verification of species by field experts, and technical assistance in the classroom and field by science professionals.

Target Application: Research

Suitable for Volunteers: Yes

Training Recommended: Yes

Available: information available at: http://www.swrp.org/ndex.html

Monitoring Focus: Water quality and watershed resources

Geographic Scale: Stream reach

Methods: Field **&** Laboratory

Level of Data Quality: Level 2

Equipment and Tools (*list*): Appendix D

Data Forms: Page 145 of the document

Examples of Filled-in Data Forms: Not provided

Key References: Appendix E of the document

Document No.: 45

Sampling Protocol: Bull Trout Habitat Study

Citation: Dunham, J. 2000. Sampling protocol: bull trout habitat study (DRAFT). U.S. Forest Service, Rocky Mountain Research Station. Boise, ID. 23 pp.


Washington State Bull Trout Habitat Study
Sampling Protocol: 27July 2000 DRAFT
DRAFT
SAMPLING PROTOCOL: BULL TROUT HABITAT STUDY
Our work on bull trout in Washington State focuses on two basic questions: 1) What is suitable habitat for spawning and early rearing of bull trout?; 2) If habitat is suitable, what is the probability of bull trout occurrence? Both questions have important implications for land management and recovery of threatened bull trout populations. Data collected in summer of 2000 will be used to develop a model of suitable habitat for spawning and early rearing of bull trout. These habitats are operationally defined as those with juvenile bull trout (< 150 mm total length) present (Rieman and McIntyre 1995). The model will be constructed to predict probability of occurrence of bull trout, given certain habitat conditions. The study will occur in three major regions: West Cascades, East Cascades, and Southern Washington (Blue Mountains)

Source: Jason B. Dunham
Research Fishery Biologist
Rocky Mountain Research Station
Boise Forestry Sciences Laboratory
316 East Myrtle
Boise, ID 83702
(208)-373-4380 (voice)
(209)-373-4391 (fax)
E-mail: jbdunham@fs.fed.us

Abstract: In 2000, the Western Division American Fisheries Society (WDAFS) elected a committee (see list of collaborators) to coordinate development of survey protocols for bull trout. Two types of protocols were requested: 1) to determine bull trout occurrence ("presence/absence") and 2) to determine potential or suitable bull trout habitat. To meet these objectives, we developed an interim sampling protocol for conducting presence/absence surveys based on currently available information. This protocol reports sample size requirements, design considerations, and procedures for determination of juvenile bull trout presence. A final, peer-reviewed product will be available by summer of 2001.Habitat and biotic conditions measured within this protocol include: temperature, stream size (width and depth), maximum water depth at the site, bankfull width, substrate (percentage composition of different substrate types), large wood (number of pieces and wood class), stream gradient, conductivity, visibility, elevation, geographic location, and the occurrence of other fish species.

Target Application: Management **&** Research

Suitable for Volunteers: No

Monitoring Focus: Suitable habitat for bull trout coupled with presence/absence information. The document focuses on monitoring such parameters as water temperature, spawning habitat availability, stream morphology, and macrohabitat classification.

Geographic Scale: Designed for the regional scale - can be applied at smaller scales

Methods: Field

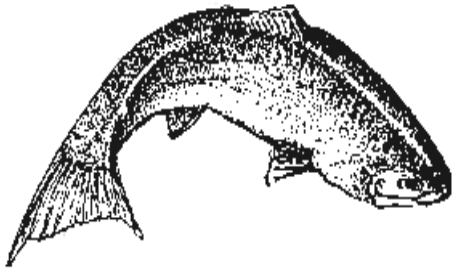
Level of Data Quality: Levels 3 **&** 4

Equipment and Tools (*list*): Appendix II of the DRAFT document

Data Forms: Not provided

Examples of Filled-in Data Forms: Not provided

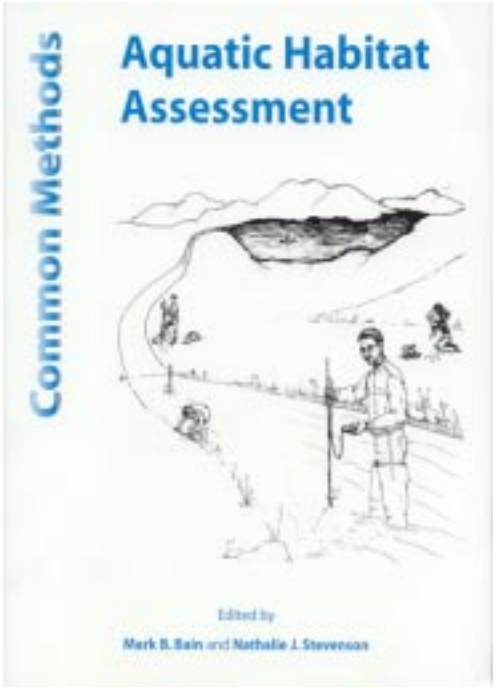
Key References: Page 15 of the DRAFTdocument



Document No.: 46

Aquatic Habitat Assessment: Common Methods

Citation: Bain, M. B. and N. J. Stevenson, editors. 1999. Aquatic habitat assessment: Common methods. American Fisheries Society, Bethesda, MD.



Source: American Fisheries Society
5410 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814-2199
http://www.fisheries.org/publications/bookpdf/aquaticintro.htm

Abstract: Habitat is now the basis of most impact assessments and resource inventories, and it is the basis of many species management plans, mitigation planning, and environmental regulation. Habitats are relatively stable through time, easily defined in intuitive physical terms, and provide a tangible resource for negotiations and decision making. Numerous and varied methods of analyzing and reporting habitat conditions have been developed by federal, state, provincial, and private agencies. Habitat assessment approaches vary greatly among regions of the continent. The great variability in methods and an unusually wide range of practices have impeded the ability of agencies to share and synthesize information. A diversity of methods is desirable in the initial stages of a rapidly developing field, but enough time has passed to assess the state-of-knowledge and identify the best of the currently used methods and techniques.

This manual is intended to provide fisheries biologists with a limited set of techniques for obtaining aquatic habitat data. The manual also describes the range of information collected and used in agency habitat analyses. Agencies planning habitat programs should review the synthesis of established and documented methods being used in North America (Appendix 1) and the planning recommendations in Chapter 2. Then, the remaining chapters should be reviewed to determine what types of habitat data should be included in the agency's program.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, with training or if supervised by experienced personnel.

Monitoring Focus: Macrohabitat classification; general vegetation, cover density, turbidity, animal shoreline damage, bank shape and cover, water chemistry, stream morphology, gravel composition, pebble count, gravel embededness, total suspended solids, barrier assessment.

Geographic Scale: Variable: basin, sub-basin, stream reach, or project site

Methods: Field

Level of Data Quality: Intended for use by fisheries biologists, thus levels 3 to 4

Where does the data go? Not specified

What's the database format? Not specified

Equipment and Tools (*list)*: Not provided

Data Forms: Variable by protocol

Examples of Filled-in Data Forms: Variable by protocol

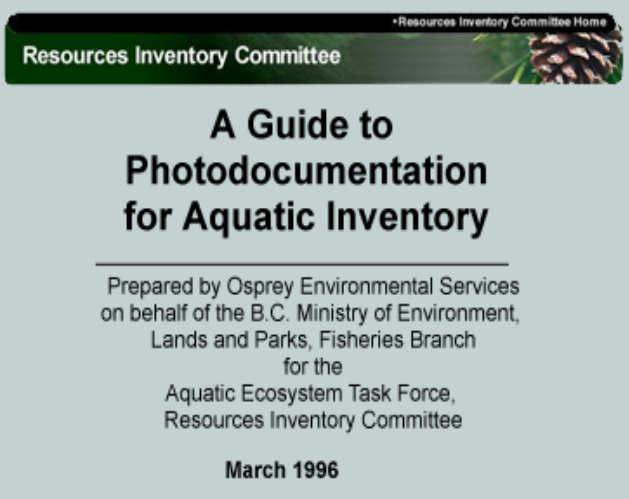
Key References: Page 201 of the document

Document No.: 47

A Guide to Photodocumentation for Aquatic Inventory

Citation: Osprey Environmental Services. 1996. A guide to photdocumentation for aquatic inventory. Prepared for the Aquatic Ecosystems Task Force, Resources Inventory Committee on behalf of the B.C. Ministry of Environment, Lands and Parks, Fisheries Branch. British Columbia, Canada.

Available online
http://www.for.gov.bc.ca/ric/Pubs/Aquatic/Photodoc/Index.htm



Source: To order hard copy manuals, call Queen's Printer Government Publications Centre at: (250) 387-3309 or Toll-free: 1-800-663-6105 or visit the RIC web pages at: http://www.publications.gov.bc.ca

Abstract: Photodocumentation is a major part of watershed, stream and lake inventories. The ability of a worker to extract useful information from a photograph will depend on: the photo subject, the quality of the image, proper storage of the image, knowledge of the photo's existence, and the ability to retrieve and view the image.

This guidebook identifies required and recommended photo subjects. The capture and storage of images are discussed in light of an ever-growing range of options (*i.e.*, film types, automated camera features, digital cameras, digitized video images, digitized film images).

Ground-based photodocumentation is addressed in this guidebook, as aerial photography and videography are reviewed elsewhere.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, with training, or if supervised by experienced personnel

Training Recommended: Yes

Monitoring Focus: Photodocumentation of aquatic systems

Geographic Scale: Basin, sub-basin, stream reach, project site, however, most appropriate for stream reach and project site

Methods: Office **&** Field

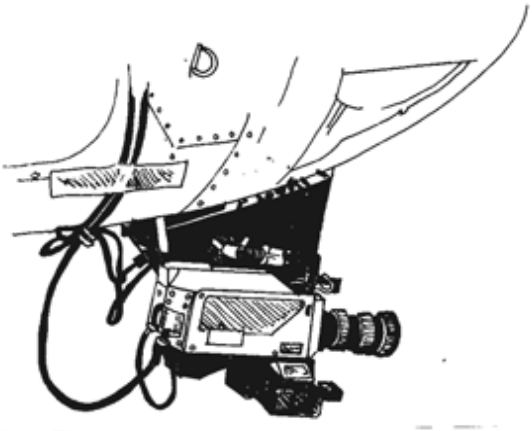
Level of Data Quality: Level 2

Equipment and Tools (*list*): The guide, in its design, reviews available equipment and tools

Data Forms: Appendix 4 of the document

Examples of Filled-in Data Forms: Not provided

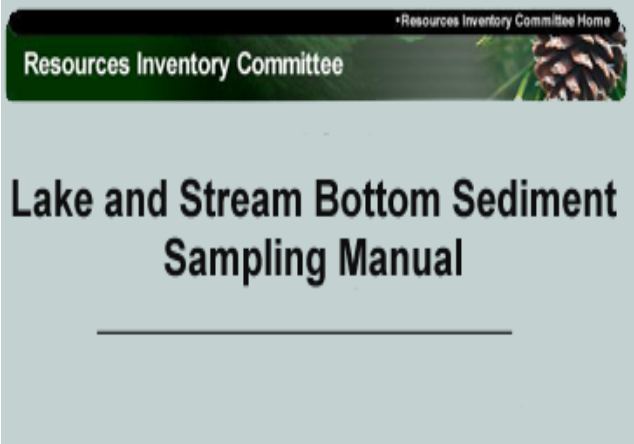
Key References: Section 11.0 of the document



Document No.: 48

Lake and Stream Bottom Sediment Sampling Manual

Citation: Province of British Columbia. 1997. Lake and stream bottom sediment sampling manual. Resources Inventory Committee (RIC), British Columbia, Canada.



Source: To order hard copy manuals, call Queen's Printer Government Publications Centre at: (250) 387-3309 or Toll-free: 1-800-663-6105 or visit the RIC web page at: http://www.publications.gov.bc.ca

Available online at: http://www.for.gov.bc.ca/ric/PUBS/Aquatic/lake-stream/index.htm

Abstract: This manual covers the minimum requirements to ensure quality and consistency of the field aspects of lake and stream bottom sediment data collection. Sediments collected using the techniques outlined here will be analyzed for sediment chemistry and for physical characteristics such as particle size distribution. The essential tasks in sediment sampling are to collect representative, undisturbed samples that meet the requirements of the program, and to prevent deterioration and contamination of the samples before analyses. The procedures outlined in this manual are orientated primarily towards BC Environment employees, consultants, or those under a legal requirement to undertake a sampling program for the Ministry. The data collected using this manual goes to the Environmental Monitoring System (EMS) for BC Environment. Following the protocols outlined in this manual will aid field staff in collecting reliable, representative samples.

Target Application: Management **&** Research

Suitable for Volunteers: Yes

Training Recommended: Yes

Monitoring Focus: This manual focuses on collecting samples of lake and stream bottom sediments for chemical and physical analysis. Protocols include sampling from a boat, bridge, winter sampling and sample handling (shipping and safety). This manual does not address project design or data interpretation. These topics can be found in:
Cavanagh, N., R.N. Nordin, L.W. Pommen and L.G. Swain. Guidelines for Designing and Implementing a Water Quality Monitoring Program in British Columbia
Avialable at the RIC webe site:
http://www.for.gov.bc.ca/ric/PUBS/Aquatic/design/index.htm

and *Guidelines for interpreting Water Quality Data.*
Available at the RIC web site:
http://www.for.gov.bc.ca/ric/PUBS/Aquatic/interp/index.htm

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Field

Level of Data Quality: Level 3

Equipment and Tools (*list*): Sample generic checklist in Appendix 1 of the document

Data Forms: Not provided

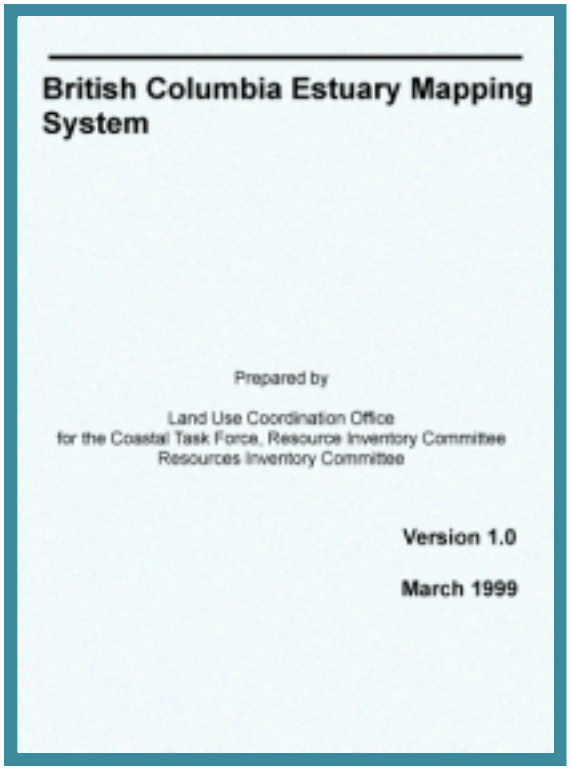
Examples of Filled-in Data Forms: Not provided

Key References: Section 7 of the document

Document No.: 49

British Columbia Estuary Mapping System

Citation: Howes, D., M. Morris, and M. Zacharias. 1999. British Columbia estuary mapping system. Prepared by the Land Use Coordination Office for the Coastal Task Force, Resource Inventory Committee. Resources Inventory Committee, British Columbia, Canada.



Source: Ministry of Environment, Lands and Parks
PO Box 9360 STN PROV OVT
Victoria, BC V8W 9M2
Phone: (250) 387-9422
Internet: http://www.gov.bc.ca/elp/cont/
To order hard copy manuals, call Queen's Printer Government Publications Centre at: (250) 387-3309 or Toll-free: 1-800-663-6105 or visit the RIC pages on their web page at: http://www.publications.gov.bc.ca
Or available in pdf format online at: http://www.for.gov.bc.ca/ric

Abstract: This manual provides a mapping and database system and methodology for large scale (typically 1:5,000) mapping of estuaries. This system builds upon an estuarine classification developed by the Ministry of Environment in 1983 (Hunter et al. 1983) and integrates components from the following RIC standards:

- British Columbia Physical Shore-Zone Mapping System (Howes et al. 1994)
- British Columbia Biological Shore-Zone Mapping System (Searing and Frith 1995)
- Wetland and Riparian Ecosystem Classification (MacKenzie and Banner in prep.)
- Standards for Terrestrial Ecosystem Mapping for British Columbia (Resource Inventory Committee 1998)
- Terrain Classification System (Howes and Kenk 1997.

This standard is composed of seven databases that separate biotic from abiotic attributes and point from polygon attributes. The design of this system permits the comparison of estuaries throughout the province, and can easily be updated to incorporate changes in any of the existing standards this work is based upon. It has been developed and structured in a manner that facilitates the incorporation of data from this standard into a GIS. Lastly, this standard is applicable for research or scientific application, as data collection methods are rigorous and the database and mapping structure has been designed with research needs in mind.

Target Application: Management **&** Research

Suitable for Volunteers: No

Monitoring Focus: Estuarine ecosystems; classification of the estuarine macrohabitat.

Geographic Scale: Designed for estuaries

Methods: Office **&** Field

Level of Data Quality: Level 4

Equipment and Tools *(list)*: Not applicable

Data Forms: Page 39 of the document

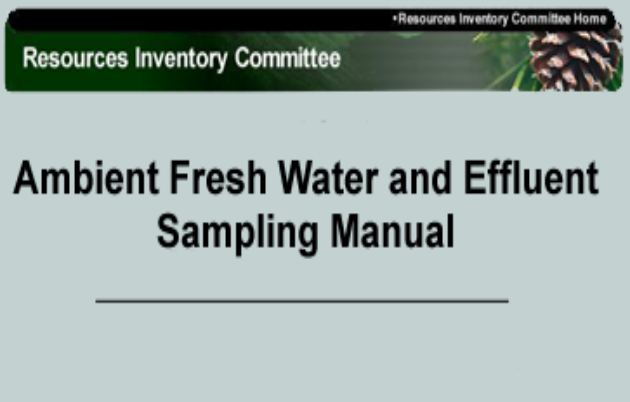
Examples of Filled-in Data Forms: Not provided

Key References: Page 44 of the document

Document No.: 50

Ambient Fresh Water and Effluent Sampling Manual

Citation: Province of British Columbia. 1997. Ambient fresh water and effluent sampling manual. Resources Inventory Committee (RIC), British Columbia, Canada.



Source: Ministry of Environment, Lands and Parks
PO Box 9360 STN PROV GOVT
Victoria B.C. V8W9M2
Phone: (250) 387-9422
Internet: http://www.gov.bc.ca/elp/con/
To order hard copy manuals, call Queen's Printer Government Publications Centre at: (250) 387-3309 or Toll-free: 1-800-663-6105 or visit the RIC web page at: http://www.for.gov.bc.ca/ric/pubs/aquatic/ambient/index.htm

Abstract: This manual covers the minimum requirements to ensure quality and consistency of the field aspects of ambient water and effluent data collection. The essential tasks in water sampling are to obtain a sample that meets the requirements of the program, in terms of location and frequency, and to prevent deterioration and contamination of the sample before analysis. The procedures outlined in this manual are orientated primarily towards BC Environment employees, consultants, or those under a legal requirement to undertake a sampling program for the Ministry. The data obtained through the use of this manual will be incorporated into standardized fields into a database (Environmental Monitoring System, EMS, for BC Environment).

The protocols outlined in this manual will aid field staff in collecting reliable, representative water samples.

Target Application: Management **&** Research

Suitable for Volunteers: No

- **Monitoring Focus:** This manual focuses on monitoring water quality/water chemistry of ambient as well as effluent freshwater of rivers and lakes. Included in the manual are procedures for monitoring: temperature,
- dissolved oxygen,
- conductivity/salinity, pH,
- water clarity,
- ORP,
- and stream flow

This manual does not address project design or data interpretation. These topics are available in:

Cavanagh, N., R.N. Nordin, L.W. Pommen and L.G. Swain. Guidelines for Designing and Implementing a Water Quality Monitoring Program in British Columbia
Avialable at the RIC web site:
http://www.for.gov.bc.ca/ric/PUBS/Aquatic/design/index.htm

and *Guidelines for interpreting Water Quality Data.*
Available at the RIC web site:
http://www.for.gov.bc.ca/ric/PUBS/Aquatic/interp/index.htm

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Field

Level of Data Quality: Levels 3 **&** 4

Equipment and Tools (*list*): Generic field checklist in appendix 1 of the document

Data Forms: Appendix 2 of the document

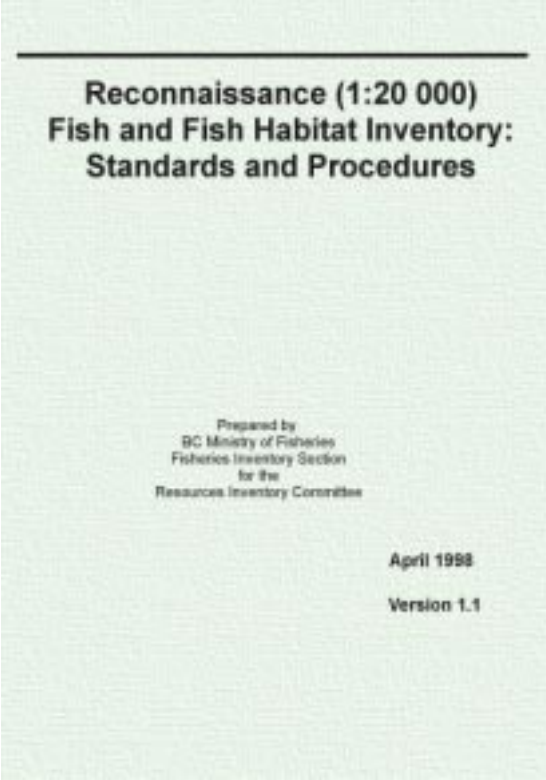
Examples of Filled-in Data Forms: Not provided

Key References: Section 10 of the document

Document No.: 51

Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures

Citation: Province of British Columbia. 1998. Reconnaissance (1:20,000) fish and fish habitat inventory: standards and procedures. Prepared by BC Ministry of Fisheries, Fisheries Inventory Section for the Resource Inventory Committee. British Columbia, Canada.



Source: Ministry of Agriculture, Food and Fisheries
BC Fisheries
PO Box 9043 STN PROV GOVT
Victoria V8W9E2
Phone: (250) 387-1023
Internet: http://www.gov.bc.ca/fish/
#200 – 1112 West Pender Street
Vancouver, BC V6E 2S1
Phone: (604) 683-2181
Fax: (604) 683-2189
Or available online at:
http://www.for.gov.bc.ca/ric

Abstract: This manual describes the Resources Inventory Committee (RIC) standard for Reconnaissance (1:20,000) Fish and Fish Habitat Inventory for British Columbia. The reconnaissance is a sample-based survey covering whole watersheds. It provides information regarding fish species distributions, characteristics and relative abundance. It also provides stream reach and lake biophysical data for interpretation of habitat sensitivity and capability for fish production. This manual presents all phases of the inventory, from pre-field data review to data compilation, and preparation of final reports and maps.

Target Application: Management **&** Research

Suitable for Volunteers: No

Monitoring Focus: fish species distributions, characteristics and relative abundance – stream reach and lake biophysical data including macrohabitat classification, general vegetation, temperature, water chemistry, cover composition and abundance, stream morphology, substrate (pebble count), bank and shoreline cover, channel classification, and photodocumentation.

Geographic Scale: Basin

Methods: Office Field

Level of Data Quality: Levels 3 and 4

Equipment and Tools (*list)*: Not provided

Data Forms: Available online at: http://www.for.gov.bc.ca/ric/PUBS/Aquatic/index.htm

Examples of Filled-in Data Forms: Not provided

Key References: At the end of each chapter of the document

Document No.: 52

Title: Quality Assurance Sample Procedures for Water Quality Surveys

Citation: Bauer, S.B., W.H. Clark. 1986. Quality Assurance Sample Procedures for Water Quality Surveys. Journal of the Idaho Academy of Science. 22 (2). 22-55.

Quality Assurance Sample Procedures for Water Quality Surveys

by

Stephen B. Bauer and William H. Clark
Idaho Department of Health and Welfare
Division of Environment
450 West State Street, Boise, ID 83720

and

James A. Dodds
Idaho Department of Health and Welfare
Bureau of Laboratories
2200 Old Penitentiary Road, Boise, ID 83712

Source: Idaho Department of Environmental Quality
Contact: William H. Clark
1410 N. Hilton Street
Boise, ID 83720
Phone: (208) 373-0502
Internet: http://www2.state.id.us/deq

Abstract: Quality assurance procedures were tested using Division of Environment water quality studies of agricultural runoff in the Twin Falls (Rock Creek) and Lewiston areas, 1984-1985. Average relative range, a precision estimate, was calculated as a measure of dispersion between field split samples. Precision for suspended sediment, total Kjeldahl nitrogen, total inorganic nitrogen (nitrate & nitrite), and total phosphorus was good (4.4-20.7%), but fair for dissolved ortho-phosphate (16.6- 26.9%) and poor for fecal coliform bacteria (52.1%). Percent recovery (accuracy) was calculated from field spiked samples. Average recovery was good for most parameters (90.3-112.8%), fair for ammonia (120%) and hydrolysable phosphorus (80%), and poor for fluoride (20.7%). We recommend replicate sampling for estimation of precision and field spiking for estimation of accuracy be included as an integral part of water quality investigations. These procedures can be applied to collection of other categories of environmental measures.

Target Application: General **&** Management

Suitable for Volunteers: No

Training Required: Yes
Available? No

Monitoring Focus: This document provides a good example of a water quality program QAPP, and discusses possible sources of error.

Geographic Scale: Basin to reach

Methods: Field **&** Laboratory

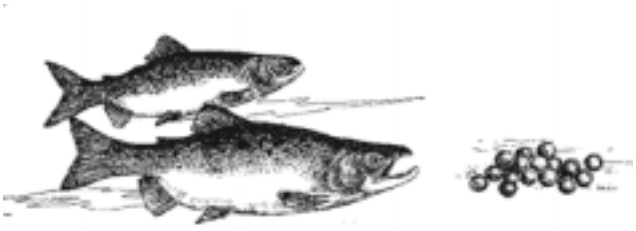
Level of Data Quality: Not applicable

Equipment and Tools (*list*): Not applicable

Data Forms: Not provided

Examples of Filled-in Data Forms: Not provided

Key References: Page 54 of the document



Document No.: 53

Field Testing of New Monitoring Protocols to Assess Brown Trout Spawning Habitat in an Idaho Stream

Citation: Maret, T.R., T.A. Burton, G.W. Harvey, and W.H. Clark. 1993. Field testing of new monitoring protocols to assess Brown Trout spawn ing habitat in an Idaho stream. North American Journal of Fisheries Management. 13: 567- 580.


FIELD TESTING OF NEW MONITORING PROTOCOLS TO ASSESS BROWN TROUT SPAWNING HABITAT IN AN IDAHO STREAMS

T.R. MARET, T.A. BURTON, G.W. HARVEY, AND W.H. CLARK

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Source: North American Journal of Fisheries Management
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U.S. Geological Survey, Water Resources Division, Idaho District Office
230 Collins Road, Boise Idaho 83702, USA

Abstract: The effects of nonpoint source pollution on salmonid incubation and embryo survival to emergence were evaluated on Rock Creek in south-central Idaho. New monitoring protocols were applied to evaluate effects of sediments and associated pollutants on spawning and recruitment of brown trout *Salmo trutta*. According to these new protocols, incubation success in artificial egg pockets is measured in terms of intragravel dissolved oxygen (IGDO), percent fine sediment (< 2.0 mm) in the substrate, and survival of embryos and alevins to emergence. Mean IGDO concentrations and saturation levels were significantly less ($P < 0.05$) at stations affected by agricultural pollutants than at a control station. Up to 40% of IGDO measurements were below 6.0 mg/L, the proposed water quality criterion for salmonid spawning in Idaho streams. Mean values for percent fine sediment were also higher at all impacted stations. Survival to emergence at the control station ranged from 19 to 83% and averaged 48%. Survival at impacted stations ranged from 0 to 54% and averaged 17%. Survival generally increased with mean IGDO concentrations above 8.0 mg/L and 70% saturation. A growth index expressed as the ratio of alevin total length to thermal units of exposure (summed daily degrees above 0°C) during stream incubation showed reduced alevin growth during incubation at impacted stations. Significant positive relationships were found between IGDO saturation and survival to emergence ($P < 0.01$). We found significant inverse relationships for percent fine sediment and survival ($P < 0.05$).

Target Application: Management **&** Research

Suitable for Volunteers: No

Training Required: Yes
Available? No

Monitoring Focus: This document provides a method for artificial redd construction, and measurement of intragravel dissolved oxygen and percent fine sediments in the redd.

Geographic Scale: Project site

Methods: Field

Level of Data Quality: Level 3

Equipment and Tools (*list*) : Provided in the document

Data Forms: Not provided

Examples of Filled-in Data Forms: Not provided

Key References: Page 579 of the document

Document No.: 54

Coordinated Nonpoint Source Water Quality Monitoring Program for Idaho

Citation: Clark, W.H. 1990. Coordinated nonpoint source water quality monitoring program for Idaho. Idaho Department of Health & Welfare, Division of Environmental Quality. 138 pp.

Source: Idaho Department of
Environmental Quality
Contact: William H. Clark
1410 N. Hilton Street
Boise, ID 83720
Phone: (208) 373-0502
Internet: http://www2.state.id.us/deq

Abstract: In August 1988 an Anti-degradation Agreement for Idaho was finalized after months of negotiations between agricultural, timber, and mining interests, Indian tribes, sportsmen, and the conservation community. The key provisions of this landmark agreement are Basin Area Meetings will be held biennially across the state to discuss water quality and to allow citizens to nominate stream segments of concern; establishment of a coordinated monitoring program; and a process for designating outstanding resource waters.

This document was developed by an eight member technical advisory committee to meet the second provision of the agreement, establishment of a coordinated monitoring program. Its broad objective is to maximize water quality data collection efforts in Idaho by providing a standard monitoring format that all con follow, by eliminating duplication of monitoring effort and development of a shared common surface water quality database. The program will require cooperation by all involved with water quality monitoring in Idaho.

This document describes Basin and Watershed Trend Monitoring; Beneficial Use Monitoring; and Best Management Practice (BMP) Effectiveness Monitoring. The program addresses the three main nonpoint source activities in Idaho: agriculture, forestry, and mining. For each of these activities an introduction and objectives section is included, as well as a description of the current program and a description of the recommended program.

The monitoring program described here addresses trends in major river basins and watersheds, beneficial use support status, and best management practice effectiveness. A listing of appropriate parameters and protocols is included for reference. A checklist of major items to be included in a nonpoint source water quality monitoring plan is included as a practical guide to plan preparation.

Target Application: Management **&** Research

Suitable for Volunteers: No

Training Required: Yes

Monitoring Focus: This document provides a plan to organize sampling efforts across Idaho. A discussion on different types of monitoring (ambient trend monitoring, beneficial use assessment monitoring, and BMP effectiveness monitoring) for different types of land uses (agriculture, forestry, and mining) is included. Recommendations for common data storage are outlined. An appendix with suggested protocols for different variables is included.

Geographic Scale: Basin to reach

Methods: Office **&** Field **&** Laboratory

Level of Data Quality: Level 4

Equipment and Tools (*list*): Not applicable

Data Forms: Idaho Forest Practice Evaluation Worksheet

Key References: Pages 66-71 of the document

Document No.: 55

Protocols for Assessment of Dissolved Oxygen Fine Sediment and Salmonid Embryo Survival in an Artificial Redd

Citation: Burton, T.A., G.W. Harvey, and M.L. HcHenry. 1990. Protocols for assessment of dissolved oxygen, fine sediment and salmonid embryo survival in an artificial redd. Idaho Depart ment of Health and Welfare, Division of Environ mental Quality, Water Quality Bureau. 25 pp.

Source: Idaho Department of
Environmental Quality
1410 N. Hilton Street
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Internet: http://www2.state.id.us/deq

Abstract: Salmonid spawning is a protected beneficial use of water quality in Idaho. Several nonpoint source activities cause accelerated sedimentation, which adversely effect salmonid spawning. An interim water quality criterion for intergravel dissolved oxygen has been developed to protect salmonid spawning. Validation of the interim criterion and the need for further data require methodologies for monitoring sediment effects, which develop data leading to more refined criteria. A methodology for monitoring sediment impact has been developed.

The techniques use intergravel dissolved oxygen, fine sediment and salmonid embryo survival in artificial egg pockets. The techniques permits measurement of the fine sediment infiltrating artificial egg pockets and the dissolved oxygen concentration in the gravels. These values are compared with egg survival and alevin escapement from the artificial egg pockets. Field testing of the methods on seven streams in Idaho have verified that the techniques are workable during different seasons and in different stream conditions.

Preliminary data analysis indicates that levels of fine sediment intrusion appear related to egg survival. Also quantities of fine sediment found in substrate are related to watershed development. Streams studied in the Idaho batholith contained relatively coarser-textured intergravel fines which resulted in little or no dissolved oxygen depression, and therefore, did not limit embryo development. Observed mortalities appeared to be the result of entrapment of alevins when fines were excessive. Streams in geologies which produce silt and clay-textured fines appeared to suppress intergravel oxygen concentration and growth and survival of developing embryos.

Target Application: Management **&** Research

Suitable for Volunteers: No

Training Required: Yes
Available: No

Monitoring Focus: The intent of this protocol is to detect impacts on salmonid incubation and recruitment by measuring fine sediment intrusion, *in situ* dissolved oxygen, and emergence of alevins from the artificial redd. This document provides a method for artificial redd construction, measurement of intragravel dissolved oxygen, percent fine sediment intrusion in the redd, and collection of alevins emerging from the artificial redd.

Geographic Scale: Stream Reach **&** Project Site

Methods: Field

Level of Data: Level 4

Equipment and Tools (*list*): Provided in the document

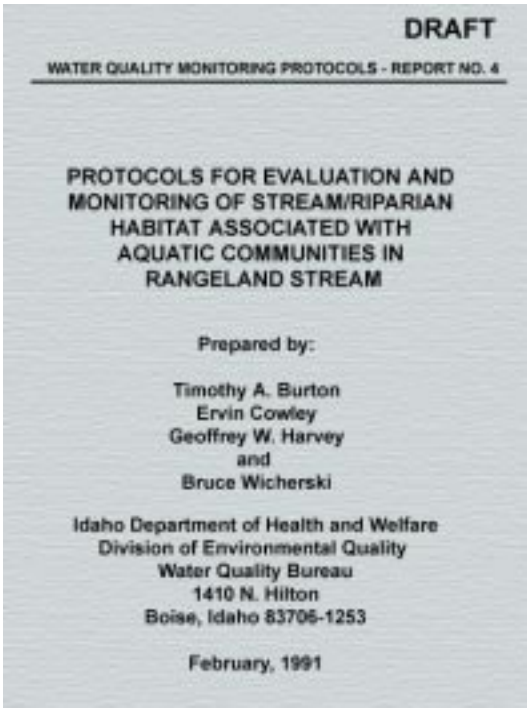
Data Forms: Not provided

Key References: Page 24 of the document

Document No.: 56

Protocols for Evaluation and Monitoring of Stream/Riparian Habitats Associated with Aquatic Communities in Rangeland Streams

Citation: Burton, T.A., G.W. Harvey, and B.C. Wicherski. 1991. Protocols for Evaluation and Monitoring of Stream/Riparian Habitats Associated with Aquatic Communities in Rangeland streams Idaho Department of Health & Welfare, Division of Environmental Quality, Water Quality Bureau. Boise, Idaho. 31 pp. + appendices.


DRAFT

WATER QUALITY MONITORING PROTOCOLS - REPORT NO. 4

PROTOCOLS FOR EVALUATION AND MONITORING OF STREAM/RIPARIAN HABITAT ASSOCIATED WITH AQUATIC COMMUNITIES IN RANGELAND STREAM

Prepared by:

Timothy A. Burton
Ervin Cowley
Geoffrey W. Harvey
and
Bruce Wicherski

Idaho Department of Health and Welfare
Division of Environmental Quality
Water Quality Bureau
1410 N. Hilton
Boise, Idaho 83706-1253

February, 1991

Source: Idaho Department of Environmental Quality
1410 N. Hilton Street
Boise, ID 83720
Phone: (208) 373-0502
Internet: http://www2.state.id.us/deq

Abstract: This document discusses types of degradation associated with rangeland uses, describes a "stratified-systematic" monitoring design, and provides protocols to measure different parameters associated with the water column, streambank/channel, and riparian vegetation. Site selection is based on an initial hierarchical stratification of stream "sub-areas" based on natural factors, land use, and sampling requirements. Within homogenous "sub-areas", a reach representative of the "sub-area", in terms of pool and riffle density, is chosen for monitoring.

Monitoring protocols for parameters associated with the water column, streambank/channel, and riparian vegetation are described. Water column variables include water temperature, nutrients, bacteria, other indicators of chemical pollution, and streamflow. Streambank/Channel variables include streambank stability, undercut streambank, rearing habitat, and substrate sedimentation. Riparian vegetation variables include greenline vegetation ecological status, woody regeneration, and soil compaction. Evaluation methods of status and trends associated with each variable are discussed.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, if supervised by experienced personnel

Training Required: Yes
Available: No

Monitoring Focus: This document has been developed to define the appropriate parameters and outline specific protocols for monitoring and evaluation in the agriculture water quality program.

Geographic Scale: Stream reach

Methods: Field

Level of Data Quality: Level 4

Equipment and Tools (*list*): Provided in the document

Data Forms: Forms for all variables are provided

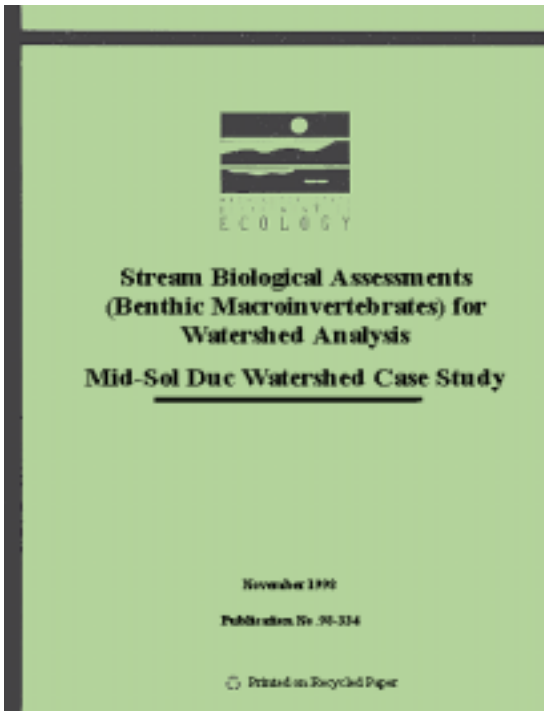
Examples of Filled-in Data Forms: Not provided

Key References: Pages 27-31 of the document

Document No.: 57

Stream Biological Assessments (Benthic Macroinvertebrates) for Watershed Analysis; Mid Sol Duc Watershed Case Study

Citation: Plotnikoff, R. 1998. Stream Biological Assessments (Benthic Macroinvertebrates) for Watershed Analysis; Mid-Sol Duc Watershed Case Study. Washington State Department of Ecology, Environmental Assessment Program. Olympia, WA. Publication No. 98-334. 37 pp.



Source: Washington Department of Ecology
Environmental Investigations
and Laboratory Services Program
Olympia, Washington 98504-7710
Copies can be obtained at:
Department of Ecology
Publications
P.O. Box 47600
Olympia, WA 98504-7600
Phone: (360) 407-7472
Internet: http://www.ecy.wa.gov

Abstract: A method was developed for surveying current biological conditions in a watershed and interpreting the results. The biological condition of five streams was compared to several watershed scale assessments.

Benthic macroinvertebrate communities were evaluated using biometric analysis and site condition was determined using diagnostic flow charts. The survey of benthic macroinvertebrates identified three categories of risk from further changes to current watershed condition. Biological responses to temperature and sediment condition were identified as influential physical features to macroinvertebrates in this watershed.

Minor impairment to the biological community was identified at sites where physical changes to the stream were not obvious. Macroinvertebrate surveys in five stream settings were able to describe the vulnerability of stream biota and the physical variables that would further degrade the communities. This manual also includes an itemized cost for the project in Appendix C of the protocol.

Target Application: Management

Suitable for Volunteers? No

Training Recommended: Yes. Two levels Education as well as substantial amount of field experience are recommended:

***Level 1*:** Bachelor's degree in aquatic entomology or ecology, or in a related field such as fisheries, science, zoology, etc.
Level 2: Master's Degree in aquatic entomology or ecology, or in a related field.

Monitoring Focus: Surveying current biological conditions of a watershed by analyzing the benthic macroinvertebrate community. The methods focus on physical stream channel conditions, riparian conditions, and the type and quantity of available food.

Geographic Scale: Watershed

Methods: Office **&** Field

Level of Data Quality: Level 3

Equipment and Tools (*list)*: Not provided

Data Forms: Appendix A of the document

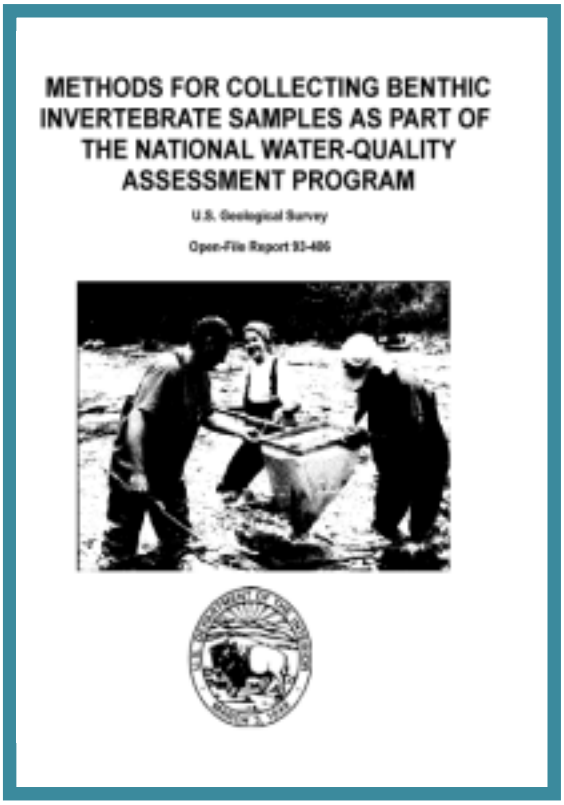
Examples of Filled-in Data Forms: Not provided

Key References: Pages 35-37 of the document

Document No.: 58

Methods for Collecting Benthic Invertebrate Samples as Part of the National Water-Quality Assessment Program

Citation: Cuffney, T., M. Gurtz, and M. Meador. 1992. Methods for Collecting Benthic Inverte brate Samples as Part of the National Water Quality Assessment Program. United States Geological Survey, National Water-Quality Assess ment Program. Open-File Report 93-406.



Source: U.S. Geological Survey
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Denver, CO 80225
Also available online at: http://water.usgs.gov/nawqa/protocols/OFR-93-406/inv1.html
For additional information write to:
District Chief
U.S. Geological Survey
3916 Sunset Ridge Road
Raleigh, NC 27607

Abstract: Benthic invertebrate communities are characterized in the United States Geological Survey's National Water-Quality Assessment (NAWQA) Program as part of an integrated physical, chemical, and biological assessment of the nation's water quality. This multidisciplinary approach provides multiple lines of evidence for evaluation water-quality status and trends, and for refining our understanding of the factors that control water quality. This is accomplished by integrated, multi-year sampling at sites chosen to represent combinations of natural and anthropogenic factors that are important in influencing water quality, locally, regionally, and nationally.

Each sampling reach is characterized using a combination of qualitative and quantitative samples. Qualitative samples collect benthic invertebrates from as many of the 51 in stream habitat types as are present and accessible within the sampling reach. Quantitative sampling is used to measure community structure, expressed as relative abundance of each taxon, within standardized habitat types.

Suitable for Volunteers? No

Monitoring Focus: The sampling methods and procedures presented here are intended to give guidance to study-unit biologists collecting benthic invertebrates as part of the USGS's NAWQA Program. Various sample collection techniques, equipment, and data forms are presented for use at basic fixed sampling sites.

Geographic Scale: The communities and habitat conditions are characterized within the study length of a stream and are referred in this manual as the "sampling reach." This approach provides a com-mon spatial scale upon which to assess community and habitat characteristics.

Methods: Field

Level of Data Quality: Level 2 **&** 3

Equipment and Tools (*list*): No list, but there are illustrated examples of invertebrate sampling equip-ment.

Data Forms: Provided in each section

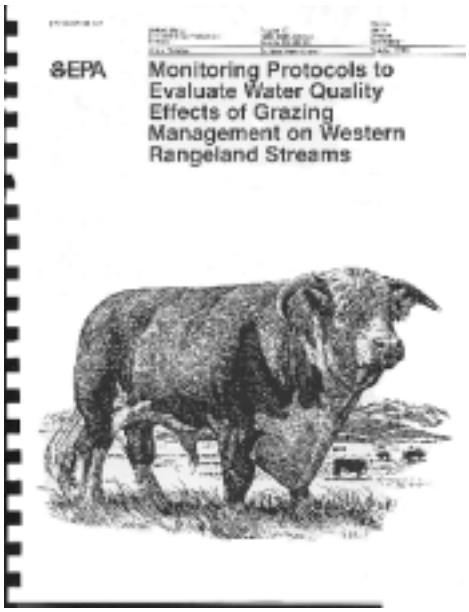
Examples of Filled-in Data Forms: None

Key References: Page 62-66 of the document

Document No.: 59

Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams.

Citation: Bauer, S., and T. Burton. Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams. EPA 910/R-93-017. Idaho Water Resources Research Institute, University of Idaho. Moscow, ID. 179 pp.



Source: Idaho Water Resources Research Institute
University of Idaho
Moscow, Idaho 83843
and
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Abstract: This document describes a monitoring system to assess grazing impacts on water quality in streams of the western United States. The protocols were developed to assess water quality improvement resulting from stream restoration projects funded under the Clean Water Act Amendments of 1987 and the Coastal Zone Management Act as amended in 1990. The monitoring methods were selected for application by natural resource professionals typically involved in these projects. This includes resource professionals with backgrounds in soils, range, hydrology, fisheries biology, and water quality.

A goal for this project is to describe methods that are easy to use and cost-effective. This is achieved by using methods that reduce sample frequency, minimize the need for specialized equipment, and reduce costly laboratory analyses.

Target Application: Management

Suitable for Volunteers? No; the procedures outlined in this manual require an interdisciplinary team with skills in riparian plant identification, fisheries, habitat assessment, stream type and soils classification.

Training Recommended: Yes

Monitoring Focus: Assessment of grazing impacts on water quality in streams of the western United States. The focus is primarily on attributes of the stream channel, stream bank and streamside vegetation of wadable streams, which are sampled during the low flow conditions in the summer

Geographic Scale: Sub-basin, basin, stream reach, project site

Methods: Office **&** Field

Level of Data Quality: Levels 3 **&** 4

Where does the data go? State water quality agencies, Soil Conservation Districts, USDA Soil Conservation Service, USDA Forest Service, USDI Bureau of Land Management, tribes, and other state and federal agencies.

Equipment and Tools (*list*): Included at the end of each section describing a particular protocol.

Data Forms: Included at the end of each section describing a particular protocol.

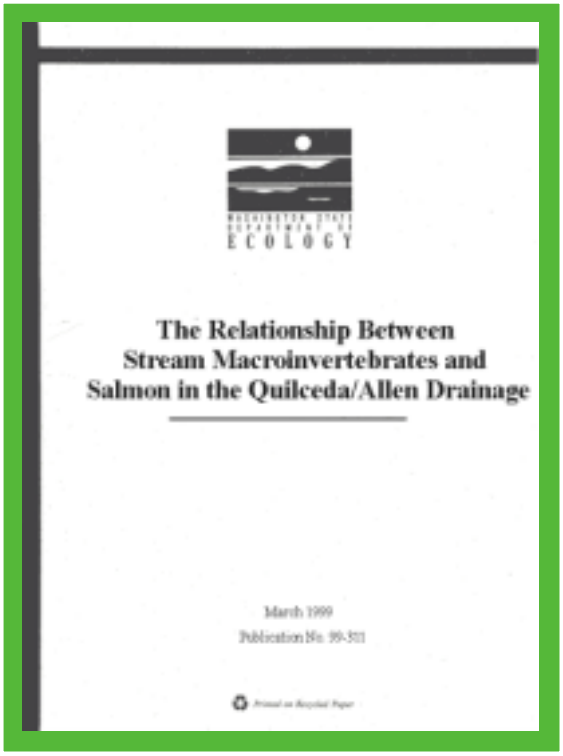
Examples of Filled-in Data Forms: Not provided

Key References: At the end of each section and pages 170-179.

Document No.: 60

The Relationship Between Stream Macroinvertebrates and Salmon in the Quilceda Allen Drainage

Citation: Plotnikoff, R. , and J. Polayes. 1999. Biological Assessment of Quilceda/Allen Drainage: Salmon Use & Stream Macroinvertebrates. Wash ington State Department of Ecology, Environmental Assessment Program. Olympia, WA. Publication No. 99-311, 20 p. + appendices.



Source: Washington State Department of Ecology
Environmental Assessment Program
Olympia, Washington 98504-7710
Copies can be obtained at:
Department of Ecology
Publications
P.O. Box 47600
Olympia, WA 98504-7600
Phone: (360) 407-7472
Available in pdf format at: http://www.ecy.wa.gov/programs/eap/fw_benth/fwb_pubs.html

Abstract: Stream macroinvertebrates were surveyed at several reaches in the Quilceda/Allen drainage to establish their value as an indicator of stream quality for salmon use. Four benthic samples were collected each from riffle and pool habitat. Quantitative physical measurements, along with water quality measurements, were made of the stream channels. High quality biological conditions were found at sites where the riparian corridor was visually intact. These sites had a high percentage of coarse gravel and cobble-sized stream bottom substrate. Additionally, canopy shading was related to biological condition of stream macroinvertebrate communities. Coho salmon (*Oncorhynchus kisutch*) use is not reported to occur in stream reaches that were severely degraded, physically and chemically. The response by the macroinvertebrate community to channel degradation was coincident with changes in reported salmon use.

Target Application: Management

Suitable for Volunteers? No

Monitoring Focus: Providing a baseline for determining trends in the basin; determining the availability of food organisms for salmon over a range of land uses, investigate the association between biological measures and known water quality probes, gather information that can be used in convincing public officials of the need of action.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Field

Level of Data Quality: Levels 2 **&** 3

Equipment and Tools (*list*): Not provided

Data Forms: Appendix A of the document

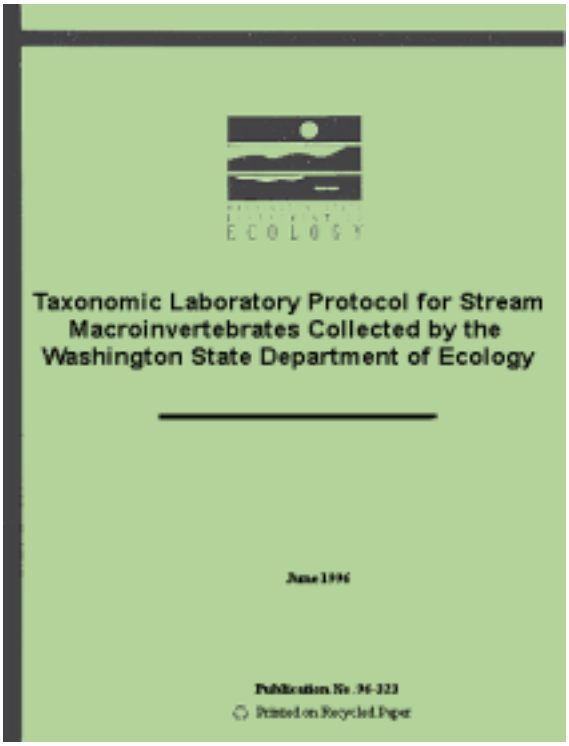
Examples of Filled-in Data Forms: Not provided

Key References: Pages 19-20 of the document

Document No.: 61

Taxonomic Laboratory Protocol for Stream Macroinvertebrates Collected by the Washington State Department of Ecology

Citation: Plotnikoff, R., and J. S. White. 1996. Taxonomic Laboratory Protocol for Stream Macroinvertebrates Collected by the Washington State Department of Ecology. Washington State Department of Ecology, Environmental Assessment Program. Olympia, WA. Publication No. 96-323, 32 p. + appendices.



Source: Department of Ecology
Publications
P.O. Box 47600
Olympia, WA. 989504-7600
Phone: (360) 407-7472
Internet: http://www.ecy.wa.gov

Abstract: The Washington State Department of Ecology (Ecology) is engaged in collection and storage of biological data from Washington State's surface waters. Biological data collection is, in part, intended to be used for delineating temporal and spatial distribution patterns as well as establishing biocriteria. The long term program goal is to develop a diagnostic tool for determining the condition and source of degradation in the state's aquatic systems. Ecology's aquatic invertebrate biological assessment program and other related monitoring programs in the agency consist of several components: field collection, sample processing, organism identification, data storage/analysis, and interpretation of results. Protocols that standardize methods for each component help assure consistent and comparable results between projects. Standardized field collection protocols and sample processing protocols have already been described in other Ecology quality assurance project plans (Merritt, 1994; Plotnikoff, 1994).

The taxonomic laboratory protocol provides guidance for consistent aquatic macroinvertebrate (invertebrate) identifications. Consistency between taxonomists and between projects enhances comparability of taxonomic effort.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, with training and supervision.

Training Recommended: Yes
Available: Limited training available
Where: The Xerces Society
4828 SE Hawthorne Blvd
Portland OR 97215-3252
Phone: (503) 232-6639
Fax: (503) 233-6794
General E-mail: xerces@teleport.com
Internet: http://www.xerces.org/aquatic.htm

Monitoring Focus: Water-quality based on stream macroinvertebrate assemblages

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Laboratory

Level of Data Quality: Levels 3 **&** 4

Equipment and Tools (*list*): Not provided

Data Forms: Not provided

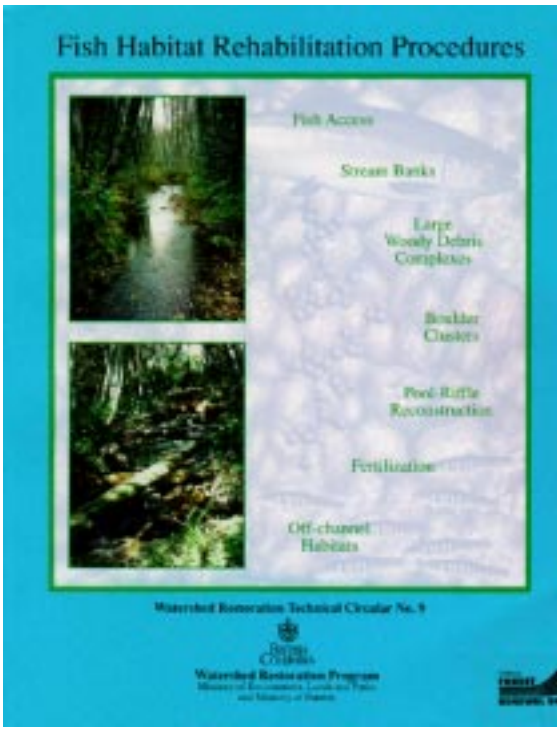
Examples of Filled-in Data Forms: Not provided

Key References: Page 28 of the document

Document No.: 62

Fish Habitat Rehabilitation Procedures

Citation: Stanley, P. A., and D. Zaldokas. 1997. Fish Habitat Rehabilitation Procedures. Watershed Restoration Technical Circular No.9. Watershed Restoration Program. Ministry of Environment, Lands and Parks. Vancouver, B.C.



Source: Watershed Restoration Program
Ministry of Environment, Lands and Parks
2204 Main Mall, UBC
Vancouver, BC B6T 1Z4
To order call: (250) 952-4460

Abstract: This manual focuses on riparian habitat rehabilitation techniques from a management prospective. The rehabilitation techniques follow and introduction section, in which planning of stream restoration projects is discussed in detail including a practical methodology to the implementation of a multiple account evaluation framework for screening watershed rehabilitation projects. The habitat rehabilitation section is full of illustrated examples and includes cost of the discussed projects. Chapters in this section provide the technical basis for a suite of integrated restorative measures to accelerate natural recovery process in forested watershed impacted by past practices. The authors stress the importance of training and skills development initiatives, as well as effective monitoring techniques. Included are 8 published guides (or technical circulars) that provided technical standards for aquatic ecosystem restoration. Examples of some of the circulars are: watershed assessment procedures, riparian assessment and prescription procedures, channel condition assessment and prescriptions, fish habitat assessment procedures, fish habitat rehabilitation procedures.

Suitable for Volunteers: Yes, if supervised by experienced personnel or with appropriate training.

Training Recommended: Yes

Monitoring Focus: This guide focuses on recovery of structural diversity and nutrient sources leading to restoration of aquatic communities and biodiversity of disturbed areas. Attributes covered in this guide include: stream channel rehabilitation, fish passage, bank stabilization, nutrient subsidy, macrohabitat classification, and gravel rehabilitation.

Geographic Scale: Sub-basin, basin, stream reach, project site

Methods: Office **&** Field

Level of Data Quality: Level 3

Equipment and Tools (*list)*: Some equipment requirements are discussed in a few chapters

Data Forms: Not applicable

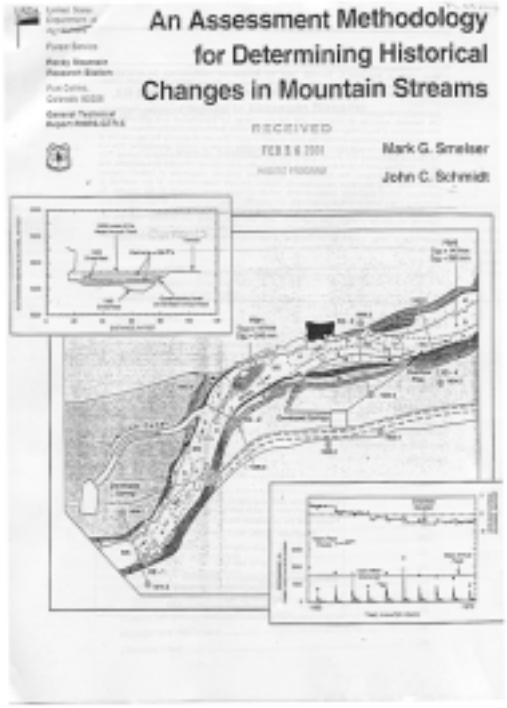
Examples of Filled-in Data Forms: Not applicable

Key References: Pages R1-17 of the document

Document No.: 63

An Assessment Methodology for Determining Historical Changes in Mountain Streams

Citation: Smelser, M. G. and J. C. Schmidt. 1998. An assessment methodology for determining historical changes in mountain streams. General Technical Report RMRS-GTR-6. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 29 pp.



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Abstract: Successful management of water in mountain streams by the USDA Forest Service requires that the link between resource development and channel change be documented and quantified. The characteristics of that linkage are unclear and the adjustability of these streams to land-use and hydrologic change has been argued in court. One way to quantify the adjustability of a stream is to examine its geomorphic history. An excellent source of historic geomorphic data are the records associated with stream gaging stations maintained by the U.S. Geological Survey. This report describes what records are available, how to organize the data on computer spreadsheets, and discusses 6 techniques that quantify the spatial and temporal magnitude of historic channel adjustments. The discharge measurements include physical measurements of the channel. In particular, USGS discharge measurements include physical measurements of the channel. In analyzing these measurements collectively, it is possible to quantify monthly, annual, and decadal scales of adjustment. Once the history of channel adjustment is determined, it can be compared to histories of climate change, flow regulation, and land use. These comparisons may link the geomorphic adjustments to particular patterns, events, or activities. Resource managers can use this knowledge to better assess the ramifications of resource development, land use, and restoration efforts on mountain stream systems.

Target Application: Management **&** Research

Suitable for Volunteers: No

Monitoring Focus: The geomorphic history of mountain streams relative to histories of climate change, flow regulation, and land use

Geographic Scale: Sub-basin

Methods: Office **&** Field

Level of Data Quality: Levels 2 **&** 3

Equipment and Tools (*list)*: None

Data Forms: Not provided

Examples of Filled-in Data Forms: Not provided

Key References: Page 28 of the document

Document No.: 64

Channel Classification, Prediction of Channel Response, and Assessment of Channel Condition

Citation: Montgomery, D. R., and J. M. Buffington. 1993. Channel Classification, Prediction of Channel Response, and Assessment of Channel Condition. Report TFW-SH10-93-002. SHAMW Committee of the Washington State Timber/Fish/Wildlife Agreement. 84 pp.

Source: SHAMW Committee of the Washington State Timber/Fish/Wildlife Agreement.

Abstract: Addressing concerns over environmental degradation requires strategies for assessing land management impact on landscapes and ecosystems. Watersheds provide natural land management units because their boundaries coincide with those of natural precesses. Changes in watershed processes can alter fluvial systems. At present, however, prediction of stream channel reponse to land use and disturbance is a weak link in watershed assessment methodologies, because channel processes are either poorly represented or viewed in isolation from the rest of the watershed. This manual proposes a process based classification of landscape and channel form that provides a foundation for interpreting channel morphology, assessing channel condition, and predicting response to natural and anthropogenic disturbances.

This protocol focuses mainly on the valley segment and channel reach levels. It discusses the theoretical basis for possible channel responses and reviews previous work on measuring and predicting channel change. It then synthesizes previous studies of channel processes into a channel classification that illustrates how different portions of drainage basin function and respond to perturbations. This classification provides a framework for both studying watershed processes and drainage basin evolution and assessing channel condition and response potential.

Target Application: Management

Suitable for Volunteers: No

Monitoring Focus:
1) macrohabitat classification,
2) classification and assessment of channels,
3) stream morphology

Geographic Scale: Watershed

Methods: Office

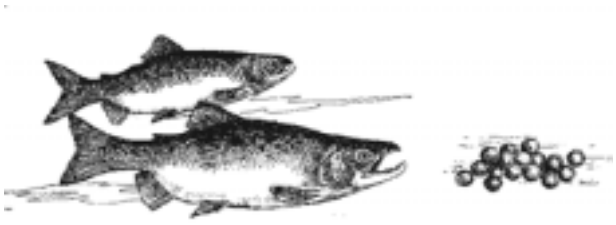
Level of Data Quality: Level 3

Equipment and Tools (*list*): Not applicable

Data Forms: Not applicable

Examples of Filled-in Data Forms: Not applicable

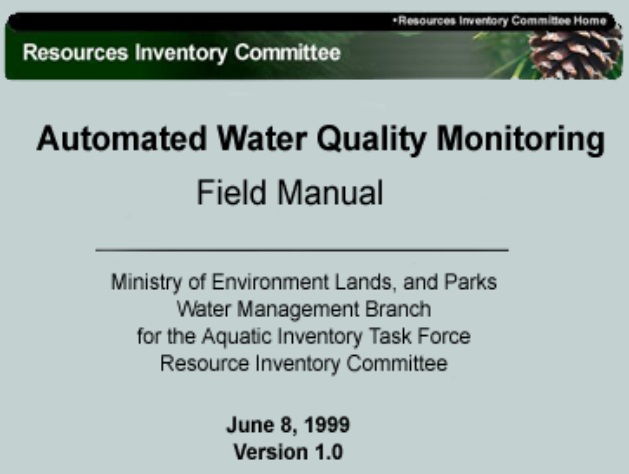
Key References: Page 67 of the document



Document No.: 65

Automated Water Quality Monitoring

Citation: Ministry of Environmental Lands, and Parks. Water Management Branch for the Aquatic Inventory Task Force. Automated Water Quality Monitoring. 1999. Automated Water Quality Monitoring. 61 pp.



Source: Ministry of Environmental Lands, and Parks. Water Management Branch for the Aquatic Inventory Task Force.
Copies can be obtained from:
Government Publications Centre
Phone: (250) 387--3309
Toll free: 1-800-663-6105
Fax: (250) 387-0388
Available in pdf format at: http://www.for.gov.bc.ca/ric/pubs/aquatic/waterqual/index.htm

Abstract: The procedures outlined in this manual represent a compilation of material from various agencies and individuals working in the area of automated water quality monitoring.

This field manual addresses the minimum requirements for the establishment and operation of reliable automated water quality monitoring program.

The intent of this manual is to aid field staff in developing an automated monitoring station and collecting reliable, representative data. Discrete sampling protocols for ambient freshwater are not addressed in this manual. Subjects such as sample containers, preservation techniques, safety measures, etc. are only briefly discussed in this manual. Among topics covered in this manual are: site selection, training, operational considerations (personnel, responsibilities), equipment testing, QA/QC, documentation, and and data management.

The procedures outlined in this manual are the most acceptable ones used at present.

Target Application: Management

Suitable for Volunteers: No

Training Recommended: Yes

Monitoring Focus: This manual focues on automated water quality/water chemistry monitoring. Protocols include: turbidity, conductivity, and water temperature.

Geographic Scale: Can be applied at all scales.

Methods: Field

Level of Data Quality: Level 2

Equipment and Tools (*list*): General checklist in Appendix 3 of the document

Data Forms: Appendix 2 of the document

Examples of Filled-in Data Forms: Not provided

Key References: Pages 5, 17, 35 of the document

Document No.: 66

Processing, Taxonomy, and Quality Control of Benthic Macroinvertebrate Samples

Citation: Moulton, S. R. II, J. L. Carter, S. A. Grotheer, T. F. Cuffney, and T. M. Short. 2000. Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory – processing, taxonomy, and quality control of benthic macroinvertebrate samples. U.S. Geological Survey Open-File Report 00-212, Denver, CO. 49 pp.

Source: U.S. Geological Survey
Information Services
Box 25286, Mail Stop 417
Denver Federal Center
Denver, CO 80225-0286

Abstract: Qualitative and quantitative methods to process benthic macroinvertebrate (BMI) samples have been developed and tested by the U.S. Geological Survey's National Water Quality Laboratory Biological Group. The qualitative processing method is based on visually sorting a sample for up to 2 hours. Sorting focuses on attaining organisms that are likely to result in taxonomic identifications to lower taxonomic levels (for example, genus or species). Immature and damaged organisms are also sorted when they are likely to result in unique determinations. The sorted sample remnant is scanned briefly by a second person to determine if obvious taxa were missed.

The quantitative processing method is based on a fixed-count approach that targets some minimum count, such as 100 or 300 organisms. Organisms are sorted from randomly selected 5.1- by 5.1 centimeter parts of a gridded subsampling frame. The sorted remnant from each sample is resorted by a second individual for at least 10 percent of the original sort time. A large-rare organism search is performed on the unsorted remnant to sort BMI taxa that were not likely represented in the sorted grids.

After either qualitatively or quantitatively sorting the sample, BMIs are identified by using one of three different types of taxonomic assessment. The Standard Taxonomic Assessment is comparable to the U.S. Environmental Protection Agency Rapid Bioassessment Protocol III and typically provides genus- or species-level taxonomic resolution. The Rapid Taxonomic Assessment is comparable to the U.S. Environmental Protection Agency Rapid Bioassessment Protocol II and provides Family-level and higher taxonomic resolution. The Custom Taxonomic Assessment provides species-level resolution whenever possible for groups identified to higher taxonomic levels by using the Standard Taxonomic Assessment. The consistent use of standardized designations and notes facilitates the interpretation of BMI data within and among water-quality studies. Taxonomic identifications are quality assured by verifying all referenced taxa and randomly reviewing 10 percent of the taxonomic identifications performed weekly by Biological Group taxonomists. Taxonomic errors discovered during this review are corrected.

BMI data are reviewed for accuracy and completeness prior to release. BMI data are released phylogenetically in spreadsheet format and unprocessed abundances are corrected for laboratory and field subsampling when necessary.

Target Application: Management **&** Research

Suitable for Volunteers: No

Training Recommended: Yes

Monitoring Focus: Water-quality based on benthic macroinvertebrate assemblages

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Laboratory

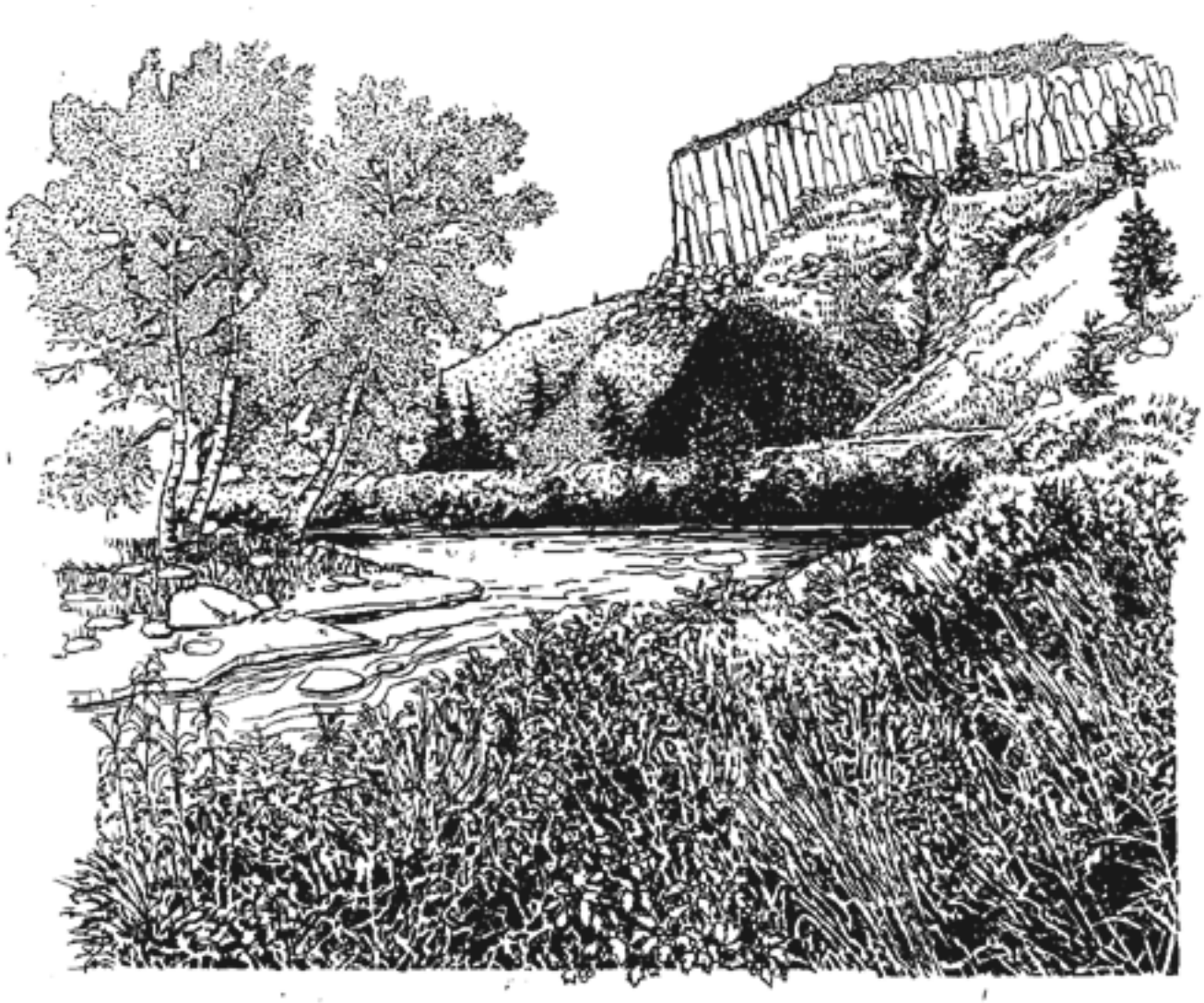
Level of Data Quality: Levels 3 **&** 4

Equipment and Tools *(list)*: Page 3 of the document

Data Forms: Page 5 of the document

Examples of Filled-in Data Forms: Not provided

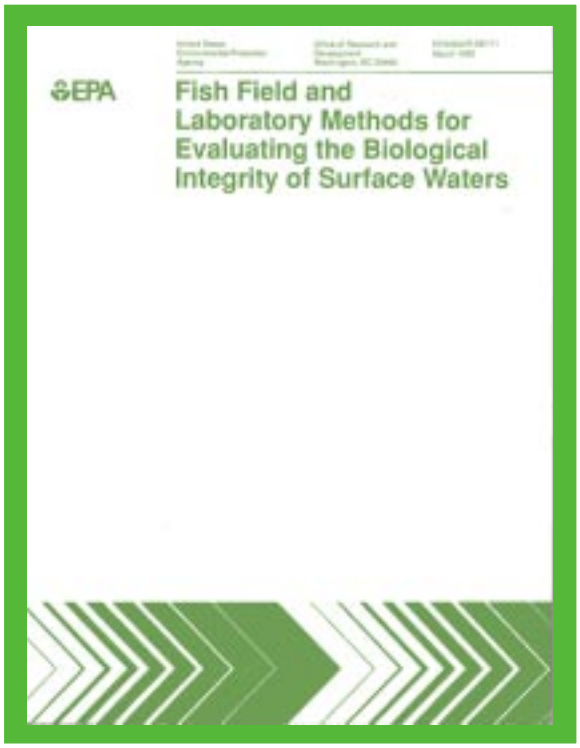
Key References: Page 31 of the document



Document No.: 67

Fish Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters

Citation: Klemm. D., J., Q. J. Stober, and J. M. Lazorchak. 1993. Fish Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters. EPA/600/R-92/111. U.S. Environmental Protection Agency. Environmental Monitoring System Laboratory. Cincinnati, Ohio. 348 pp.



Source: U.S. Environmental Protection Agency
Environmental Monitoring System Laboratory
Cincinnati, Ohio 45268

Abstract: This manual contains biocriteria and describes guidelines and standardizes methods for using fish in evaluating the health and biological integrity of surface waters and for protecting the quality of water resources. Included are sections on quality assurance and quality control procedures; safety and health recommendations; fish collection techniques; specimen processing techniques; identification and taxonomic references; fish age, growth, and conditions determinations; data recording; length -frequency; length-age conversion; annulus formulation; relative weight index; flesh tainting; fish kill investigation; bioassessment protocols for use in streams assessment; guidelines for fish sampling and tissue preparation for bioaccumulative contaminants; and an extensive bibliography for fisheries.

Target Application: Management

Suitable for Volunteers? No

Training Recommended: All personnel need to have adequate education, training, and experience in the areas of their technical expertise, responsibilities, and in quality assurance. Recommended periodic assessment of the training needs of the personnel engaged in QA and support their participation in relevant seminars, training courses, and evaluation/certification programs.
Available: Yes. On the job training.
Where: Regional EPA agencies

Monitoring Focus: Using fish as indicators of ecosystem health and evaluating the biological integrity of surface waters and protecting quality water resources.

Geographic Scale: Basin, sub-basin, stream reach, project site.

Methods: Field **&** Laboratory

Level of Data Quality: Levels 3 **&** 4

Equipment and Tools (*list*): Section 4, Sample Collection for Analysis of the Structure and Function of Fish Communities, Table 3, General Checklist of Fish Field Equipment and Supplies.

Data Forms: Provided in the appropriate sections of the document.

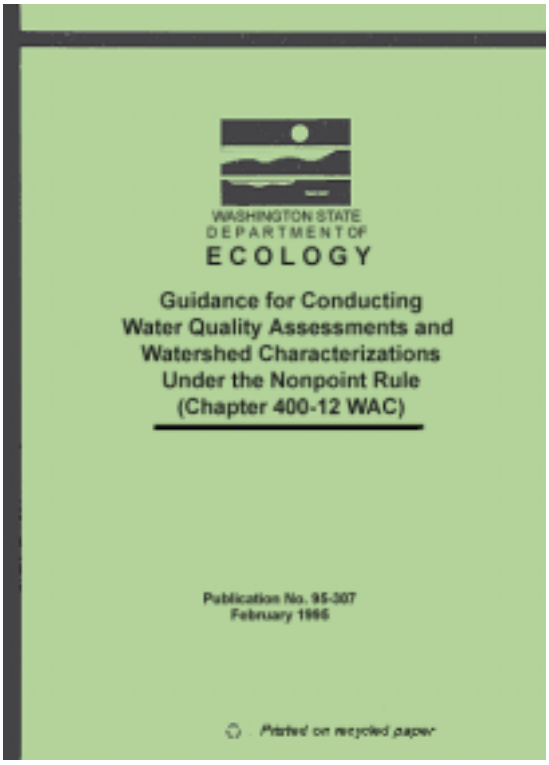
Examples of Filled-in Data Forms: Sample Report Summary on page 286-288 of the document.

Key References: At the end of each section and general reference section on pages 305-348 of the document.

Document No.: 69

Guidance for Conducting Water Quality Assessments and Watershed Characterizations Under the Nonpoint Rule

Citation: Coots, R. (editor). 1995. Guidance for conducting water quality assessments and watershed characterizations under the Nonpoint Rule (Chapter 400-12 WAC). Publication No. 95-307, Washington State Department of Ecology, Environmental Investigations and Laboratory Services and Water Quality Programs, Olympia, WA. 76 pp.



Source: Department of Ecology
Publications Distributions Office
P.O. Box 47600
Olympia, WA 98504-7600
Phone: (360) 407-7472
Internet: http://www.ecy.wa.gov

Abstract: This guidance is based on the procedures and requirements of Chapter 400-12 WAC. It provides watershed management committees with information on the water quality assessment components of the action plans (Chapter 400-12-515(2)(c)(iv)). It makes recommendations for using water quality monitoring as a tool to meet immediate and long-term watershed management objectives. This guidance manual will enable development of sound monitoring programs by directing water quality managers to resources for data collection and recording.

Among topics discussed in the manual are: QA/QC activities, study design, equipment needs and budget, data summaries, analysis, and management, and long-term monitoring aspects of watershed management, riparian corridor assessment, and land use characterization.

Target Application: Management

Suitable for Volunteers: No

Monitoring Focus: Development of water quality/water chemistry, monitoring program at the watershed level.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

Level of Data Quality: Level 4

Equipment and Tools (*list*): Not provided

Data Forms: Not provided

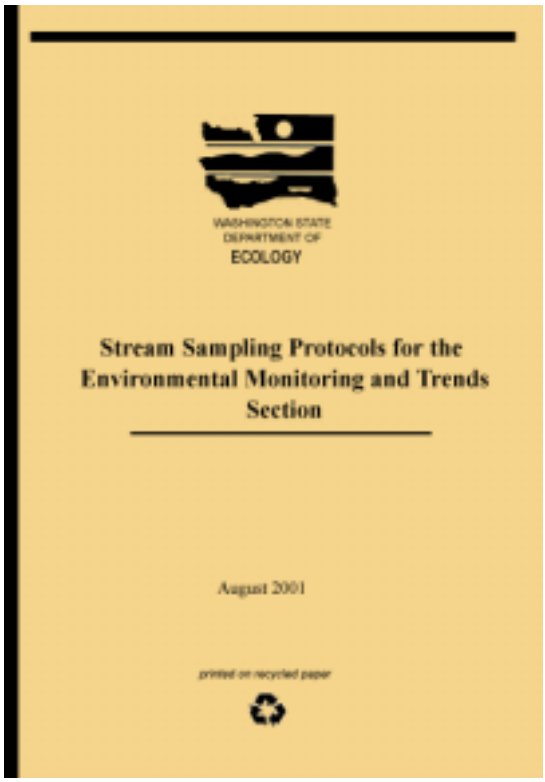
Examples of Filled-in Data Forms: Not provided

Key References: Page 33 of the document

Document No.: 70

Sampling Protocols for River and Stream Water Quality Monitoring - DRAFT

Citation: Ward, B. (editor), B. Hopkins, D. Hallock, C. Wiseman, R. Plotnikoff, and W. Ehinger. 2001. Stream sampling Protocols for the Environmental Monitoring and Trends Section. Washington State Department of Ecology Environmental Assessment Program. Olympia, WA. 31 pp. and appendices.



Source: Department of Ecology Publications
Distributions Office
P.O. Box 47600
Olympia, WA. 98504-7600
Phone: (360) 407-7472
E-mail: ecypub@ecy.wa.gov
Internet: http://www.ecy.wa.gov

Abstract: This document provides background information on the Department of Ecology's long-term river and stream monitoring program that was begun in 1970. Parameters that are measured in the field include: temperature, pH, dissolved oxygen, specific conductivity, and barometric pressure. Parameters that are measured at the laboratory include: ammonia – N (NH_3), enterococci, fecal coliform, nitrate + nitrite (NO_3^- + NO_2^-), orthophosphate (dissolved), total persulfate nitrogen (TPN), total phosphorous (TP), total suspended solids, and turbidity.

Preparation for sampling runs is outlined as well as field procedures for sampling personnel. The sampling procedure, a typical sampling routine, and field processing of samples are outlined in step by step format.

Target Application: Management **&** Research

Suitable for Volunteers: No

Training Recommended: Yes
Available: Limited training available for Department of Ecology employees
Where: Department of Ecology

Monitoring Focus: Water quality of rivers and streams

Geographic Scale: Basin, sub-basin

Methods: Office & Field

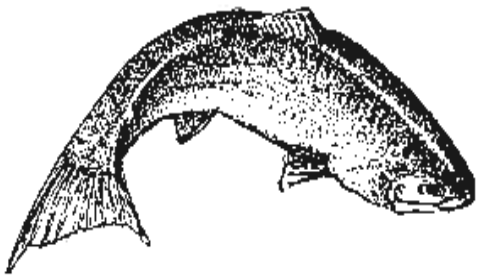
Level of Data Quality: Level 4

Equipment and Tools (*list*): Appendix A of the document.

Data Forms: Appendices B-F of the document

Examples of Filled-in Data Forms: Not provided

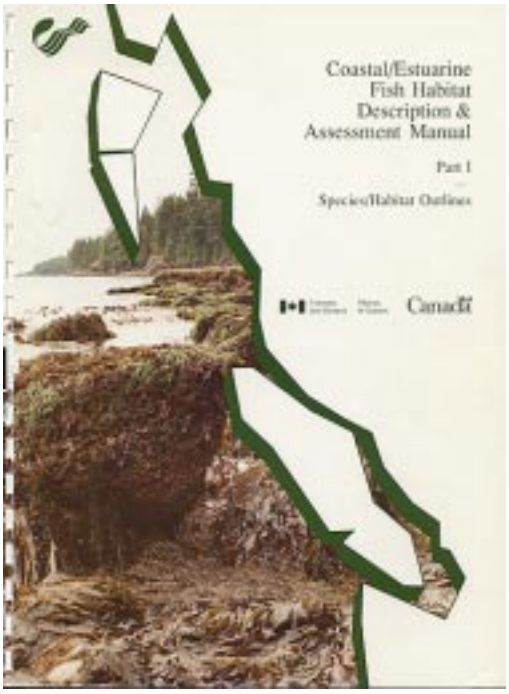
Key References: Page 30 of the document



Document No.: 71

Coastal/Marine Fish Habitat Description and Assessment Manual

Citation: Williams, G. L. 1989. Coastal/Marine Fish Habitat Description and Assessment Manual. Part II. Habitat Description Procedures. G.L. Williams & Associates Ltd. Coquitlam, B.C.38 pp + appendices.



Source:

Department of Fisheries and Oceans and Pacific Region
Habitat Enhancement Branch
Suite 400-555 West Hastings St.
Vancouver, B.C., V6B 5G3
Contact: Joanne Day
Phone: (604) 666-6614

Abstract: The intention of this document is to develop marine foreshore and on-site habitat description and assessment evaluation manual for the Department of Fisheries and Oceans (DFO).

The overall objective of this manual was to develop practical, consistent and ecologically based procedures for conducting through and consistent habitat assessments in the Pacific Region to ensure that the habitats of ecologically and economically important fisheries species are conserved. The manual consists of three parts: species/habitat outlines for 49 species important to the commercial sport and native fisheries, species/habitat references appendix, habitat description procedures manual, and discussion paper on habitat evaluation procedures. The procedures address nearshore habitats extending from the backshore or upland to the 20 m subtidal depth (below low water).

Target Application: Management

Suitable for Volunteers: No

Monitoring Focus: Development of classification system for marine and estuarine fish habitat integrating physical and biological characteristics. Among the specific objectives are to utilize to a great extent existing databases to incorporate biophysical relationships in the evaluations and have a sound technical basis in the scientific literature. This document focuses on the following attributes: macrohabitat classification, general vegetation, and biomonitoring of macroinvertebrates and fish communities.

Geographic Scale: marine, nearshore, estuary

Methods: Office **&** Field

Level of Data Quality: Level 3

Equipment and Tools (*list*): Not provided

Data Forms: Pages 26-28 of the document

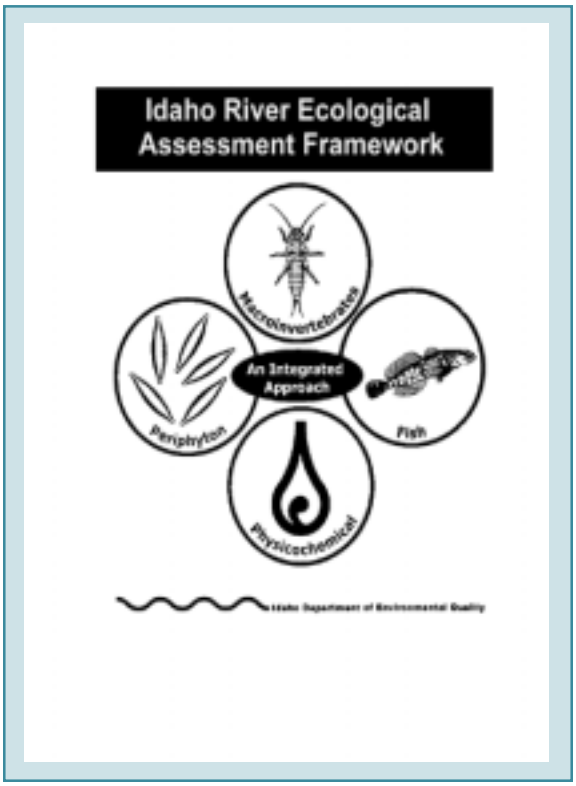
Examples of Filled-in Data Forms: Page 40-42 of protocol; Also provided are photographs corresponding to a given habitat classified in the document

Key References: Page 37 of the document

Document No.: 72

Idaho River Ecological Assessment Framework

Citation: Grafe, C. S., editor. 2000. Idaho River Ecological Assessment Framework: an Integrated Approach. Idaho Department of Environmental Quality. Boise, Idaho.



Source: Idaho Department of Environmental Quality
1410 N. Hilton
Boise, Idaho 83706
Phone: (208) 373-0502
Available online at: www2.state.id.us/deq

Abstract: This manual uses biological indicators, physicochemical data and numeric water quality criteria to assess aquatic life use support for rivers. The intent of this document is to provide detailed technical information concerning the development and integration of the River Macroinvertebrate Index (RMI), River Fish Index (RFI), River Diatom Index (RDI), and River Physicochemical Index (RPI) used in the aquatic life use support determination.

The Idaho Department of Environmental Quality (DEQ) developed a separate bioassessement for rivers because biological communities naturally change as stream size increases from headwaters to mouth. Also, practical sampling and safety considerations make biological Further, larger systems have highly variable biological and physical properties with often extensive, complex human impacts that require a much larger scope of analysis. DEQ applies the river ecological assessment approach based on results from three water body size criteria: stream order, width, and depth. In general, the river method is applied to water bodies that have an average water body size criteria rating of greater than or equal to 1.3.

Target Application: Management **&** Research

Suitable for Volunteers? No

Monitoring Focus: Provide detailed and technical information concerning the development of the River Macroinvertebrate Index, River Fish Index, River Diatom Index, and River Physicochemical Index used in determination of aquatic life use support in Idaho's rivers.

Geographic Scale: This method is applied to water bodies that have an average water body size criteria rating of greater than or equal to 1.3.

Methods: Office

Level of Data Quality: Level 3

Equipment and Tools (*list*): Not applicable

Data Forms: Not applicable

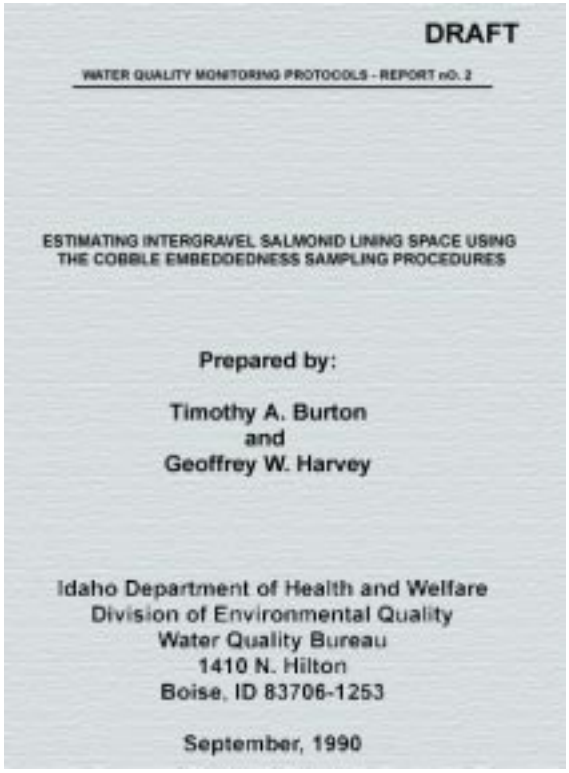
Examples of Filled-in Data Forms: Not applicable

Key References: Provided at the end of each section

Document No.: 73

Estimating Intergravel Salmonid Living Space Using the Cobble Embeddedness Sampling Procedure - DRAFT

Citation: Burton, T., and G. W. Harvey. 1990. Estimating Intergravel Salmonid Living Space Using the Cobble Embeddedness Sampling Procedure. Idaho Department of Health and Welfare. Division of Environmental Quality. Boise, Idaho. 16 pp. + appendices.


DRAFT

WATER QUALITY MONITORING PROTOCOLS - REPORT nO. 2

ESTIMATING INTERGRAVEL SALMONID LINING SPACE USING THE COBBLE EMBEDDEDNESS SAMPLING PROCEDURES

Prepared by:

Timothy A. Burton
and
Geoffrey W. Harvey

Idaho Department of Health and Welfare
Division of Environmental Quality
Water Quality Bureau
1410 N. Hilton
Boise, ID 83706-1253

September, 1990

Source: Idaho Department of Environmental Quality
1410 N. Hilton Street
Boise, ID 83720
Phone: (208) 373-0502
Internet: http://www2.state.id.us/deq

Abstract: The purpose of this report is to define state-of-the-art protocols for sampling and analyzing cobble embeddedness to determine living space requirements for young fish. Measurement of the interstitial space of streambed cobble habitat, which is an important overwintering as well as feeding and refuge habitat for young salmonids.

The manual discusses scale, grid and visual estimation methods for measuring percent fines in monitoring changes in stream sediments ove time. Data collected using this manual is entered into the Embededness Analysis System that runs on BASIC, or QuickBASIC. The manual includes detailed instruction on database structure and data entry and help with calculation of cobble embededness.

Copies of the program can be obtained by sending a 3.5 inch floppy disk, formatted IBM or compatible to:

Idaho Department of Health and Welfare
Division of Environmental Quality
Water Quality Bureau
1410 N. Hilton
Boise, Idaho 83720

Target Application: Management

Suitable for Volunteers: No

Training Recommended: Yes
Available: No

Monitoring Focus:

Geographic Scale: Stream reach

Methods: Field

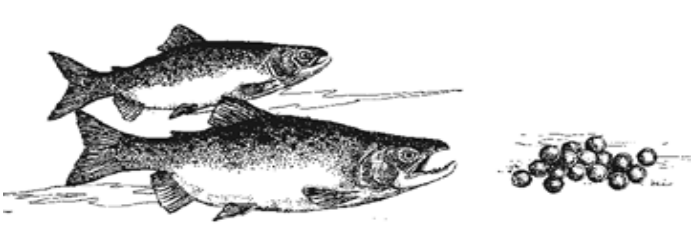
Level of Data Quality: Level 2

Equipment and Tools (*list*): Provided on page 6 of the document

Data Forms: Appendix I of the document

Examples of Filled-in Data Forms: Not provided

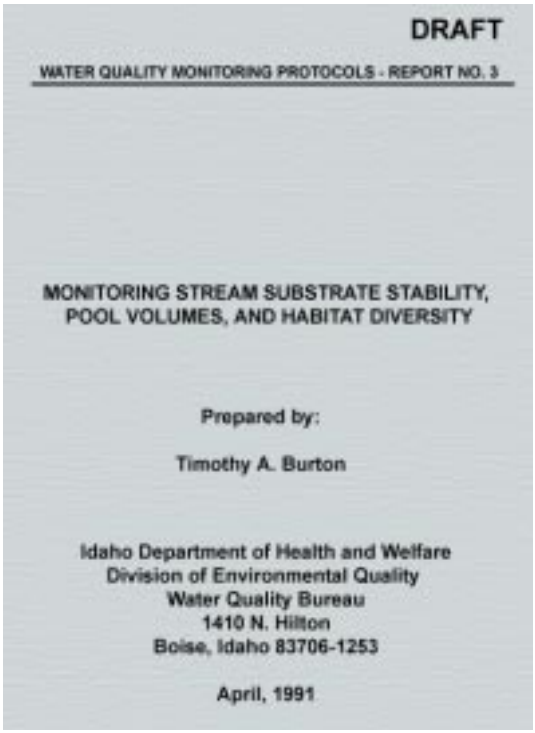
Key References: Pages 15-16 of the document



Document No.: 74

Monitoring Stream Substrate Stability, Pool Volumes, and Habitat Diversity - DRAFT

Citation: Burton, T. 1991. Monitoring Stream Substrate Stability, Pool Volumes, and Habitat Diversity. Idaho Department of Health and Welfare. Division of Environmental Quality. Boise, Idaho. 8 pp. + appendices.


DRAFT

WATER QUALITY MONITORING PROTOCOLS - REPORT NO. 3

MONITORING STREAM SUBSTRATE STABILITY, POOL VOLUMES, AND HABITAT DIVERSITY

Prepared by:

Timothy A. Burton

Idaho Department of Health and Welfare
Division of Environmental Quality
Water Quality Bureau
1410 N. Hilton
Boise, Idaho 83706-1253

April, 1991

Source: Idaho Department of Environmental Quality
1410 N. Hilton Street
Boise, ID 83720
Phone: (208) 373-0502
Internet: http://www2.state.id.us/deq

Abstract: The purpose of this manual is to define protocols to measure factors limiting fish abundance on a regional scale in Idaho. This manual lists and shortly describes a few protocols that deal with measuring such factors as substrate stability, pool volumes, and habitat diversity.

Thalweg profile surveys are recommended to measure bed elevations and monitor changes in bed morphology. Discussed are the rod and level thalweg profile procedures (reach identification and profile survey), the rapid thalweg profile procedure, measuring pool/riffle quality, and residual pool index.

The protocol also addresses the assessment of the relative composition of various critical habitat units of the entire stream based on sample-based estimates.

Target Application: Management

Suitable for Volunteers: No

Monitoring Focus: Monitoring channel bed stability and pool diversity and overall habitat diversity.

Geographic Scale: Stream reach

Methods: Field

Level of Data Quality: Level 3

Equipment and Tools (*list*): Not provided

Data Forms: Appendix I of the document

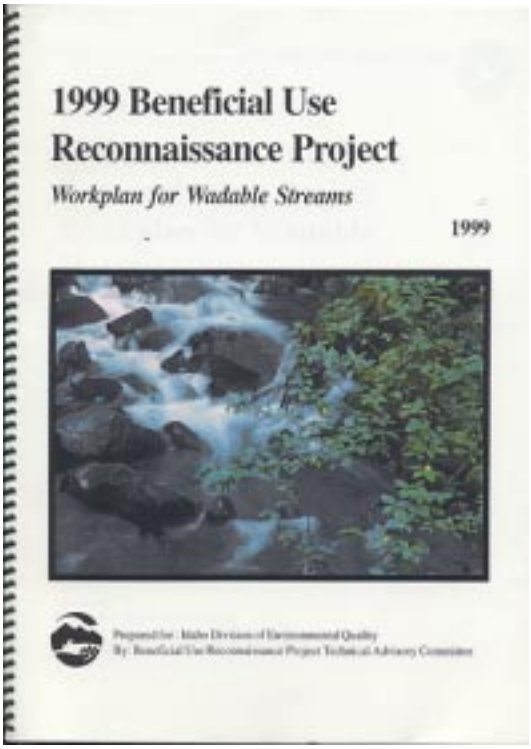
Examples of Filled-in Data Forms: Not provided

Key References: Page 7-8 of the document

Document No.: 75

1999 Beneficial Use Reconnaissance Project – Workplan for Wadable Streams

Citation: Idaho Division of Environmental Quality. Beneficial Use Reconnaissance Project Technical Advisory Committee. 1999. Beneficial Use Reconnaissance Project. Workplan for Wadable Streams.



Source: Beneficial Use Reconnaissance Project (BURP) Technical Advisory Committee.
Idaho Department of
Environmental Quality
Contact: William H. Clark
1410 N. Hilton Street
Boise, ID 83720
Phone: (208) 373-0502
Internet: http://www2.state.id.us/deq

Abstract: Provide statewide consistency in the monitoring and data collection as described in the Coordinated Nonpoint Source Water Quality Monitoring Program for Idaho (Clark 1990).

This document describes how to conduct data collection for the BURP process. It lays out the assumptions, methods, and equipment required. For each core variable, the authors provided method references and level of intensity.

This protocol does not describe the analysis and interpretation of the data collected. For the interpretation of BURP data, the reader is directed to Water Body Assessment Guidance (WBAG) document.

Target Application: Management

Suitable for Volunteers? No. The data collection and handling is done by the BURP crew members and State Office Technical Team staff.

Training Recommended: Yes

Available? Regional BURP Coordinator Workshops for the crew supervisors, provided annually. The crew supervisors then conduct training of crew within their regions.

Where? Regional BURP centers

Monitoring Focus: Sampling of selected variables for the potential Reference conditions/ streams: flow, width and depth, substrate, habitat types, bank stability, riparian vegetation, pool complexity, large woody debris, photo documentation, and diagrammatic mapping, stream channel classification, conductivity, and biological (macroinvertebrates, fish, periphyton, *E. coli*, and amphibians).

Geographic Scale: Stream reach, project site

Methods: Field

Level of Data Quality: Level 3 **&** 4

Equipment and Tools (*list*): Appendix I of the document

Data Forms: Appendix II-V of the document

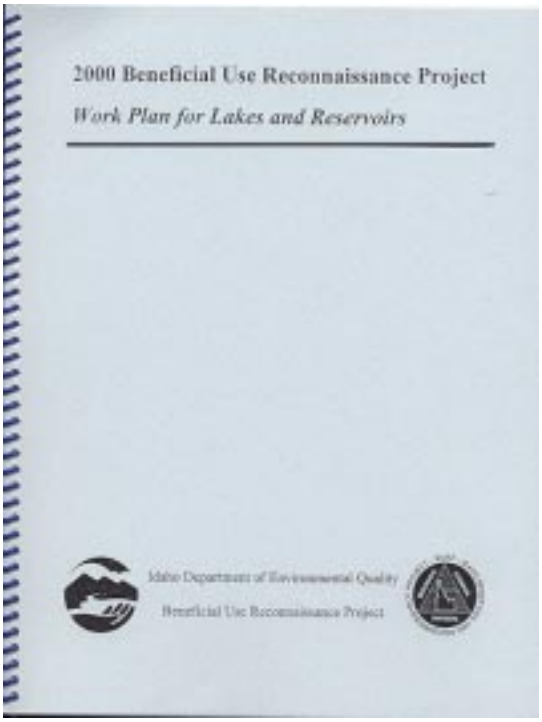
Examples of Filled-in Data Forms: See document No. 79

Key References: Page 29-37 of the document

Document No.: 76

2000 Beneficial Use Reconnaissance Project – Work Plan for Lakes and Reservoirs

Citation: Hoelscher, B. 2000. 2000 beneficial use reconnaissance project – work plan for lakes and reservoirs. Idaho Department of Environmental Quality, State Technical Services Office, Boise, ID. 33 pp. + appendices.



Source: Idaho Department of Environmental Quality
State Technical Services Office
1410 N. Hilton
Boise, ID 83706

Abstract: The Beneficial Use Reconnaissance Project protocols use the best science and understanding available to characterize water quality based on biological community attributes and their environment. They provide statewide consistency in monitoring and data collection.

This protocol is applicable to lentic waters, that is, lakes and reservoirs. It describes the methodology and provides a list of required equipment and the forms for recording data. It does not describe data analysis nor interpretation.

Target Application: Management **&** Research

Suitable for Volunteers: No. The data collection and handling is done by the BURP crew members and State Office Technical Team staff.

Training Recommended: Yes
Available? Regional BURP Coordinator Workshops for the crew supervisors, provided annually. The crew supervisors then conduct training of crew within their regions.
Where? Regional BURP locations

Monitoring Focus: Water quality based on biological community attributes and their environment

Geographic Scale: Designed for lakes and reservoirs

Methods: Office

Level of Data Quality: Levels 3 **&** 4

Equipment and Tools (*list*): Appendix II of the document

Data Forms: Appendix III of the document

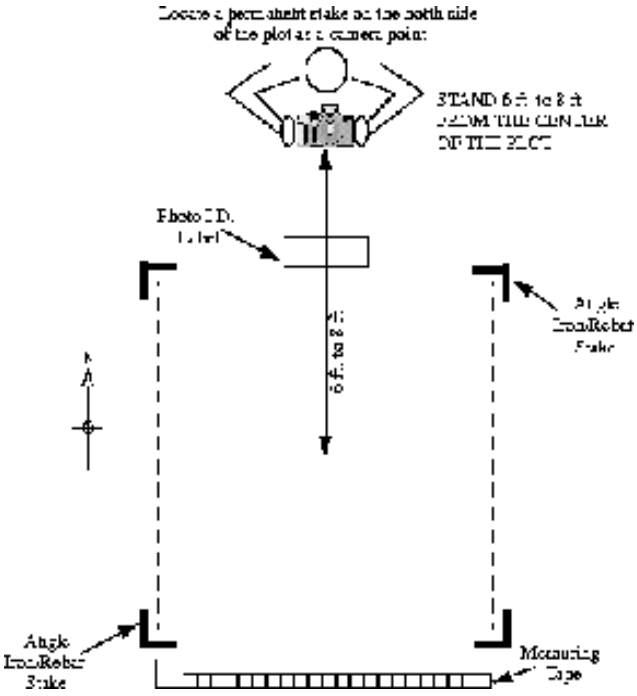
Examples of Filled-in Data Forms: Not provided

Key References: Page 21 of the document

Document No.: 77

A Guide to Establishing Points and Taking Photographs to Monitor Watershed Management Projects

Citation: The Governor's Watershed Enhancement Board. 1993. A guide to establishing points and taking photographs to monitor watershed management projects. The Governor's Watershed Enhancement Board, Salem, OR.



Source: http://www.salmonweb.org/salmonweb/pubs/pplots.html

Abstract: Monitoring is an effective way to find out if a watershed management project is meeting its goals and objectives. Monitoring can show how well, or how poorly, a management system is working. It can help identify needed changes in management and can show others how to improve watersheds and riparian areas.

Many kinds of monitoring systems are used to document the results of watershed enhancement projects. Some systems, such as taking measure and recording scientific data, can be exacting and quite complicated. The data may take many years to develop and analyze. Other systems are quite simple. Taking photographs is one of the most basic monitoring techniques. While photographs information can be gathered from photographs taken at the same point over a number of years.

Photographs often reveal changes that measurements miss. They serve as a remainder of how far you have come in establishing a healthy-functioning, natural resource area. Photos are an easy way to make others aware of the benefits of good land management practices.

This booklet can help you establish the reference points or photo plots from which to take the pictures to monitor changes resulting from a resource management project.

Target Application: Management & Research

Suitable for Volunteers: Yes

Training Recommended: No

Monitoring Focus: Photographing

Geographic Scale: Project site

Methods: Field

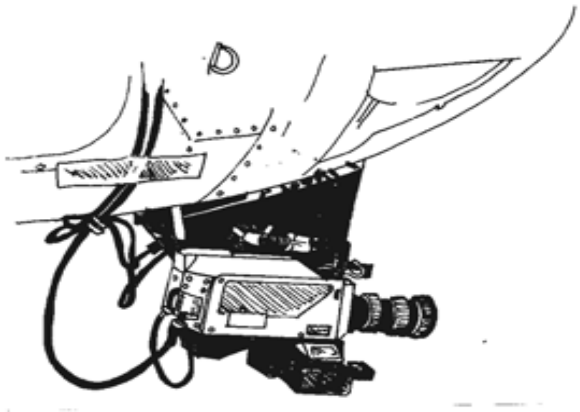
Level of Data Quality: Level 2

Equipment and Tools (*list*): Page 2 of the document

Data Forms: Page 6 of the document

Examples of Filled-in Data Forms: Not provided

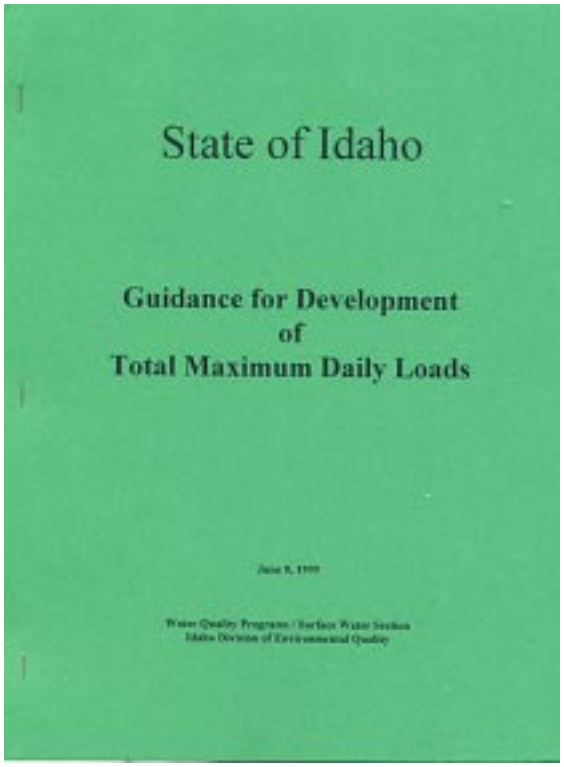
Key References: Not provided



Document No.: 78

Guidance for Development of Total Maximum Daily Loads

Citation: State of Idaho. 1999. Guidance for Development of Total Maximum Daily Loads. Water Quality Programs. Surface Water Section. Idaho Division of Environmental Quality.



The document has evolved into guidance and broadened its audience somewhat to other agencies and interests outside DEQ.

Target Application: Management

Suitable for Volunteers? No

Monitoring Focus: Total maximum daily loads are watershed-based analyses of the quantities and sources of pollutants which prevent a water from meeting its beneficial uses. The aim is to restore those uses through reductions in pollutants added to the water. A watershed-based approach recognizes the effect of both point and nonpoint sources of pollution in degrading water quality. The analysis identifies the causes of beneficial use impairment and estimates pollutant loads which will meet water quality criteria and restore impaired uses within a specified time.

Geographic Scale: Sub-basin

Methods: Office

Level of Data Quality: Levels 3 **&** 4

Equipment and Tools (*list*): Not applicable

Data Forms: Not applicable

Examples of Filled-in Data Forms: Not applicable

Key References: Not applicable

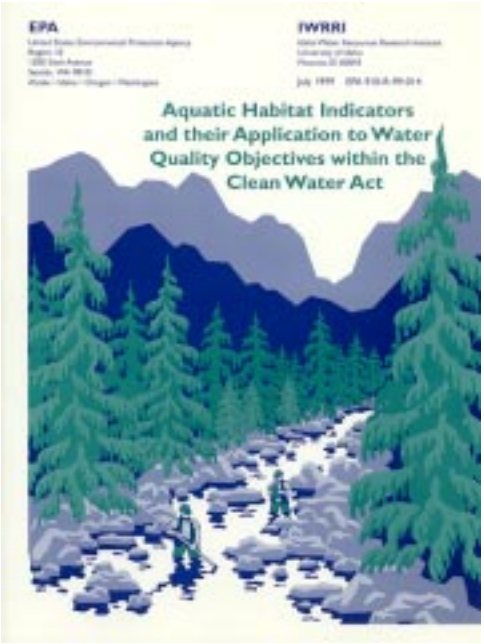
Source: Water Quality Programs.
Surface Water Section.
Idaho Division of Environmental Quality
1410 N. Hilton
Boise, ID 83706
Phone: (208) 373-0502
Internet: http://www2.state.id.us/deq

Abstract: This document addresses various aspects of how DEQ and the State of Idaho intends to go about development of Total Maximum Daily Loads analyses for water quality assessment. This document originated as specific policy statement intended to guide internal working arrangements.

Document No.: 80

Aquatic Habitat Indicators and their Application to Water Quality Objectives within the Clean Water Act.

Citation: Bauer, S. B., and S. C. Ralph. 1999. Aquatic Habitat Indicators and their Application to Water Quality Objectives. EPA-910-R-99-014. US. Environmental Protection Agency, Region 10, Seattle, WA.



Source: US Environmental Protection Agency,
Region 10, Seattle, Washington
and
Idaho Water Resources Research Institute
University of Idaho
Moscow, Idaho 83843
Copies may be requested at: EPA Region 10
Phone: 1-800-424-4372
Internet: http://www.epa.gov/r10earth

Abstract: The objective of this document is to evaluate the application of aquatic habitat variables to water quality objectives under authority of the Clean Water Act (CWA). The project is limited to freshwater, lotic aquatic habitats in the Pacific Northwest and Alaska with an emphasis on salmonid habitat. Habitat variables were placed into one of the following categories - flow regime, habitat space, channel structure, substrate quality, streambank condition, riparian condition, temperature regime, and habitat access. Candidate habitat variables were evaluated for their relevance to the biotic community, responsiveness to human impacts, applicability to target landscapes, and measurement reliability. The most critical obstacles for use of habitat variables at the regional level are the quantification of biological effect and the unreliability of the measurement system. Inherent variability and unreliable data quality preclude the use of numeric values for habitat variables as compliance indicators in statewide water quality criteria. Rather, habitat variables should be used as developed and calibrated at local or ecoregional scales as stratified by landscape and stream characteristics. Currently only a few habitat variables meet the evaluation criteria established by the authors for use under CWA authority, specifically large woody debris, pool frequency, and residual pool depth. It is recognized that this limited set of variables will not satisfy the ecological habitat requirements needed to protect cold water biota. Recommendations to increase the applicability of habitat indicators to CWA objectives include an interagency (and international) effort to evaluate landscape classification of aquatic areas, identify and measure reference area condition at ecoregional scales, and develop a systematic approach for habitat indicator quantification.

In the interim, the authors recommend a reexamination of the narrative water quality standards in EPA Region 10 to provide more specificity in regards to salmonid habitat protection. Water quality standards should also specify the process whereby numeric criteria can be established at the local or ecoregional scale.

Target Application: Management **&** Research

Suitable for Volunteers? No

Monitoring Focus: The objective of this project was to evaluate the potential inclusion of aquatic habitat indicators into water quality programs as one component of a developing EPA strategy to address declining salmonid populations in the Pacific Northwest.

Key points of this document are:

- Relevance of Aquatic Habitat Indicators to Clean Water Act Objective.
- Challenges to Using Aquatic Habitat as an Indicator
- Use of Aquatic Habitat Variables as Diagnostic Indicators
- Applicability of Indicators within Diverse Landscapes and Stream Networks
- Assessment and Monitoring Issues
- Potentially Useful Aquatic Habitat Indicators
- Numeric Format and Data Interpretation
- Application to Water Quality Standards and Total Maximum Daily Loads (TMDL)

Geographic scale: Not applicable

Methods: Office

Level of Data Quality: Levels 3 **&** 4

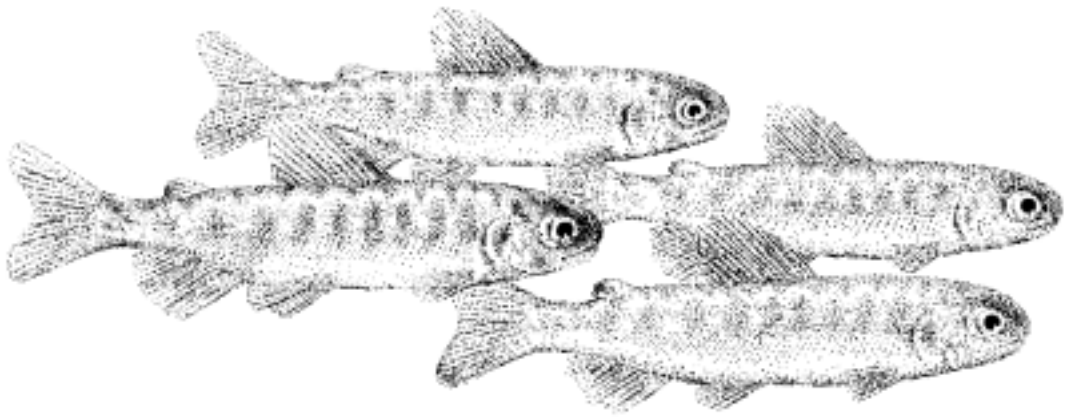
Equipment and Tools (*list*): Not applicable

Data Forms: Not applicable

Examples of Filled-in Data Forms: Not applicable

Key References: Page 70-77 of the document and at the end of Appendix A and B.

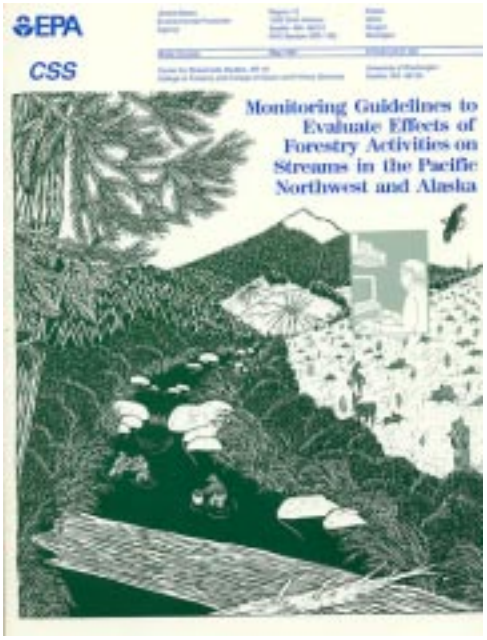
Note: The annotated bibliography is available on the Environmental Protection Agency Region 10 Internet web page at: http://www.epa.gov/r10earth



Document No.: 81

Monitoring Guidelines to Evaluate Effects of Forestry Effects on Streams in the Pacific Northwest and Alaska

Citation: MacDonald, L. H., A. W. Smart, andR. C. Wissmar. 1991. Monitoring Guidelines to Evaluate Effects of Forestry Effects on Streams in the Pacific Northwest and Alaska. EPA 910/9-91-001. US. Environmental Protection Agency, Seattle, Washington.



Source: Center for Streamside Studies in Forestry, Fisheries and Wildlife
College of Forest Resources/College of Ocean and Fishery Sciences
University of Washington
Seattle, Washington

Copies can be obtained from:
U.S. Environmental Protection Agency
Region 10, NPS Section, WD-139
1200 Sixth Ave., Seattle, WA 98101

Note: Copies of the expert system may be obtained by sending a diskette formatted in MS-DOS to the same address.

Abstract: This document is to assist land use managers and their technical staff in designing water quality monitoring projects and selecting monitoring parameters. Although the focus is on forest management and streams in the Pacific Northwest and Alaska, a broader perspective is taken, and much of the information is more widely applicable.

Part I reviews the regulatory mechanisms for nonpoint source pollution and defines seven types of monitoring. A step-by-step process for developing monitoring projects is presented. Because monitoring is a sampling procedure, study design and statistical analysis are explicitly addressed. The selection of monitoring parameters is defined as a function of the designated uses, management activities, sampling frequency, monitoring costs, access, and the physical environment. Approximately 30 parameters are rated with regard to these controlling factors. A qualitative combination of these ratings yields recommended monitoring parameters for various management activities. This parameter selection process has been incorporated into an interactive PC-based expert system called PASSSFA.

Part II is a technical review of the parameters, which are grouped into six categories: physical and chemical constituents, flow, sediment, channel characteristics, riparian, and aquatic organisms. The review of each parameter is organized into seven sub-sections: definition, relation to designated uses, response to management activities, measurement concepts, standards, current uses, and assessment.

Target Application: Management

Suitable for Volunteers? No

Monitoring Focus: The scope of this protocol is limited to forested areas in Washington, Oregon, Idaho, and Alaska. The focus is on the effects of forestry and forestry-related activities on streams. Other management activities that often occur in forested areas (e.g., grazing, mining, and recreation) also are discussed because they directly affect water quality in forested areas, and the effects of these other activities generally cannot be monitored independently from forest management activities.

Similarly, this guideline focuses on streams and does not directly address monitoring procedures in lakes, reservoirs, and other downstream designated uses.

Geographic Scale: Not applicable

Methods: Office

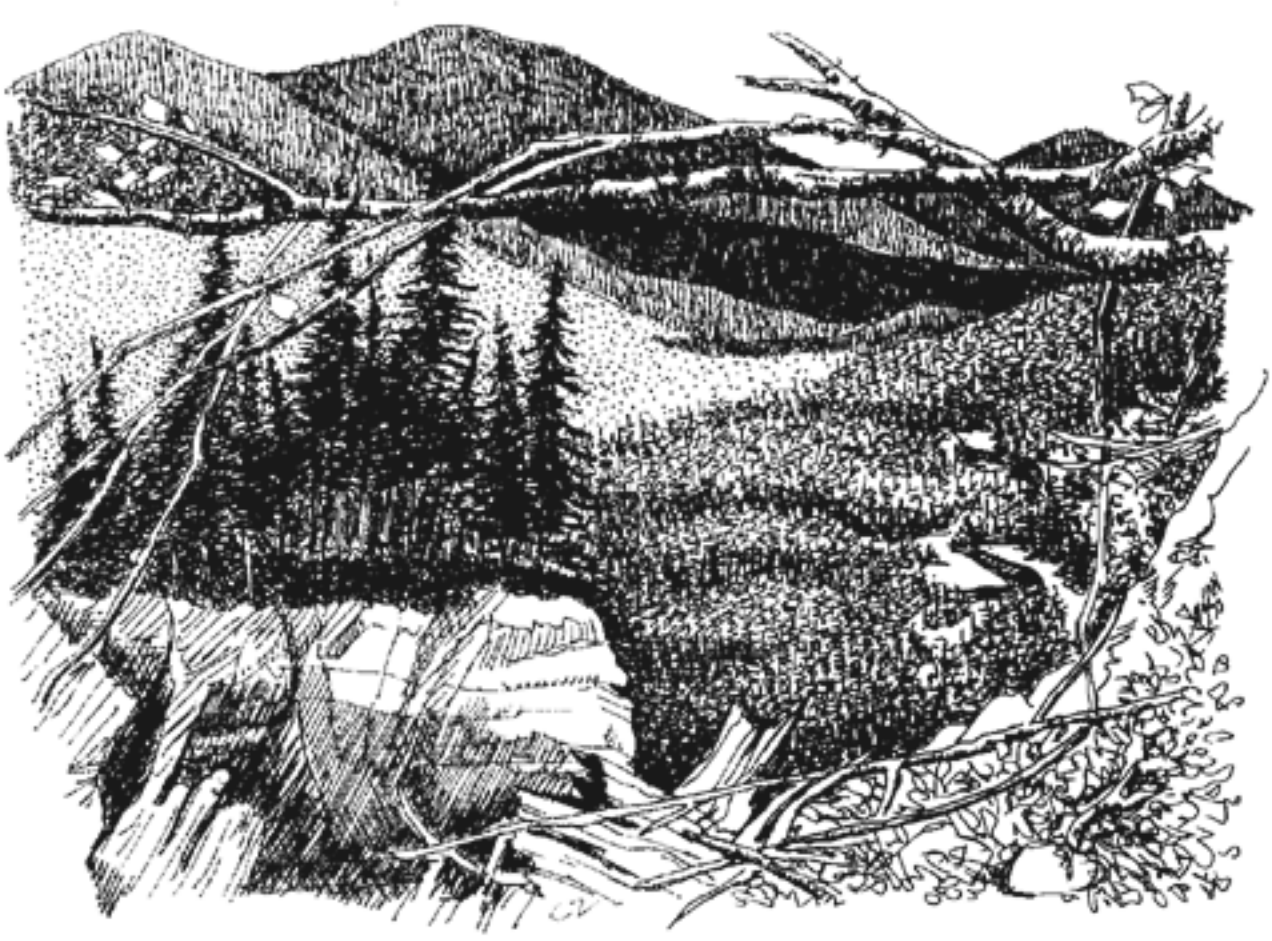
Level of Data Quality: Level 3 **&** 4

Equipment and Tools (*list*): Not applicable

Data Forms: Not applicable

Examples of Filled-in Data Forms: Not applicable

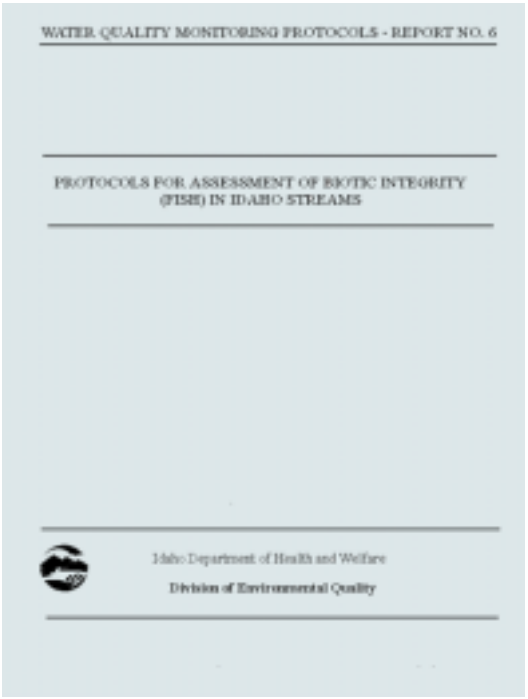
Key References: Provided at the end of Part I and Part II of the document



Document No.: 82

Protocols for Assessment of Biotic Integrity (Fish) in Idaho Streams.

Citation: Chandler, G. L., T. R. Maret, and D. W. Zaroban. 1993. Protocols for Assessment of Biotic Integrity (Fish) in Idaho Streams. Water Quality Monitoring Protocols – Report No. 6. Idaho Department of Health and Welfare. Division of Environmental Quality Monitoring and Technical Support Bureau. Boise, ID.



Source: Idaho Department of Health and Welfare.
Division of Environmental Quality
Monitoring and Technical Support Bureau.
1410 N. Hilton
Boise, Idaho 83706-1253
Cost: $3.22

Abstract: This protocol is one in a series intended to help provide consistency in water quality monitoring methods in Idaho resulting from the Final Agreement To Implement An Anti-degradation Policy For the State of Idaho, Executive Order No. 92-23 (Office of the Governor 1992)., and the Coordinated Nonpoint Source Water Quality Monitoring Program For Idaho (Clark 1990). Other protocols in a series that are included in this publication include protocol No. 55, 56, 73, and 74.

Target Application: Management

Suitable for Volunteers? No

Monitoring Focus: T his document focuses on monitoring fish, macroinvertebrates, and periphyton communities, water quality, and macrohabitat classification. The methods outlined in this manual are designed to be performed in three different levels of intensity:

1) Estimate the condition of the site through an extensive literature review followed by a qualitative and limited in scope quantitative assessment.

2) Collect biological samples representative of stream reach. All the samples are then identified to the species level.

3) The last step (the most intensive) is intended to provide fish and macroinvertebrates population information, density, and statistically valid results.

Geographic Scale: Stream reach

Methods: Office **&** Field

Level of Data Quality: Level 2, 3, **&** 4

Equipment and Tools (*list*): Appendix A of the document

Data Forms: Page 29 of the document

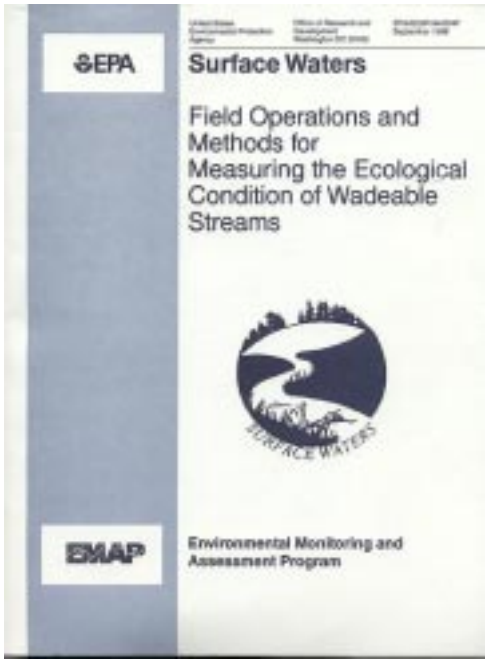
Examples of Filled-in Data Forms: Not provided

Key References: Page 11-13 of the document

Document No.: 83

Field Operations and Methods for Measuring the Ecological Condition of Wadable Streams

Citation: Lazorchak, J. M., D. J. Klemm, and D. V. Peck, editors. 1998. Environmental Monitoring and Assessment Program: Surface Waters. Field Operations and Methods for Measuring the Eco logical Condition of Wadable Streams. EPA/620/R 94/004F. U.S. Environmental Protection Agency, Washington, D.C.



Source: Environmental Protection Agency
National Exposure Research Laboratory
Ecological Exposure Research Division
Cincinnati, Ohio
and
National Health and Environmental Effects Research Laboratory
Western Ecology Division
Corvallis, Oregon

Abstract: The methods and instructions for field operations presented in this manual for surveys of wadable streams were developed and tested during 5 years of pilot and demonstration projects (1993 through 1997). These projects
were conducted under the sponsorship of the U.S. Environmental Protection Agency and its collaborators through the Environmental Monitoring and Assessment Program (EMAP). This program focuses on evaluating ecological conditions on regional and national scales. This document describes environmental measures, or attributes of indicators of stream ecosystem condition. The procedures presented in this manual were developed based on standard or accepted methods, modified as necessary to adapt them to EMAP sampling requirements. They are intended for use in field studies sponsored by EMAP, and related projects such as the Temporally Integrated Monitoring of Ecosystems study (TIME) and USEPA Regional Environmental Monitoring and Assessment Program (R-EMAP).

In addition to methodology, additional information on data management, safety and health, and other logistical aspects is integrated into the procedures and overall operational scenario. Procedures are described for collecting field measurements data and /or acceptable index samples for several response and stressor indicators, including water chemistry, physical habitat, benthic macroinvertebrate assemblages, aquatic vertebrate assemblages, fish tissue contaminants, periphyton assemblages, sediment community metabolism, and sediment toxicity. The manual describes field implementation of these methods and the logistical foundation constructed during field projects. Flowcharts and other graphic aids provide overall summaries of specific field activities required to visit a stream site and collect data for these indicators. Tables give step-by-step protocol instructions. These figures and tables can be extracted and bound separately to make a convenient quick field reference for field teams.

Target Application: Management **&** Research

Suitable for Volunteers? No

Training Recommended: Yes

Monitoring Focus: Collecting samples and measurements data from various biotic and abiotic components of wadable streams.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Field

Level of Data Quality: Levels 3 **&** 4

Where does the data go? Can be used by various regional, enforcement, and research programs engaged in inland, estuarine, and marine water quality and permit compliance monitoring and status/or trends.

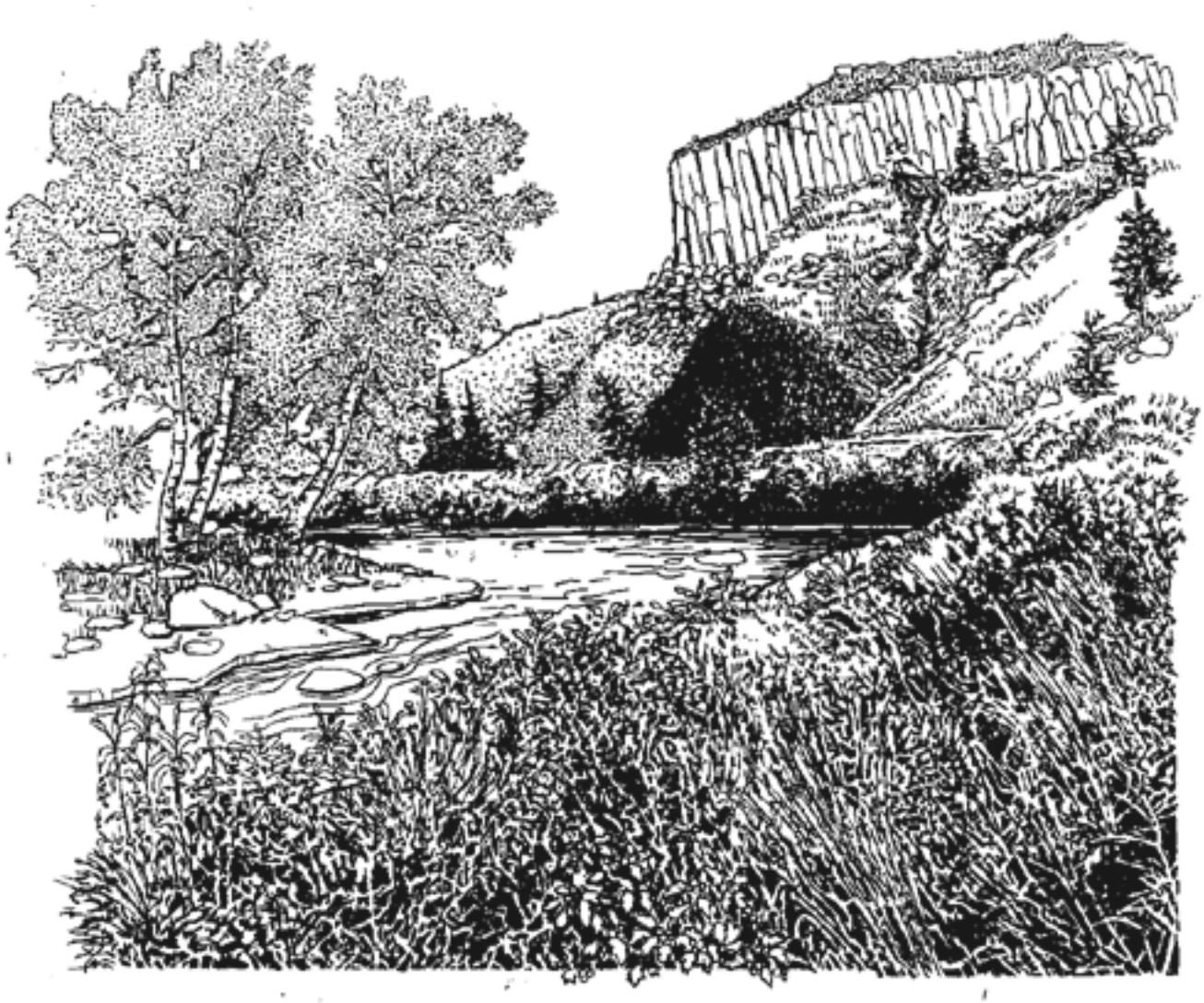
Equipment and Tools (*list*): Appendix A of the document

Data Forms: Appendix C of the document; electronic versions of the forms may be obtained from:

EMAP-Surface Waters Technical Director
U.S. EPA, 200 SW 35th St
Corvallis, OR 97333

Examples of Filled-in Data Forms: Provided in sections describing field sampling and measurement procedures for different indicators.

Key References: Provided at the end of each section.



Document No.: 84

Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters

Citation: Klemm, D. J., P. A. Lewis, F. Fulk, and J. M. Lazorchak. 1990. Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters. EPA/600/4-90/030.

Source: U.S. Environmental Protection Agency
Environmental Monitoring System Laboratory
Cincinnati, Ohio 45268

Abstract: This manual describes guidelines and standardized procedures for using benthic macroinvertebrates in evaluating the biological integrity of surface waters. Included are sections on quality assurance and quality control procedures, safety and health recommendations, selection of sampling stations, sampling methods, sample processing, data evaluation, and an extensive taxonomic bibliography of the benthic macroinvertebrate groups. Supplementary information on the pollution tolerance of selected species and examples of macroinvertebrate bench sheets and macroinvertebrate data summary sheets.

Target Application: Management

Suitable for Volunteers? No

Training Recommended: Yes

Available? On the-job training. Recommended periodic assessment of the training needs of the personnel engaged in QA and support their participation in relevant seminars, training courses, and evaluation and certification programs.

Where? Regional EPA agencies.

Monitoring Focus: Assessment of the chemical and biological quality of surface waters.

Geographic Scale: Basin, sub-basin, stream reach, project site.

Methods: Field & Laboratory

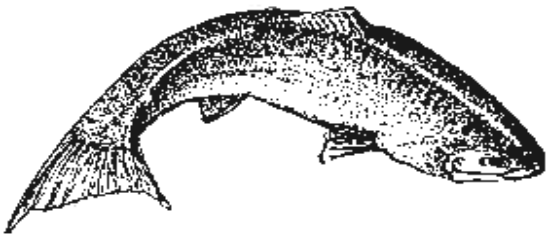
Level of Data Quality: Levels 3 **&** 4

Equipment and Tools (*list*): Appendix E of the document

Data Forms: Appendix C and D of the document

Examples of Filled-in Data Forms: Not provided

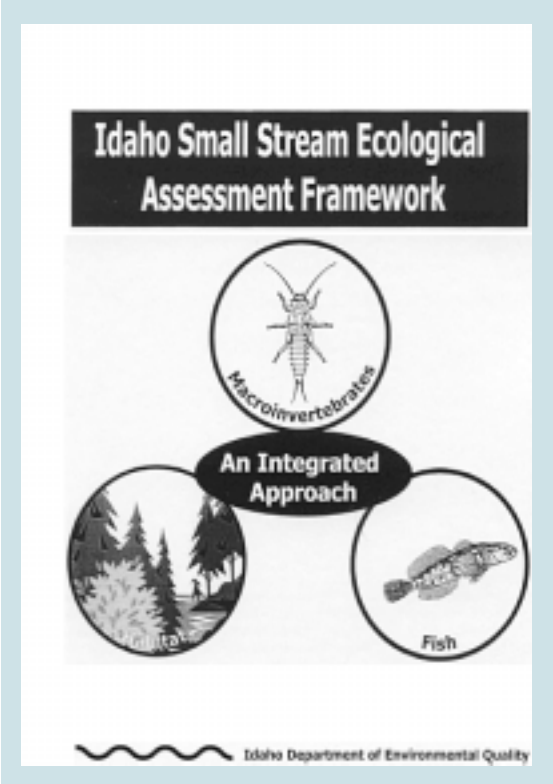
Key References: Provided at the end of each section of the document. This manual also includes an extensive taxonomic bibliography of the benthic macroinvertebrate groups.



Document No.: 85

Idaho Small Stream Assessment Framework

Citation: Grafe, C. S., editor. 2000. Idaho Small Stream Ecological Assessment Framework: An Integrated Approach. Idaho Department of Environmental Quality. Boise, Idaho.



Source: Idaho Department of Environmental Quality
Boise, Idaho
Available online at:
http://www2.state.id.us/deq

Abstract: This document describes the Idaho Department of Environmental Quality's (DEQ) ecological assessment approach to determine aquatic life use support in Idaho's small streams, using biological indicators, habitat data and numeric water quality criteria. The intent of this document is to provide detailed technical information concerning the development and integration of the Stream and Macroinvertebrate Index (SMI), Stream Fish Index (SFI), and Stream Habitat Index (SHI) used in the aquatic life use support determination.

DEQ applies the stream ecological assessment approach based on results from three water bodies that have an average water body size criteria rating of less than or equal to 1. DEQ uses several bioassessment tools or multimetric indexes to limit reliance on just one tool and still ensure direct measurements of aquatic life. DEQ contracted Jessup and Gerritsen with Tetra Tech, Inc. to develop the SMI. Jessup and Gerritsen used sites identified as least impacted and stressed to develop the SMI. The macroinvertebrate data is evaluated within the context of three bioregions: Northern Mountains, Central and Southern Mountains, and Basins. Based on this classification system, Jessup and Gerritsen identified nine significant macroinvertebrate metrics to characterize water quality condition. These SMI metrix include: total taxa, Ephemeroptera taxa, Plecoptera taxa, percent Plecoptera, Hilsenhoff Biotic Index, percent five dominant taxa, scraper taxa, and clinger taxa.

Target Application: Management **&** Research

Suitable for Volunteers? No

Monitoring Focus: Provide detailed and technical information concerning the development of the River Macroinvertebrate Index, River Fish Index, River Diatom Index, and River Physicochemical Index used in determination of aquatic life use support in Idaho's rivers.

Geographic Scale: Basin, sub-basin, stream reach, and project site

Methods: Office

Level of Data Quality: Level 3

Where does the data go? Idaho Department of Environmental Quality Boise, Idaho

Equipment and Tools (*list)*: Not applicable

Data Forms: Not applicable

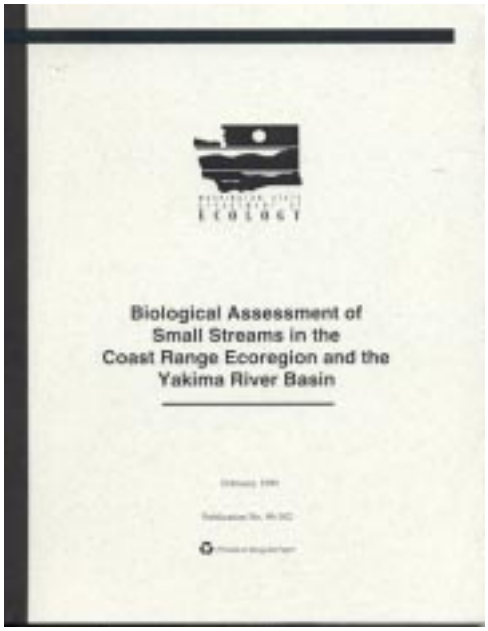
Examples of Filled-in Data Forms: Not applicable

Key References: At the end of each section of the document

Document No.: 86

Biological Assessment of Small Streams in the Coast Range Ecoregion and the Yakima River Basin

Citation: Merrit, G. D., B. Dickes, and J. S. White. 1999. Biological Assessment of Small Streams in the Coast Range Ecoregion and the Yakima River Basin. Washington State Department of Ecology. Olympia, WA. Publication No. 999-302. 59 pp + appendices.



Source: Washington State Department of Ecology
Environmental Investigation and
Laboratory Services Program
Olympia, WA 98504-7710
Copies can be obtained at:
Department of Ecology
Publications
P.O. Box 4760
Olympia, WA 98504-7600
Phone: (360) 407-7472

Abstract: The Washington Department of Ecology examined 78 first-order through third-order streams in the Yakima River Basin and the Coast Range Ecoregion, using methods developed for the national Environmental Monitoring and Assessment Program. To help develop water quality biological criteria, Ecology examined a modified benthic index of biological integrity (B-IBI) and four fish assemblage metrics. Sites were grouped into 15 classes based on ecoregion, wetted width, and geomorphology and estimated site quality using physical habitat data. Then, the B-IBI was compared against habitat quality. A conclusion was reached that the B-IBI could provide useful descriptions of biological integrity, but that the EMAP derived invertebrate sampling methods needed modification. Target streams yielded too few fish species for practical use of the fish metrics.

To assess the ecological condition of streams in each region, Ecology sampled 74 "probability" sites to measure chemical, and biological status. Streams in each region were apparently unaffected by chemical, physical, and biological status.

Poor physical habitat conditions and impaired biological integrity were evident in both regions. Ecology ascribed regional stream conditions to forest land uses, because land use/land cover above streams in both regions was almost entirely forest. The conclusion was reached that the EMAP techniques were well adapted to fulfilling portions of Washington State duties under the Clean Water Act, especially reporting regional status under Section 305 (b).

Target Application: Management

Suitable for Volunteers? No

Training Recommended: Yes
Available? Yes; R-EMAP training sessions

Monitoring Focus: Provide information for the development of water quality biological criteria; determine the ecological condition of target streams; relate condition to predominant land uses; determine the applicability of EMAP-derived methods in Washington state.

Geographic Scale: Stream reach

Methods: Field **&** Laboratory

Level of Data Quality: Level 3 **&** 4

Equipment and Tools (*list*): Not provided

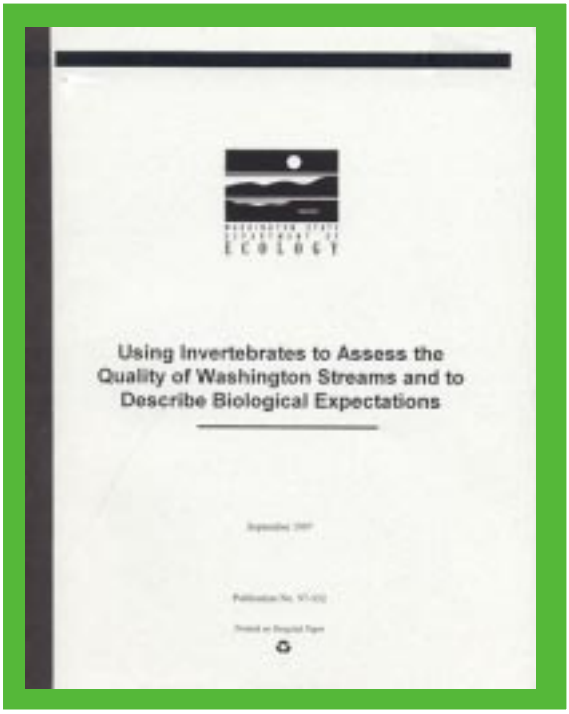
Examples of Filled-in Data Forms: Not provided

Key References: Pages 53-59 and A-16-17

Document No.: 87

Using Invertebrates to Assess the Quality of Washington Streams and to Describe Biological Expectations

Citation: Plotnikoff, R. W., and S. I. Ehinger. 1997. Using Invertebrates to Assess the Quality of Washington Streams and to Describe Biological Expectations. Washington State Department of Ecology. Olympia, WA. Publication No. 97-332. 56 pp. + appendices.



Source: Washington State Department of Ecology
Environmental Investigation and
Laboratory Services Program
Olympia, WA 98504-7710

Copies can be obtained at:
Department of Ecology - Publications
P.O. Box 4760
Olympia, WA 98504-7600
Phone: (360) 407-7472
Available in pdf format at: http://www.ecy.wa.gov/programs/eap/fw_benth/fwb_pubs.html

Abstract: An ongoing survey of streams in Washington state has been based on collection and analysis of the macroinvertebrate assemblage. A hypothesis-testing approach was used to define a hierarchical framework that would identify biological regions, important environmental variables and indicator assemblages. Classification analysis was used to define geographic regions that were biologically similar across the Washington landscape and physicochemical variables associated with regions.

Eight hypotheses were proposed in order to determine distinctions among a landscape, reach and site-specific biological conditions. Data collected from most areas of the state indicated three emergent biological regions: western Cascades and lowlands (Puget Sound and Coast Range), interior plateau and eastern Cascades (Columbia Plateau and east Cascades), and northeastern interior mountains (Northern Rockies). Two of the biological regions were further divided into distinct groups and appeared to be distinguished by local geology, topography, climate and anthropogenic impacts. Five environmental variables were characteristic of site conditions within clusters: water temperatures, pH, conductivity, gradient, and elevation.

Biological regions and environmental variables are the basis for categorizing streams across the Washington landscape. Taxa assemblages were found to be strongly associated with some of the stream conditions in the regions. Verification of the proposed expected biological conditions for each region/stream type combination will be based on future surveys.

Target Application: Management

Suitable for Volunteers? No

Monitoring Focus: Identifying the relationship between the environmental variables and invertebrate communities.

Geographic Scale: Stream reach

Methods: Field

Level of Data Quality: Levels 3 **&** 4

Equipment and Tools (*list*): Not provided

Data Forms: Appendix I of the document

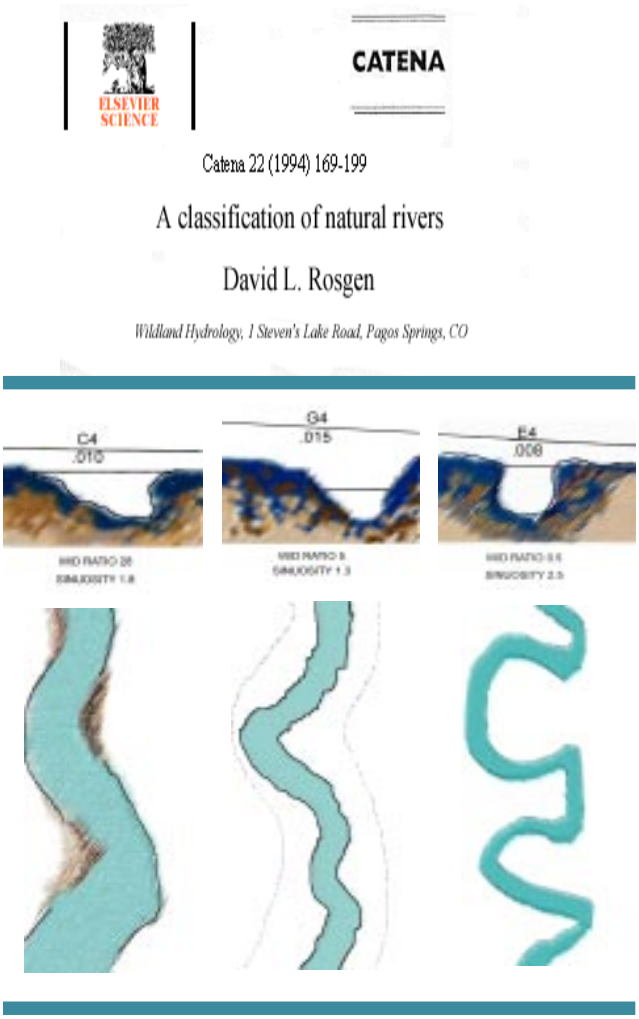
Examples of Filled-in Data Forms: Not provided

Key References: Pages 54-56 of the document

Document No.: 88

A classification of natural rivers

Citation: Rosgen, D. L. 1994. A classification of natural rivers. Catena 22 (1994) 169-199.



Source: This publication can be ordered at: http://www.elsevier.nl/inca/publications/store/5/2/4/6/0/9/index.htt

Abstract: A classification system for natural rivers is presented in which a morphological arrangement of stream characteristics is organized into relatively homogenous stream types. This paper describes morphologically similar stream reaches that are divided into 7 major stream type categories that differ in entrenchment, gradient, width/depth ratio, and sinuosity in various landforms. Within each major category are six additional types delineated by dominant channel materials from bedrock to silt/clay along a continuum of gradient ranges. Recent stream type data used to further define classification interrelationships were derived from 450 rivers throughout the U.S., Canada, and New Zealand. Data used in the development of this classification involved a great diversity of hydro-physiographic/geomorphic provinces from small to large rivers and in catchments from headwater streams in the mountains to the coastal plains. A stream hierarchical inventory system is presented which utilizes the stream classification system. Examples for use of this stream classification system for engineering, fish habitat enhancement, restoration and water resource management applications are presented. Specific examples of these applications include hydraulic geometry relations, sediment supply/availability, fish habitat structure evaluation, flow resistance, critical shear stress estimates, shear stress/velocity relations, streambank erodibility potential, management interpretations, sequences of morphological evolution, and river restoration principles.

Target Application: Management **&** Research

Suitable for Volunteers: Yes, if supervised by experienced personnel

Training Recommended: Yes
Available? No

Monitoring Focus: Pre-project evaluation of channel type and general macrohabitat classification.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office and Field and Laboratory

Level of Data Quality: Levels 3 **&** 4

Equipment and Tools (*list*): Not provided

Data Forms: Not provided

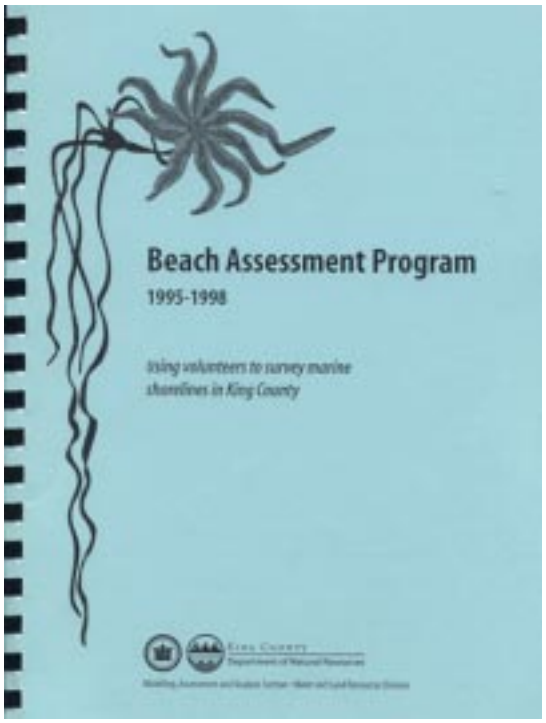
Examples of Filled-in Data Forms: Not provided

Key References: Page 197 of the document

Document No.: 89

Beach Assessment Program 1995-1998. Using Volunteers to Survey Marine Shorelines in King County

Citation: King County Department of Natural Resources. 1998. Assessment Program Report. Using Volunteers to Survey Marine Shorelines in King County.



Source: King County Department of
Natural Resources
Water and Land Resource Division
Modeling, Assessment and Analysis Section

Abstract: This report provides data collected by volunteers at 16 beaches of Central Puget Sound, in King County, Washington. It provides information on the status of plant and animal life in the intertidal area. It focuses on invertebrates, clams, and seaweed. In addition, observations of use of the beaches are instructive in determining threats to the habitat of the marine life.

These data can by used as one of the ways to determine the status of beach life as well as to compare among beaches or to assess the changes from the past and obtain indications of trends that may alert us to the need for protective actions. With people on the beaches conducting surveys and noting observations, it is possible to discover indications of possible depletion of resources, the presence of exotic species, or habitat misuse and degradation. In conjunction with other monitoring programs, these findings can be used to manage resources.

The experience of this program can be applied to similar beach assessment programs. Cities of the region may develop their own programs, contract with other cities or the County. Volunteer groups may use this information to start their own programs. It can be used by the County to improve future volunteer assessment programs.

Target Application: General **&** Management

Suitable for Volunteers? Yes

Training Recommended: Yes, but not required
Available? Yes
Where? Volunteers were trained by the staff of the King County Department of Natural Resources from the Marine, Modeling, and Assessment Group, and the Seattle Aquarium staff during an orientation session. Additional training was provided on the project sites.

Monitoring Focus: Monitoring Invertebrates and marine vegetation on the beaches using volunteers.

Geographic Scale: Project sites.

Methods: Field

Level of Data Quality: Level 1

Equipment and Tools (*list*): Identification Keys for selected intertidal invertebrates are provided in Appendix C of protocol. Equipment list is provided in Appendix D.

Data Forms: Appendix B of the document

Examples of Filled-in Data Forms: Not provided

Key References: Washington State Department of Fish and Wildlife's *Population Assessment Procedures Guide* (1995) by William W. Campbell

Document No.: 90

Freshwater Biological Sampling Manual

Citation: Resources Inventory Committee. 1997. Freshwater Biological Sampling Manual (Resource Inventory Committee). 42 pp.

Source: Ministry of Environment, Lands and Parks
and Ministry of Forest
Resource Inventory Committee
British Columbia

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Phone: (250) 387-6409 or 1-800-663-6105
E-mail: ubscustomerser@mail.qp.gov.bc.ca
Cost: $4.20
Also available online at:
http://www.for.gov.bc.ca/RIC/Pubs/Aquatic/freshwaterbio/index.htm#a

Abstract: This manual covers the minimum requirements to ensure quality and consistency of the field aspects of biological data collection. The essential tasks in biological sampling are to collect representative samples that meet the requirements of the program, and to prevent deterioration and contamination of the samples before analysis. The procedures outlined in this manual are oriented primarily towards BC Environment employees, consultants, or those under a legal requirement to undertake a sampling program for the Ministry. Following the protocols outlined in this manual will aid field staff in collecting reliable, representative samples. The protocols presented here are the most acceptable ones used at present. It should be emphasized that in unusual circumstances or with development of new methods, experienced professional judgment is a necessary component of method choice and application. It is intended that this document will be updated as the need arises to incorporate new knowledge. For specialized sampling needs, considerable literature exists and should be consulted. This is particularly the case with benthic stream invertebrates.

The importance of entering standardized field data into a database (Environmental Monitoring System, EMS, for BC Environment) that is accessible to others, needs to be stressed. Field data become useful information when they have been collected following standard protocols and exist in a form that is easily retrieved for a variety of purposes.

This document does not address project design (site locations, frequency of sampling, duration, quality assurance program, etc.) or data interpretation. These topics can be found in: *Cavanagh, N., R.N. Nordin, L.W. Pommen and L.G. Swain. Guidelines for Designing and Implementing a Water Quality Monitoring Program in British Columbia.* Avialable at the RIC webe site: http://www.for.gov.bc.ca/ric/PUBS/Aquatic/design/index.htm
and *Guidelines for interpreting Water Quality Data.* Available at the RIC web site: http://www.for.gov.bc.ca/ric/PUBS/Aquatic/interp/index.htm

The sample containers, preservatives and sampling procedures described in this manual reflect those generally used by BC Environment staff. Shipping procedures and safety measures are also outlined. Different agencies or laboratories may have specifications which differ from those described here.

Target Application: Management **&** Research

Suitable for Volunteers? No

Monitoring Focus: Collecting and processing biological samples from lakes, streams and rivers. Included are protocols for collection and storage of: bacteria, zooplankton, periphyton, phytoplankton, benthic fauna, macrophytes, and fish.

Geographic Scale: Stream reach, project site,

Methods: Field

Level of Data Quality: Level 2 **&** 3

Equipment and Tools (*list*): Generic Checklist

Data Forms: Provided is a list of fields

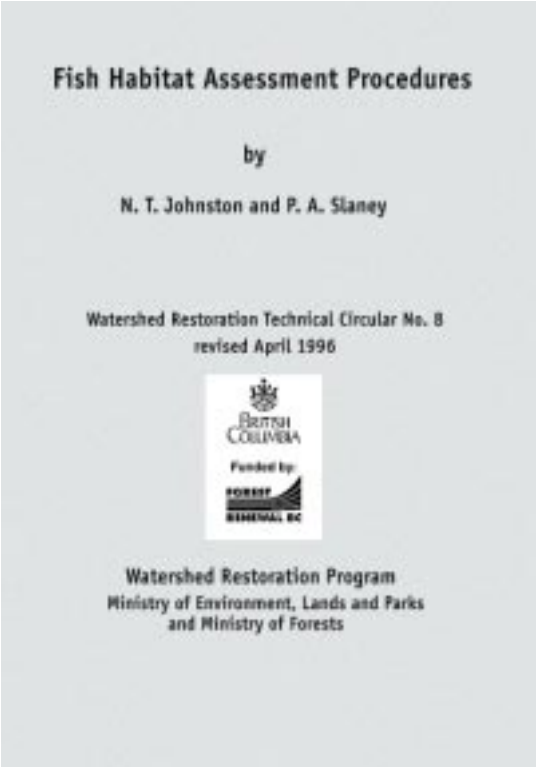
Examples of Filled-in Data Forms: Not provided

Key References: Provided in the document

Document No.: 91

Fish Habitat Assessment and Procedures

Citation: Johnston, N. T., and P. A. Staney. 1996. Watershed Restoration Technical Circular No. 8: Fish Habitat Assessment and Procedure. 106 pp.



Source: Ministry of Environment, Lands and Parks and Ministry of Forest
Watershed Restoration Program
The University of British Columbia
2204 Main Mall, Vancouver
British Columbia, Canada V6T 1Z4

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Phone: (250) 387-6409 or 1-800-663-6105
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Price: $15.72

Abstract: This manual is designed to assist in planning restoration projects on a watershed level. This manual is designed to assist local groups to develop and implement integrated, effective, and cost-efficient projects to rehabilitate or restore fishery resources that have been adversely impacted by past forestry practices. The manual provides a standard framework for identifying the needs and opportunities for fish habitat restoration through systematic resource assessments, and for prescribing and implementing effective activities to improve fishery and aquatic resources. The description and evaluation of fish habitat conditions were implemented in three distinct steps: 1) an overview summary, 2) a reconnaissance field survey, and 3) detailed site-specific field surveys. This manual should be used with the following related manuals:

- Guidelines for planning watershed restoration projects (see document 93)
- Channel Assessment Procedures (see document 92);
- Riparian Assessment Procedures, and (see document 94);
- Fish Habitat Rehabilitation Procedures (see document 62)

Target Application: Management/Research

Suitable for Volunteers? No. Reconnaissance field surveys should be done by experienced fisheries technicians with a working understanding of fish habitat restoration options and methods. Detailed site-specific surveys can be completed by experienced fisheries technicians working, if necessary, under the supervision of a professional biologist.

Monitoring Focus: This document focuses on providing procedures for monitoring general vegetation, spawning habitat availability, channel classification, stream morphology, fish passage and biomonitoring fish community.

Geographic Scale: Watershed

Methods: Field

Level of Data Quality: Level 3

Equipment and Tools (*list*): Not provided

Data Forms: Appendix F of the document

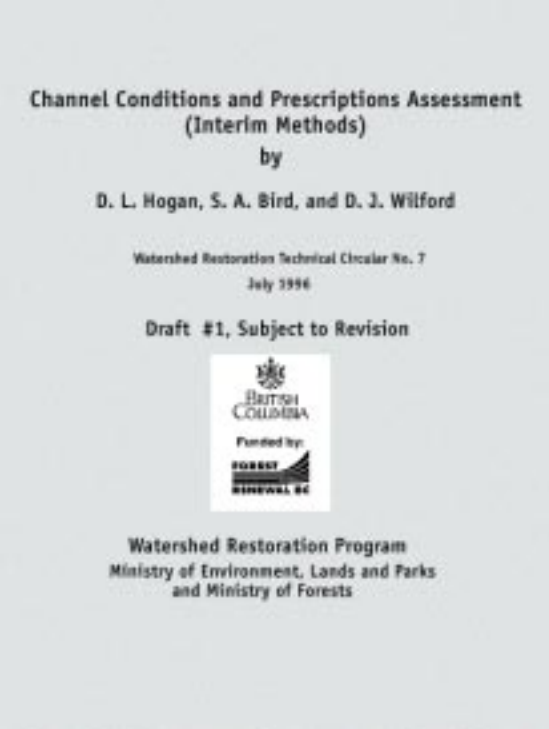
Examples of Filled-in Data Forms: Not provided

Key References: Page 65 of the document

Document No.: 92

Channel Conditions and Prescriptions Assessment

Citation: Hogan, D. L., S. A. Bird, and D. J. Wilford. 1996. Channel Conditions Prescriptions Assessment (Interim Method). B.C. Ministry of Environment, Lands and Parks and Ministry of Forestry. Watershed Restoration Technical Circular No.7 - DRAFT #1. 48 pp.



Source: Ministry of Environment, Lands and Parks and Ministry of Forest
Watershed Restoration Program
The University of British Columbia
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Phone: (250) 387-6409 or 1-800-663-6105
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Price: $8,76

Abstract: This method represents one component of the Watershed Restoration Program (WRP) and is intended to supplement several other assessment procedures, particularly the Fish Habitat Assessment Procedures (see document 91).

This manual provides a relatively simple, consistent, and repeatable means of classifying a stream channel into a morphological type, and assesses the relative level of channel disturbance based on fundamental, morphological channel characteristics. The assessment of downstream impacts is accomplished by viewing the overall watershed as a network of linked tributaries and mainstem channel segments that transfer both water and sediment to the drainage basin outlet. The system evaluates the sediment transfer characteristics within each tributary and mainstem segment and then evaluates the transfer between different areas of the watershed.

This method manual consists of four sections and each explains, step by step, how to complete the channel analysis. Section 2 provides a summary of the Channel Assessment Procedures Guidebooks and background on the assessment. Section 3 outlines the appropriate restoration activities associated with each channel condition (i.e., the level of disturbance). Section 4 relates the restoration activities back to the watershed conditions that may impair the effectiveness or long term success of the planned works. At this level, the links between channel restoration and watershed conditions are not specific; that is the overall conditions of the watershed are linked to channel restoration in general and no attention is paid to any particular segment of channel. Section 5 considers explicitly the channel network and details the linkages between watershed characteristics and downstream channel conditions.

Target Application: Management **&** Research

Suitable for Volunteers? No

Monitoring Focus: The objective of this manual is the integration of the watershed processes so that control channel conditions that appropriate rehabilitation techniques can be prescribed and implemented with long term success. Emphasis is placed upon assessment of the channel condition and morphology, prescribing the appropriate restoration activities, and assessing the risk to restoration works by considering sediment transfer along the drainage network.

Geographic Scale: Watershed

Methods: Field

Level of Data Quality: Level 3

Equipment and Tools (*list*): Not applicable

Data Forms: Not provided

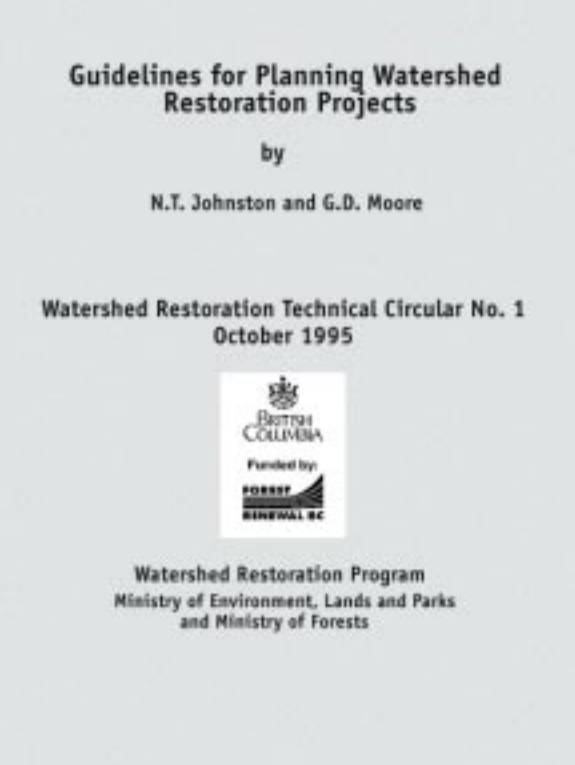
Examples of Filled-in Data Forms: Not provided

Key References: Page 42 of the document

Document No.: 93

Guidelines for Planning Watershed Restoration Projects

Citation: Johnston, N. T., and G. D. Moore. 1995. Guidelines for Planning Watershed Restoration Projects. Watershed Restoration Technical Circular No.1. B.C. Ministry of Environment, Lands and Parks and Ministry of Forests. 62 pp.



Source: Ministry of Environment, Lands and Parks and Ministry of Forest
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Abstract: The purpose of this circular is to assist local groups to develop and implement integrated, effective, cost-efficient projects at the watershed scale to rehabilitate or restore natural resources that have been adversely impacted by past forestry practices. This circular provides a standard framework for identifying the needs and opportunities for restoration through systematic resource assessments, and for prescribing and implementing effective activities to improve forest, aquatic and fishery resources. This manual should be used in conjunction with the series of Watershed Restoration Technical Circulars that describe detailed Procedures for conducting assessments and for designing appropriate restoration projects (see document 91 in this publication for more information).

Target Application: Management **&** Research

Suitable for Volunteers? No

Monitoring Focus: Identifying the needs for restoration of forest, aquatic, and fishery resources. The manual outlines a general sequence of tasks in restoration projects, such as choosing a location, identifying the restoration strategies, estimating cost, constraints and scheduling, implementation, monitoring and evaluation and more.

Geographic Scale: Watershed

Methods: Office

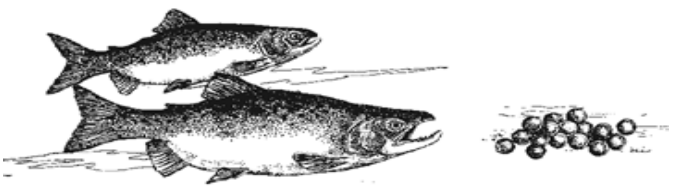
Level of Data Quality: Level 3

Equipment and Tools (*list*): Not applicable

Data Forms: Not applicable

Examples of Filled-in Data Forms: Not applicable

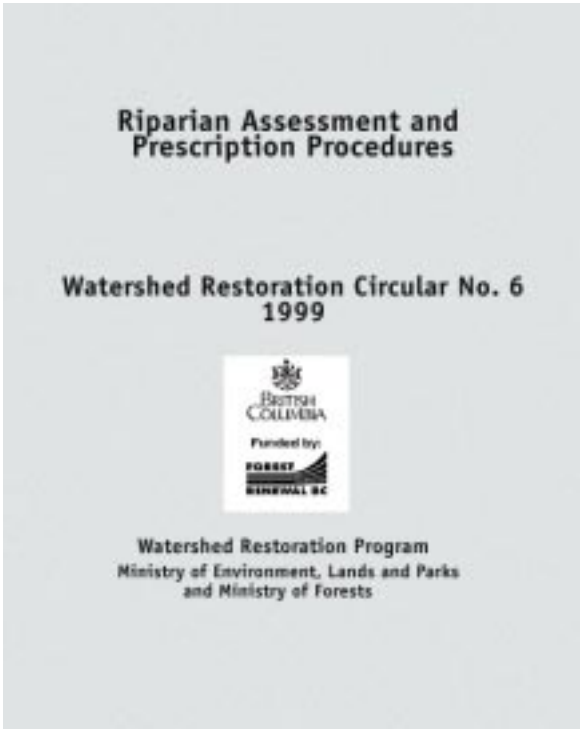
Key References: Page 44 of the document



Document No.: 94

Riparian Assessment and Prescription Procedures

Citation: Koning, C.W. , (editor). Riparian Assessment and Prescription Procedures. 1999. Watershed Restoration Technical Circular No. 6. Ministry of Environment, Lands and Parks, Watershed Restoration Program. 90 pp.



Source: Ministry of Environment, Lands and Parks and Ministry of Forest
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The University of British Columbia
2204 Main Mall, Vancouver
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Government Publication Services
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Price: $13.80

Abstract: This circular is one of a series of Technical Circulars (Protocol #90-93) funded under the Watershed Restoration Program of Forest Renewal BC, designed to assist in planning watershed restoration projects. The purpose of this manual is to assist local groups to develop and implement integrated, effective, cost-efficient projects to rehabilitate or restore riparian resources that have been adversely affected by past forestry practices. The circular provides a standard framework for identifying the needs and opportunities for riparian habitat restoration through systematic assessment, and for prescribing and implementing effective activities to improve the riparian resources.

This manual provides procedures for conducting riparian assessments based on identifying loss of riparian function (for a list of functions, see monitoring focus below) due to past logging practices. The riparian assessment procedures occur sequentially and include: identification of harvested riparian areas; field assessment and evaluation of level of impairment; identifying opportunities for restoration; prioritizing sites for restoration, developing restoration plans; implementation of restoration works; followed by maintenance and monitoring.

The prescription part of this manual involves developing a riparian restoration plan. The focus of the restoration plan is to create conditions that promote stable, diverse, and healthy riparian vegetation communities, which will perform the riparian functions.

The procedures are organized in three stages:

1. Office-based overview assessment of existing information from, maps, air photos, forest data files;

2. Reconnaissance field-based assessment;

3. Detailed field-based assessment, where required, and prescription development stage.

Target Application: Management **&** Research

Suitable for Volunteers: No. Reconnaissance field surveys should be done by experienced fisheries technicians with a working understanding of riparian vegetation and riparian habitat restoration options and methods. Technical staff should work under the supervision of an experienced professional biologist or silvicultural specialist.

Those involved in the overview assessment should also be experienced at air photo interpretation. Detailed Level 2 assessments and prescription development will usually be done by an experienced

silvicultural specialist.

Monitoring Focus: Riparian Assessment identifying loss of riparian function, which include: input of large woody debris and small organic debris to the stream; surface sediment filtering; stream shade and temperature buffering; and provision of wildlife tree, coarse woody debris and terrestrial forage material.

Geographic Scale: Watershed

Methods: Office **&** Field

Level of Data Quality: Level 3

Equipment and Tools (*list*): Not provided

Data Forms: Page 74 of the document

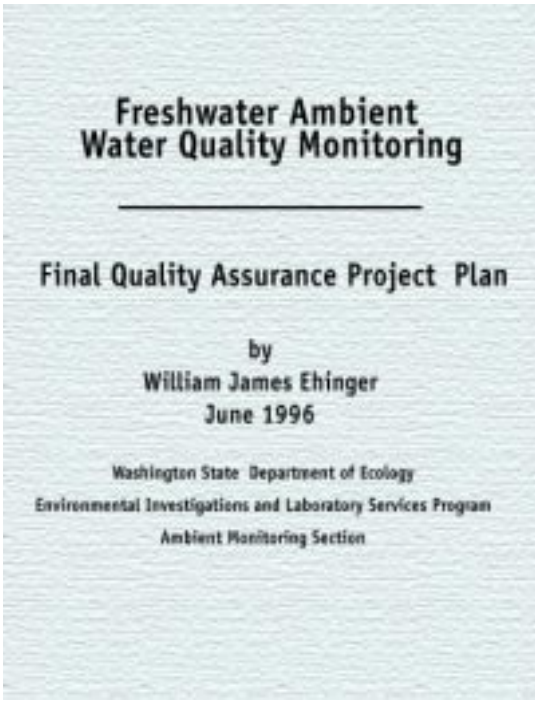
Examples of Filled-in Data Forms: Provided in the protocol. Additionally, Included in each section, are detailed instructions on completing the forms

Key References: Page 37 of the document

Document No.: 95

Freshwater Ambient Water Quality Monitoring Final Quality Assurance Project Plan

Citation: Ehinger, W. J. 1996. Freshwater Ambient Water Quality Monitoring. Final Quality Assurance Project Plan. Washington Department of Ecology. 23 pp. + appendices.



Source: Washington State Department of Ecology
Environmental Investigations and
Laboratory Services Program
Ambient Monitoring Section
Olympia, WA 98504-7710
Copies can be obtained at:
Department of Ecology Publications
P.O. Box 4760
Olympia, WA 98504-7600
Phone: (360) 407-7472

Abstract: This report covers the long-term monitoring of "conventional" water quality variables. The objectives of the heavy metal monitoring program differ substantially and so are addressed in a separate Quality Assurance Project Plan (Hopkins 1994). Since 1978, the Ambient Monitoring Section of the Department of Ecology has collected samples at monthly intervals from numerous rivers and streams through Washington state. The variables measured include temperature, dissolved oxygen, pH, specific conductivity, suspended solids, turbidity, total phosphorus, soluble reactive phosphorus (i.e., orthophosphate), total nitrogen, nitrate+nitrite-N, ammonia-N, and fecal coliform bacteria, although this list has varied somewhat because of changes in the methods of chemical analysis and the different site-specific objectives. Monitoring activities prior to 1978 ranged from monthly to quarterly sampling at fixed stations for various durations of time, and included a variety of variables.

The role of the ambient monitoring network is to provide timely water quality data and periodic data analysis reports to clients within the Department of Ecology and elsewhere, and to make this data and reports available to the public (i.e., other government agencies, educational institutions, consulting firms, and interested individuals).
The above protocol discusses the Water Quality Monitoring Project and addresses issues such as quality control, recommended calibration standards, sampling and analytical procedures. This protocol does not, however, contain procedures for water quality *per se*.

Target Application: General **&** Management **&** Research

Suitable for Volunteers: No

Monitoring Focus: Ambient water quality protocols such as: pHmeasuring, specific conductivity, temperature, dissolved oxygen, suspended solids, turbidity, nitrates, nitrites, ammonia, total nitrogen, and fecal coliform.

Geographic Scale: Can be applied at all scales

Methods: Office

Level of Data Quality: Level 3

Equipment and Tools (*list*): Not applicable

Data Forms: Not applicable

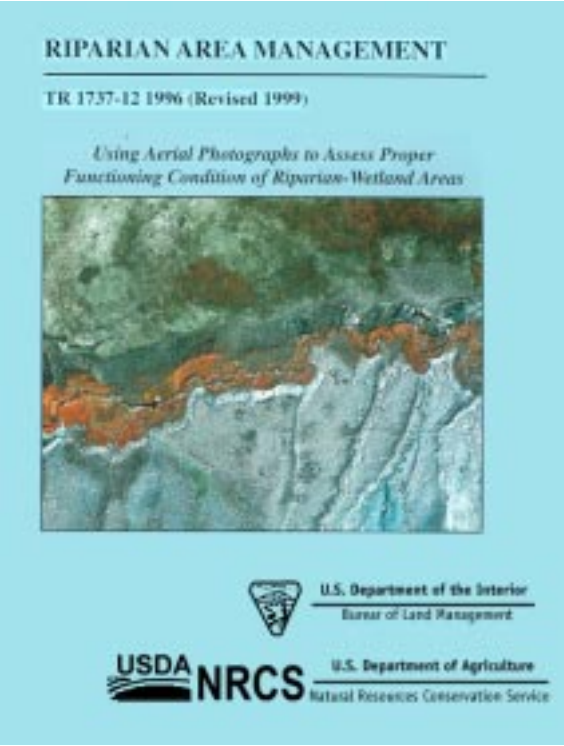
Examples of Filled-in Data Forms: Not applicable

Key References: Pages 21-23 of the document

Document No.: 96

Using Aerial Photographs to Assess Proper Functioning Condition of Riparian-Wetland Areas

Citation: Clemmer, P., M. Gorges, G. Meyer, D. Prichard, and K. Shumac. 1999. Using Aerial Photographs to Assess Proper Functioning Condition of Riparian-Wetland Areas. Riparian Area Management. U.S. Department of the Interior. BLM. TR 1737-12 1996 (revised in 1999). 64 pp.



Source: U.S. Department of Interior
Bureau of Land Management
PFC Aerial Photo Interpretation Team
and
U.S. Department of Agriculture
Natural Resources Conservation Service
Copes available from:
Bureau of Land Management
National Business Center
BC-650B
P.O. Box 25047
Denver, Colorado 80225-0047

Abstract: This manual provides a procedure for using aerial photography to answer Properly Functioning Conditions checklist items in two standard procedures for assessing the condition of riparian wetland areas (see Documents No. 30 and 38). This methods allows for speed the processes described in documents 30 and 38. Aerial photography can provide useful data to make ecosystem based and site-specific riparian-wetland management decisions. According to the authors, data from this protocol "when carefully selected prior to a project, allows analysis of a larger area of interest, at a minimum cost, in less time per hectare than conventional on-the-ground methods. To ensure success of the assessment of the proper functioning conditions of the riparian wetlands, procedures outlined in this protocol should be followed according to the recommendations provided on page 15 of the document.

Target Application: Management

Suitable for Volunteers: No

Training Recommended: Yes; recommended training in photo interpretation, field experience, and knowledge of field sites.

Monitoring Focus: Assessing the properly functioning conditions of riparian-wetland areas focusing on vegetation.

Geographic Scale: Project site

Methods: Office

Level of Data Quality: Level 2

Equipment and Tools (*list*): Not provided

Data Forms: Included are photo interpretation examples

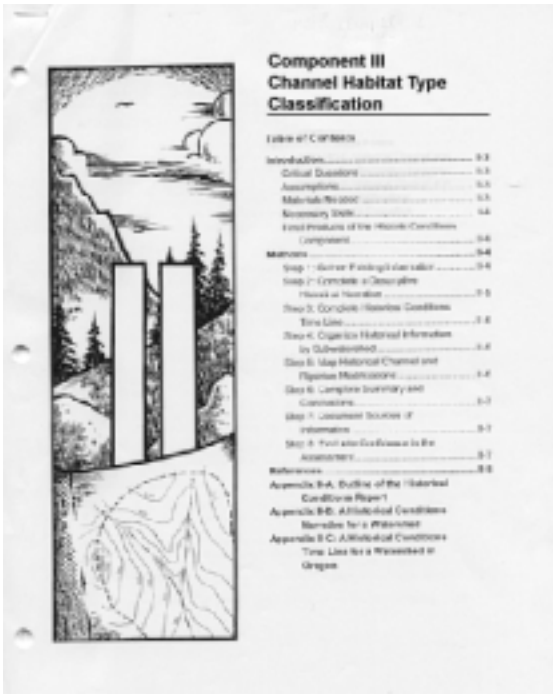
Examples of Filled-in Data Forms: Standard Checklist on page 13 of the document

Key References: Page 19 of the document

Document No.: 97

Oregon Watershed Assessment Manual: Channel Type Classification. Component III

Citation: Watershed Proffessional Network. 1999. Oregon Watershed Assessment Manual: Component III. Channel Type Classification. Governor's Watershed Enhancement Board. Salem, OR.



Source: Oregon Watershed Enhancement Board
775 Summer Street NE, Suite 360
Salem, OR 97301-1290
Phone: (503) 986-0178
Internet: http://www.watershednet.com/oweb.htm
Contact: Leilani Jennings
Cost: $45.

Abstract: The Watershed Fundamentals components of this manual describes how the setting and structure of the landscape influence the shape of the stream channels. Drawing on several existing stream classification systems, basic number of channel types for Oregon streams were identified that are referred in this manual as Channel Habitat Types 1. This stream classification will enable user to better understand how land use impacts can alter the channel form, and to identify how different types of channels will respond to restoration efforts. Both channel modifications and restoration will ultimately effect fish habitat.

The stream classification system is described in this component, along with mapping instructions. In Appendix III-A, included are more detailed descriptions for each of the channel habitat types, including a drawing and photo of the physical setting common to the unit, an example from a topographic map, and a background material on stream classification, theory and methodology. The overall assessment process is designed to identify areas of the watershed in need of enhancement and restoration. To help evaluate restoration options, included are general guidelines for restoration by channel type in Appendix III-A. The channel type classifications apply to broad areas; therefore, a more through field verification of actual conditions will be necessary before project implementation.

Target Application: General **&** Management

Suitable for Volunteers: Yes

Training Required: Minimum skills necessary are: 1) ability to read and use topographic maps, and 2) an eye for visualizing 3-D landscape patterns from topographic maps.

Monitoring Focus: Segmenting stream channel; defining channel gradient and confinement; evaluation of channel conditions

Geographic scale: Basin, sub-basin, stream reach, project site

Methods: Office

Level of Data Quality: Level 2

List of Equipment and Tools (*list*): Page II-4 of the document.

Data Forms: Appendix II-B of the document

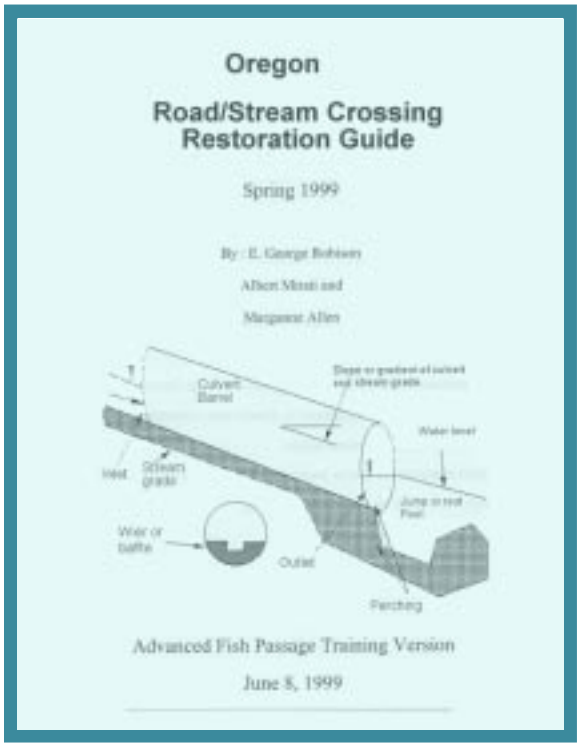
Examples of Filled-in Data Forms: Not provided

Recommended References: Page III-17 of the document

Document No.: 98

Oregon Road/Stream Crossing Restoration Guide

Citation: Robinson, E. G., A. Mirati, and M. Allen. 1999. Oregon Road/Stream Crossing Restoration Guide: Spring 1999. Advanced Fish Passage Training Version. NOAA.



Source: Oregon Department of Fish and Wildlife
2501 SW First Avenue
Portland, OR 97207
Phone: (503) 872-5268

Abstract: The primary purpose of this guide is to provide guidelines to land and fish and wildlife managers that are assessing, planning, designing, or installing repairs or replacements for road/stream crossings under the Oregon Plan for Salmon and Watersheds.

These current guidelines are an attempt to organize together and embellish the current rules, regulations, and guidance regarding road/stream-crossing installations. This current training document along with other guidance (Appendix D and E) is designed to replace earlier guidance memorandums (i.e., Robison 1995 and 1997) for fish passage guidance for state and private forestlands. For other land uses, the Oregon Department of Fish and Wildlife guidelines (Appendix A) along with other information in the Appendixes are the official rules and guidelines for fish passage. This training should prove useful for fish passage designs on other land uses (i.e. agricultural, state and county transportation, and urban) when designing for fish passage and applying for various available grants but is not regulatory. A new guidance memorandum that has excerpts from this guide that focuses on the essential elements of designing and installing replacement culverts is also available from ODF.

The introduction largely deals with background information. Following, are two methods section, which deal with information needed regarding a problem culvert. Steps four and five in the methods section provide users with alternatives to be used in culvert replacement and development of a design and plan for crossing replacement. The introduction sections as well as the rationale sections provide background information about fish passage for those interested in learning more. The Appendixes provide official rules, guidance and regulations as well as some useful checklists and how to guides.

Target Application: Management

Suitable for Volunteers: No

Monitoring Focus: Replacement/modification of culverts.

Geographic Scale: Basin, sub-basin, stream reach, study site

Methods: Office, Field

Level of Data Quality: Level 3

List of Equipment and Tools (*list*): Not provided

Data Forms: Provided in the document

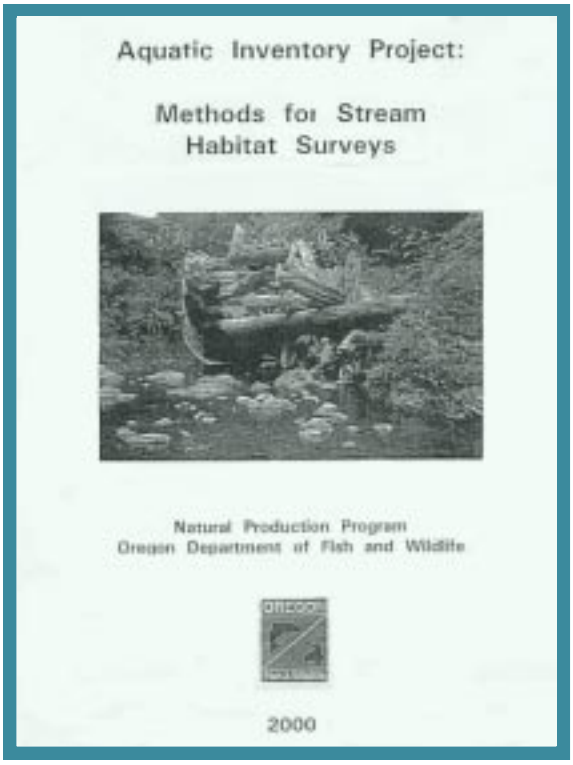
Examples of Filed-in Data Forms: Provided in the document

Key References: Provided in the document

Document No.: 99

Methods for Stream Habitat Surveys.

Citation: Moore, K.M.S., K.K. Jones, and J. M. Dambacher. 2001. Oregon Department of Fish and Wildlife, Aquatic Inventory Project, Natural Production Program, Corvallis, OR.



Source: Oregon Department of Fish and Wildlife
Aquatic Inventory Project
28655 Hwy 34
Corvallis, OR 97333
Contact: Kim, K. Jones
Phone: (541) 757-4263 ext.260
Internet: http://osu.orst.edu/Dept/ODFW/freshwater/inventory/index.html

Abstract: The Oregon Department of Fish and Wildlife conducts two types of stream habitat surveys – basin (or census) surveys and sample (or representative site) surveys. The basin-wide census surveys provided information on the quality of local aquatic habitat throughout a stream or watershed. Sample surveys select sites randomly across the landscape to monitor status and spatial distribution of aquatic habitat, and to assess temporal change. Field surveys for both survey designs collect information on channel morphology, riparian condition, and instream physical habitat using a hierarchically organized survey method incorporating habitat units and larger stream reaches. Each survey design has strengths and weaknesses in landscape-level analysis at micro and macro scales.

Complete Census (Basin) Survey. In 1990 the Oregon Department of Fish and Wildlife (ODFW) designed an aquatic inventory protocol to provide quantitative information on habitat condition for streams throughout Oregon. To date, surveys have been conducted on 10,000 kilometers of aquatic habitat in 1,600 streams. The objectives of the habitat inventories are to provide technical information that can be used to:

1) Describe important stream and watershed components and processes at different spatial scales.
2) Develop habitat protection and restoration strategies.
3) Estimate juvenile fish production and survival based on physical habitat characteristics.
4) Provide information for the aquatic component of watershed analyses and assessments.
5) Establish appropriate and measurable monitoring standards.

To meet these objectives, we designed a complete census survey using the methodology proposed by Hankin (1984) and Hankin and Reeves (1988). The method is designed to be integrated with other watershed activities such as temperature monitoring, water quality sampling, and fish population surveys. The methodology also provides flexibility of scale. Information is summarized at the level of microhabitat, associations of habitat, portions or reaches of streams, watersheds, and subunits within regions.

The sampling design is based on a continuous walking survey from the mouth or confluence of a stream to the headwaters. The surveys are intended for 1st through 5th order streams. Each stream is stratified into a series of long sections called reaches and into short habitat units within each reach. Within a watershed, crews survey all major streams and a selection of small tributaries.

Our complete census surveys describe

current habitat conditions, relationships, and processes within a survey area. The field surveys emphasize channel and valley morphology (stream and reach data), riparian characteristics and condition (reach data), and instream habitat (habitat unit data). The continuous-survey approach provides accurate estimates of habitat conditions throughout a stream, allows a complete inventory of barriers to fish passage (e.g., falls or culverts), describes habitat and hydrologic relationships among streams or landscape features, and permits stream-wide estimates of fish distribution and abundance. The results of continuous surveys can be integrated into map layers in a Geographical Information System for more powerful analyses such as watershed analysis and for display to managers and the public.

Sample (respresentative site) surveys: Sample surveys were designed to assess and monitor the status and trends in habitat across large geographic areas, such as five coastal gene conservation areas (GCA) or Evolutionary Significant Units (ESU). The survey also describes associations of geographic trends in habitat quality with geographic range and life-history diversity of salmonids. A GIS was used to randomly select sites in a spatially balanced manner in each geographic unit from all 1st though 3rd order streams on a 1:100 000 USGS hydrologic stream coverage. The sample selection process prevented clumping of sites, while meeting probability sampling assumptions. Each site represents a length of stream depending on geographic unit, providing a sample weighting for statistical analysis. The number and distribution of sample sites located across the landscape provides enough statistical power for the detection of trends and landscape-scale habitat characterization. The design of the sample selection and the number of sites allows for post-stratification, provided a minimum of 20 sites are included in each new stratum and the weights of the sample are known.

Even though the sample or stream selection criteria for monitoring surveys differed, the field method remained the same. Survey crews collect information on channel morphology, riparian characteristics, and instream habitat. We surveyed 500–1000 m at each sample site, depending on stream size, which allowed data to be collected at 20–40 habitat units at each site. A site length of 500–1000 m was sufficient to sample features that tended to be patchy in nature, such as wood debris jams and deep pools. In addition, all lengths and widths were measured, rather than estimated and calibrated as in the Hankin and Reeves methodology.

A similar field protocol is used to monitor the conditions at habitat restoration sites before and after treatment.

Data handling, analysis,and reporting are not included in the document, but are easily available at the Oregon Fish and Wildlife web site:
Internet: http://osu.orst.edu/Dept/ODFW/freshwater/inventory/index.html

Target Application: Management **&** Research

Suitable for Volunteers: No

Training Recommended: Yes
Available: Limited

Monitoring Focus: Composition of streamside vegetation: species composition and abundance, land use determination, channel morphology and classification, visual estimates of relative amount of flow, measurement of channel width, percent distribution of substrate type, quantitative estimation of wood volume,

Geographic Scale: Basin, sub-basin, stream reach, study site

Methods: Field

Level of Data Quality: Level 4

List of Equipment and Tools (*list)*: Pages 26 of the document and on the web site

Data Forms: Provided in appendices of the document and on the web site

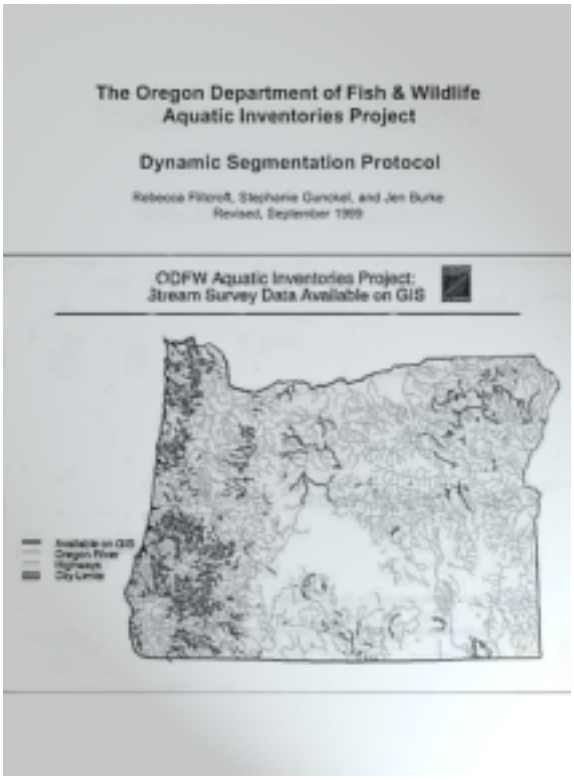
Examples of Filed-in Data Forms: Provided in the document; also included are data entry codes for each form and their descriptions

Key References: Pages 28-29 of the document

Document No.: 100

Dynamic segmentation protocol

Citation: Flitcroft, R., S. Gunckel, and J. Burke. 1999. The Oregon Department of Fish and Wildlife Aquatic Inventories Project. Dynamic Segmentation Protocol. 20 pp.



Source: Oregon Department of Fish and Wildlife
Aquatic Inventories Project
Phone: (503): 872-5268
Portland, OR 97207
Also contact: Kim K. Jones
Phone: (541) 757-4263 ext. 260
Internet: http://osu.orst.edu/Dept/ODFW/freshwater/inventory/index.html

Abstract: The purpose of the aquatic inventories project dynamic segmentation protocol is to provide information necessary to attach stream survey information to a GIS. The protocols provides step by step information on converting data files into GIS coverages. The programs used are Arc/Info and Unix platform. Included in the appendices are naming conventions; file storage and colors; handy Unix commands; useful arc tools, commands, tables, and other information.

Target Application: Management & Research

Suitable for Volunteers: No

Monitoring Focus: Outline procedures used in dynamic segmentation including HUC editing (moving endpoints of routes, route remeasuring, adding arcs), calibration coverage, snapping, editing labels, QA/QC procedures, and troubleshooting.

Geographic Scale: Basin, sub-basin, stream reach, study site

Methods: Office

Level of Data Quality: Level 3 **&** 4

List of Equipment and Tools (*list*): Not applicable.

Data Forms: Not applicable

Examples of Filled-in Data Forms: Not applicable

Key References: Not provided in the document, may be found on the Oregon Dept. of Fish and Wildlife web site above.

Document No.: 101

Surveying Oregon's Streams "A Snapshot in Time"

Citation: Moore, K., K. Jones, J. Dambacher, J. Burke, C. Stein, and STEP biologist. 1999. *In*: P. Bowers (editor). Aquatic inventory project training materials and methods for stream habitat surveys. Oregon Department of Fish and Wildlife. Portland, OR. 272 pp.

Source: Aquatic Inventories Project
Oregon Department of Fish and Wildlife
28655 Hwy 34
Corvallis, OR 97333
Contact: Kim K. Jones
Phone: (541) 757-4263 ext. 260
Internet: http://osu.orst.edu/Dept/ODFW/freshwater/inventory/index.html

Abstract: : The Oregon Department of Fish and Wildlife published a training manual and methodology for volunteers, watershed councils, and professional biologists to conduct stream habitat surveys. The surveys provide information on the quality and quantity of local aquatic habitat throughout a stream or watershed. Field surveys collect information on channel morphology, riparian condition, and instream physical habitat using a hierarchically organized survey method incorporating habitat units and larger stream reaches.

The training manual includes a lesson plan for trainers, 2 levels of habitat survey methods, a slide show and script, a trainer's tool box, a data analysis and interpretation guide, and volunteer management tools and resources.

Aquatic habitat inventory surveys collect basic information about existing stream habitat. Data collected by trained volunteers and other crews help biologists determine factors limiting natural fish production, identify habitat protection and restoration needs, and provide information for fish management plans and policies. Watershed councils also use habitat survey information to prepare watershed assessments and action plans.

With training and oversight provided by Oregon Department of Fish and Wildlife personnel, volunteers, schools, and other groups can undertake an aquatic habitat inventory. The training benefits educators, watershed council members, landowners, and others interested in learning more about stream survey methods. Participants receive both classroom and field experience during the training segment.

Methods described in this training packet are designed for compatibility with other stream habitat inventory and classification systems (Rosgen, 1985, Frissell et. al., 1986, USFS Region 6 Level II Inventory, 1992, and others). Compatibility is achieved by systematically identifying and measuring valley and stream features. The resulting measurements and relationships are then summarized into unifying valley and channel types. The surveys are designed to be integrated with other watershed activities such as temperature monitoring, water quality sampling, and fish population surveys. The methodology also provides flexibility of scale. Information is summarized at the level of microhabitat, associations of habitat, portions or reaches of streams, watersheds.

The sampling design is based on a continuous walking survey from the mouth or confluence of a stream to the headwaters. The surveys are intended for 1st through 5th order streams. Each

stream is stratified into a series of long sections called reaches and into short habitat units (such as pools, riffles, and rapids) within each reach. Within a watershed, crews survey all major streams and a selection of small tributaries.

The field surveys emphasize channel and valley morphology (stream and reach data), riparian characteristics and condition (reach data), and instream habitat (habitat unit data). The continuous-survey approach provides accurate estimates of habitat conditions throughout a stream, allows a complete inventory of barriers to fish passage (e.g., falls or culverts), describes habitat and hydrologic relationships among streams or landscape features, and permits stream-wide estimates of fish distribution and abundance. The results of continuous surveys can be integrated into map layers in a Geographical Information System for more powerful analyses such as watershed analysis and for display to managers and the public.

Data handling, analysis,and reporting are not included in the document, but are easily available at the Oregon Fish and Wildlife web site: http://osu.orst.edu/Dept/ODFW/freshwater/inventory/index.html

Target Application: Management

Suitable for Volunteers: Yes (included is a section listing contacts for volunteer programs)

Training Recommended: Yes for Intermediate Level Survey
Available: Yes
Where: Classroom and field experience are provided by the Oregon Department of Fish and Wildlife at the above address (contact local or STEP biologists)

Monitoring Focus: Photodocumentation, general freshwater classification, channel classification, pool classification, pool to riffle ratio, LWD documentation, percent flow, percent substrate composition, land use documentation, riparian zone classification, documentation of wildlife, landslides, avalanches, fish use

Geographic Scale: Basin, sub-basin, stream reach, study site

Methods: Field

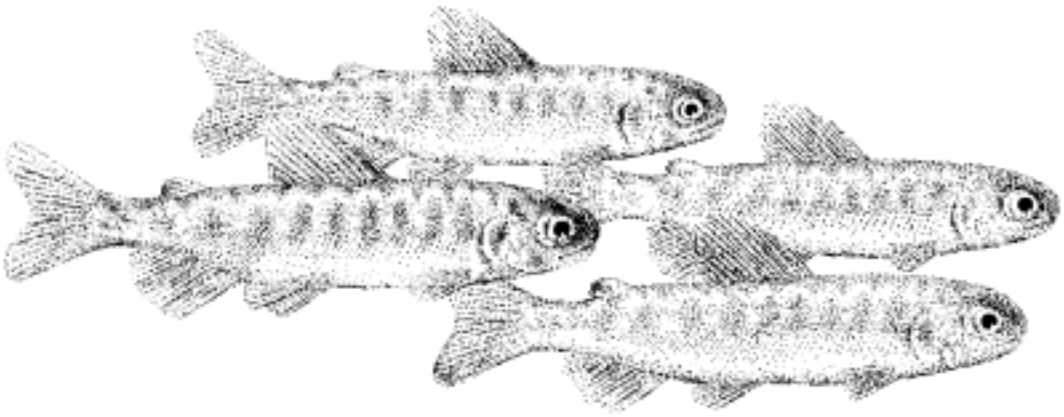
Level of Data Quality: Levels 3 **&** 4

List of Equipment and Tools (*list*): Provided in the document

Data Forms: Provided in the document

Examples of Filled-in Data Forms: Examples are included in a *Guide to Interpreting Stream Survey Analysis Report* section of the document; included are codes for data entry

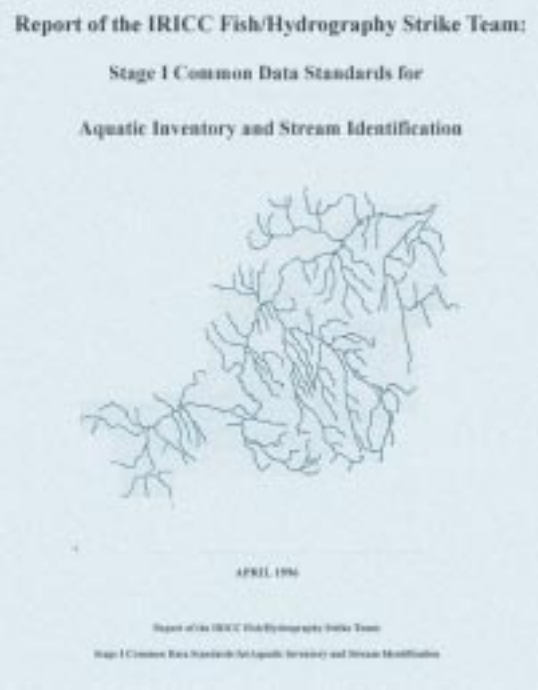
Key References: Pages L-1 through L-2 of the document and on the web site.



Document No.: 102

Stage I Common Data Standards for Aquatic Inventory and Stream Identification

Citation: Stage I Common Data Standards for Aquatic Inventory and Stream Identification. 1996. Report of the IRICC Fish/Hydrography Strike Team. 27 pp.



Source: Pacific Marine Fisheries Commission and Forest Service, Region 6

Abstract: This document provides data standards and protocols for on-the-ground collection and measurement of the core riparian attributes collected at the stream reach and project site. Those standards are intended to provide a resolution of detail consistent with information needs at the 1:24,000 scale. They conform to a hierarchical framework that allows collection of additional information at a higher resolution to meet specific information or management needs Two sets of protocols are provided in this document. The first is a set of aquatic habitat attributes that are commonly collected by the various federal and state agencies that manage stream inventory information (USFS, BLM, ODFW, WDFW, etc.). The second protocol set addressed in this document is a standardized method for managing stream hydrographic data – a method for uniquely identifying an entire stream.

Core riparian attributes were screened using a set of morphological questions regarding the FORM, FUNCTION, and EVOLUTION of aquatic systems (physical and biological). If answers to those questions suggested and attribute did not meet the information needs, it was dropped from the list.

The common data attributes provide a generalized description of aquatic habitat conditions at the stream reach scale. As such, they represent first approximation of the information needed to track attainment of the Aquatic Conservation Strategy (ACS) objectives, some of which address "watershed and landscape scale features. Standards for collection of data and the protocols may represent a change from existing standards used by various state and federal agencies. As a result, caution should be exercised before relying on the common data attributes described herein as the sole basis for an effective aquatic inventory program.
The emphasis of this document/project is to develop a core set of attributes that are collected using the same definitions so that data from different agencies are directly comparable and shared. This does not preclude the use of other metrics to meet specific management objectives or information needs of different agencies.

Target Application: Management

Suitable for Volunteers: No

Monitoring Focus: Basic channel morphology/ landform characteristics or the watershed including: 1) Riparian/floodplain characteristics as it relates to aquatic dependent resources; 2) Range and distribution of aquatic dependent vertebrate species; and 3) Range and distribution of aquatic habitat condition.

Geographic Scale: Stream reach, project site

Methods: Office

Level of Data Quality:

List of Equipment and Tools (*list*): Not applicable

Data Forms: Not applicable

Examples of Filled-in Data Forms: Not applicable

Key References: Provided in the document

Document No.: 103

Fish Passage Design at Road Culverts

Citation: Bates, K., B. Barnard, B. Heiner, P. Klavas, P. Powers. 1999. Fish Passage Design at Road Culverts. A design manual for fish passage at road crossings. Washington Department of Fish and Wildlife Habitat and Lands Program Environmental Engineering Division.

Source: Washington Department of Fish & Wildlife
Habitat and Lands Program
Environmental Engineering Division
600 Capitol Way North
Olympia, WA 98505-1091
Internet: www.wa.gov/wdf/habitat.htm
Contact: Ken Bates
E-mail: ees@dfw.wa.gov

Abstract: This manual is intended to aid in the design of permanent new, retrofit, or replacement road crossing culverts that will not block the migration of salmonids. The manual is intended for use by designers of culverts including private landowners and engineers. The level of expertise necessary to use this manual varies depending on site conditions and the design option selected. For all but the no-slope design option (described below), it is assumed that the designer has a basic background of hydraulic engineering, hydrology, and soils/structural engineering to accomplish an appropriate design. Formal fishways may be required at some culvert sites to provide passage. The design of fishways is beyond the scope of this manual; included is only a brief description of some basic design concepts. A fish passage engineer should be consulted for additional assistance for the design of fishways. The organization of the manual follows the logical steps expected in a prudent culvert design. A data form is provided in Appendix F describing the data needed for the design and for those evaluating the design and includes explanations and definitions of terms describing the channel and hydrology. Appendix G includes several case studies showing various culvert design options. Included in the manual is a discussion about the design flows and definitions. Appendix H contains a summary of an example analysis of fish passage through a culvert.

The manual is based on the premise that a culvert is the desired road crossing option at a site. That does not mean that for fish traffic, fish passage or other ecological functions, a culvert is the actually best solution or even permitted. Though this manual focuses on fish passage, there are other habitat and ecological considerations that are factors in the siting and design of road crossing structures. Those considerations are outlined in the section Other Passage and Habitat Considerations. Appendix B includes WAC providing the technical definition of a fish passage barrier.

The manual does not include guidance about the inventory of culverts or the prioritization of culvert barriers remedies. That information is included in *Fish Passage Barrier Assessment and Prioritization Manual* 1998 by WDFW and in the *Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual* 2000 by WDFW.

Target Application: Management

Suitable for Volunteers: No

Training Recommended: Basic background of hydraulic engineering, hydrology, and soils/structural

engineering required

Monitoring Focus: Design of new and modification/replacement of road culverts in order to improve fish passage

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office **&** Field

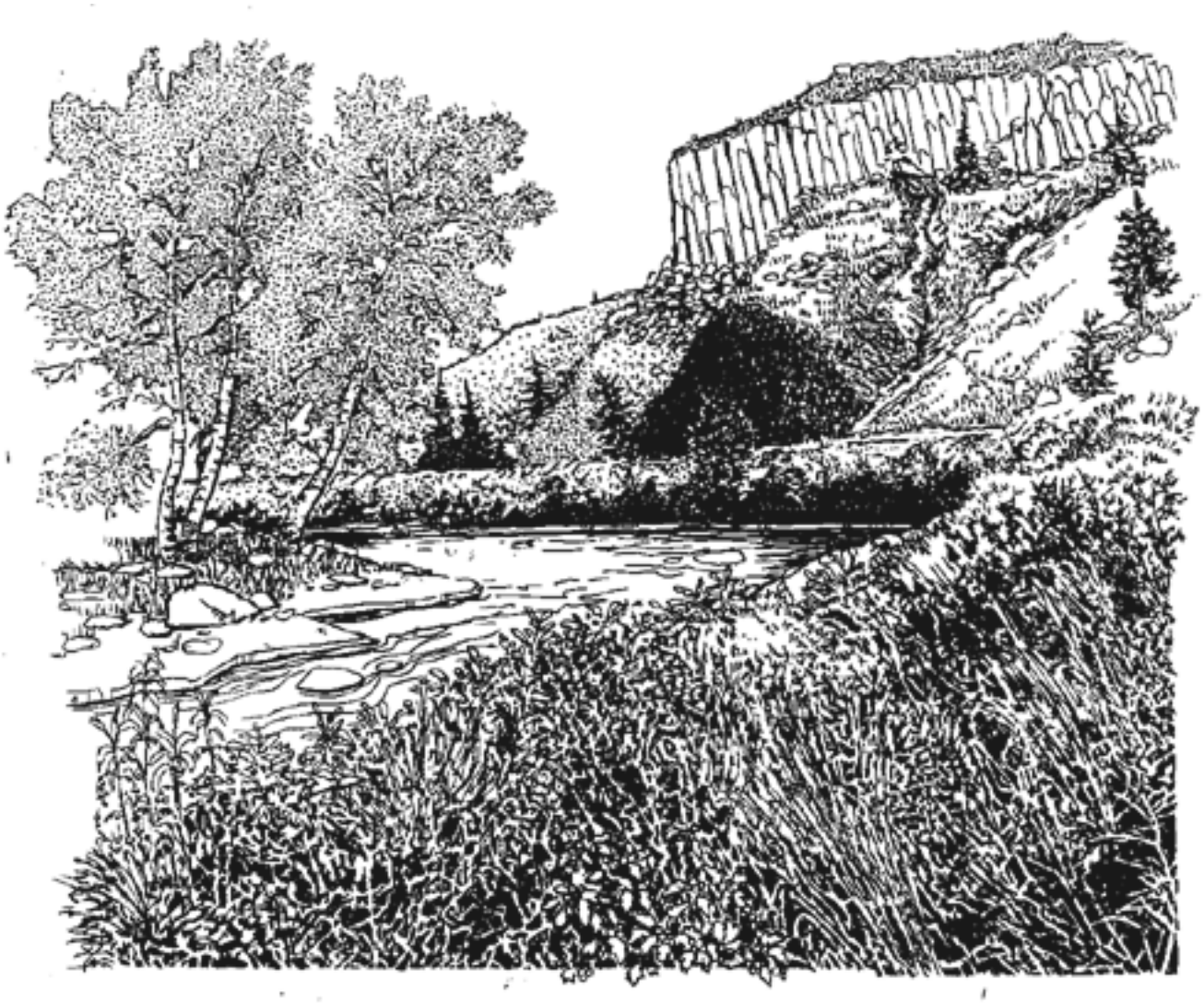
Level of Data Quality: Level 3

Equipment and Tools (*list*): Not provided

Data Forms: Provided is a fish passage design data summary form

Examples of Filled-in Data Forms: Not provided

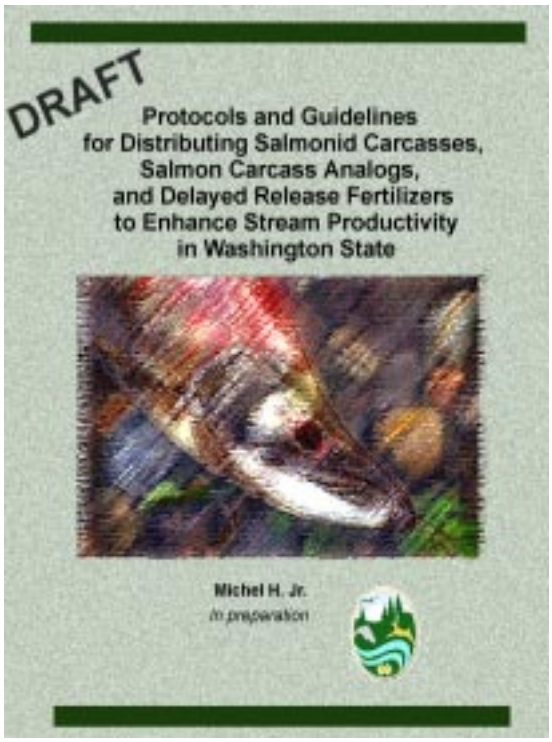
Key References: Provided in the document



Document No.: 104

Protocols and Guidelines for Distributing Salmonid Carcasses, Salmon Carcass Analogs, and Delayed Release Fertilizers to Enhance Stream Productivity in Washington State

Citation: Michel, H. Jr., In prep. Protocols and Guidelines for Distributing Salmonid Carcasses, Salmon Carcass Analogs, and Delayed Release Fertilizers to Enhance Stream Productivity in Washington State.



Source: Washington State Department
of Fish and Wildlife
1111 Washington St. SE
Olympia, WA 98504-1091
Contact: Hal Michael
Phone: (360) 902-2659
E-mail: michahhm@dfw.wa.gov

Abstract: The declining abundance in many wild salmonid populations in Washington can be attributed to a combination of factors which include harvest and hatchery issues, habitat degradation and loss, in-stream flow problems, altered basin hydrology, and stream productivity. Restoration of a population to levels capable of sustaining consumptive fisheries will require addressing all these issues; nutrient restoration issue, which this protocol centers around, is only part of the overall problem.

This protocol addresses criteria for: identification of the streams for treatment (deposition of carcasses or use of fertilizers); adult carcass deposition; criteria for carcass analog deposition; delayed fertilizer deposition; criteria for terrestrial deposition of carcasses; application and review procedures for all projects. A glossary of terms is included at the end of protocol.

Target Application: General **&** Research **&** Management

Suitable for Volunteers: Partially - distribution of salmon carcasses part of the protocols. Specific permits need to be obtained from the Washington Department of Ecology for distribution of salmonid carcass analogs and delayed release fertilizers. For more information and guidelines on distribution of carcass analogs and delayed release fertilizers, contact:
Hal Michael with the
Washington Department of Fish and Wildlife
Phone: (360) 902-2659
E-mail: michahhm@dfw.wa.gov

Training Recommended: No

Monitoring Focus: Enrichment of the productivity of streams, rivers, and estuaries by deposition of salmon carcasses.

Geographic Scale: Stream reach, project site

Methods: Office **&** Field

Level of Data Quality: Level 2

List of Equipment and Tools (*list*): Not provided

Data Forms: Application form provided at the end of the document

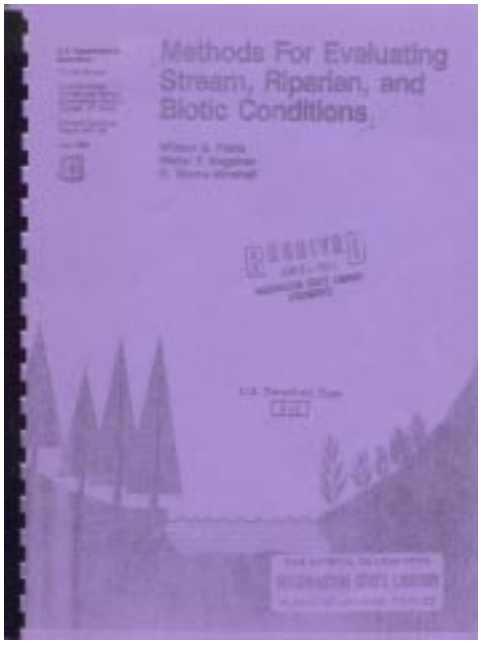
Examples of Filled-in Data Forms: Not applicable

Key References: Provided in the document

Document No.: 105

Methods for Evaluating Stream, Riparian, and Biotic Conditions

Citation: Williams, S. Platts, W. F. Megahan, and G. Wayne Minshall. 1983. Methods for Evaluating Stream, Riparian, and Biotic Conditions. U.S. Department of Agriculture Forest Service. General Technical Report INT-138. 70 pp.



Source: U.S. Department of Agriculture
Forest Service
Intermountain Forest and Range
Experimental Station
Ogden, UT 84401

Abstract: The major purpose of this document is to help standardize the way that physical and biological attributes are measured and quantified and to shed light on the strengths and weaknesses of these attributes. Only through constant refinement of present methods, incorporation of additional attributes, and standardization will we ever develop a practical means of obtaining information of use to resource managers. This report takes a step toward this goal and is presented in a format upon which future work can build and improve, thus continually upgrading the value and dependability of habitat and biomass assessment. With this improvement will come confidence in answering questions such as: 1) How much flow is needed in a specific stream for fish perpetuation? 2) How many cattle can be grazed in the riparian zone without the excessive damage to the stream? 3) How much sediment can a stream take without losing productivity and will this timber sale exceed that amount? 4) Has the stream been altered from its natural condition? 5) Has the alteration depressed fish population? 6) And, what needs to be done to rehabilitate the stream?

The procedures outlined in this manual are intended for use by field personnel, such a s biologists, hydrologists, aquatic specialists, watershed managers, entomologists, or other involved in providing information for resource management decisions. This report is set to build a valid, objective, quantitative, repeatable procedures fro measuring the aquatic, riparian and biotic attributes that will provide accurate evaluation of the stream and its biotic communities under any set of conditions. In some cases, only very basic procedures are provided here. If necessary, additional guidance is available in handbooks, standard statistical texts, and from statisticians. An important aspect of this manual is the emphasis on precision and accuracy that can be expected for each measurement.

This report is directed mainly toward ways of measuring the effects of land use practices, such as logging, road construction, livestock grazing, and mining. It does not address the hydrochemical environment or lower organisms, such as algae.

Target Application: Management

Suitable for Volunteers: No

Monitoring Focus: Stream habitat evaluation: percent substrate composition methods that detect changes due to road building or logging, channel sinuosity, fish population evaluation (for example, riparian zone – vegetation use by animals, overhanging vegetation), and macroinvertebrate analysis.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office & Field

Level of Data Quality: Level 3

List of Equipment and Tools (*list*): Not provided

Data Forms: Not provided

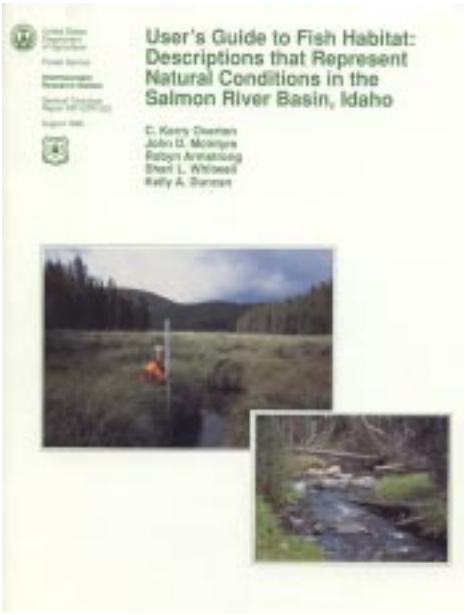
Examples of Filled-in Data Forms: Not provided

Key References: Page 46 of the document

Document No.: 106

User's Guide to Fish Habitat

Citation: Overton, C. K., J. D. McIntyre, R. Armstrong, S. L. Whitwell, and K. A. Duncan. 1995. User's Guide to Fish Habitat: Descriptions that Represent Natural Conditions in the Salmon River Basin, Idaho. 142 pp.



Source: Intermountain Research Station
324 25th Street
Ogden, UT 84401

Abstract: This User's guide and reference document describes the physical features of stream channels that represent natural conditions for fish habitat within the Salmon River Basin in Idaho. The term "natural conditions" refers to the structure and pattern of streams that have not been substantially influenced by human disturbances. Data were collected at four landscape scales – watershed, channel reach type, habitat type and meso-habitat (habitat type attribute). This hierarchical outline facilitates multi-scale data analysis; the scales are synonymous with analysis areas for watershed (cumulative effects) and site (individual project) assessments. Data were collected from streams within the Salmon River Basin (summertime base-flow inventory) using the Forest Service's R1/R4 Procedures (see Document No. 37). Summary statistics were calculated for bank stability, bank undercut, width to depth ratio, width to maximum depth ratio, surface fines, water temperature, large woody debris frequency, and pool frequency. Large woody debris and pool frequency were summarized by stream size classes. The statistical summaries for the above habitat attributes can be grouped in different ways to create meaningful comparisons. For this document, the data were grouped by all stream reaches combined, by channel reach types distinguished by gradient and confinement, and by dominant geology and channel reach type. Relative frequency distribution s and cumulative relative frequency distributions were graphed to display all the statistics of variation for the selected habitat variables grouped. Examples displaying some optional approaches for stratifying summary statistics are provided.

The intended use of this natural conditions database are to: 1) assist National Forest fishery biologists and resource managers in determining the current and potential condition of fish habitat for multi-scale analysis areas and to 2) describe the desired resource condition for a reach, watershed, or basin that can be achieved through management objectives.

Target Application: Management **&** Research

Suitable for Volunteers: No

Monitoring Focus: Determining the current and potential condition of fish habitat using statistical analysis of the following habitat attributes: bank undercut, bank instability, temperature, width to depth, width to maximum depth ratios, large woody debris, pool frequency.

Geographic Scale: Basin, sub-basin, stream reach

Methods: Office (related field methods can be found in Document No. 37)

Level of Data Quality: Levels 3 **&** 4

List of Equipment and Tools (*list*): Not applicable

Data Forms: Not applicable

Examples of Filled-in Data Forms: Not applicable

Key References: Page 101 of the document

Document No.: 107

Evaluating Stream and Watershed Conditions in Northern California

Citation: Keithley, C. 2001. Evaluating Stream and Watershed Conditions in Northern California. California Department of Forestry and Fire Protection.

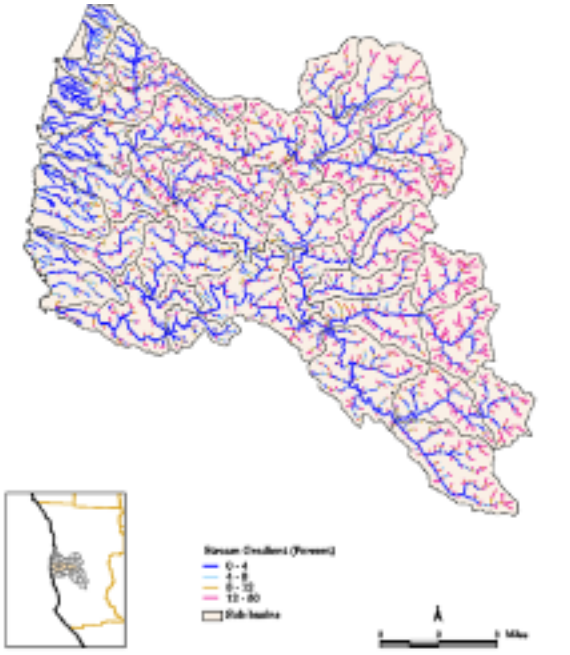


Figure 8
Noyo and Big River Stream Gradient

Source: California Department of Forestry
and Fire Protection
1920 20th Street,
Sacramento, CA 95814
Phone: (916) 227-2651
Copies available in pdf format at:
http://frap.cdf.ca.gov/projects/NC_STREAM/evaluating_stream.pdf

Abstract: A map based approach for watershed assessment was developed to estimate potential salmonid habitat within two watersheds in Northern California. Current stream condition was assessed using stream gradient and streamside vegetation. For the entire study area roughly 40% of the 900 miles of stream lengths analyzed were classified as low gradient response reaches. Within the riparian zone of response stream reaches 23% of the area contained mature forests exceeding 24" dbh, while less than 10% of the area contained late seral stage vegetation exceeding 36" dbh. Overall, the riparian forests were shown to be dominated by younger seral stage trees. Several indices were developed to represent the contribution of off-roads and timber harvesting to sediment delivery in streams. A classification of stream types combined with information on potential recruitment of LWD, hillslope stability, and road related sediment provides a basis for a watershed assessment. This baseline data was used to develop a prioritization model to identify the restoration potential for each sub-basin. This model uses spatially explicit information form a Geographic Information System (GIS) to identify basins that are in need of short term sediment risk reduction, longer term forest stand improvements and existing habitat protection.

Target Application: Management

Suitable for Volunteers: No

Monitoring Focus: Identify existing in-stream habitat conditions and potential sedimentation risks. Among the factors addressed in the protocol are gradient determination, assessment of current forest conditions (LWD, quantitative measuring of vegetation along a 60-meter stream buffer), and potential sediment delivery from road and timber harvest.

Geographic Scale: Basin, sub-basin, stream reach

Methods: Office

Level of Data Quality: Level 3

List of Equipment and Tools (*list*): Not provided

Data Forms: Not provided

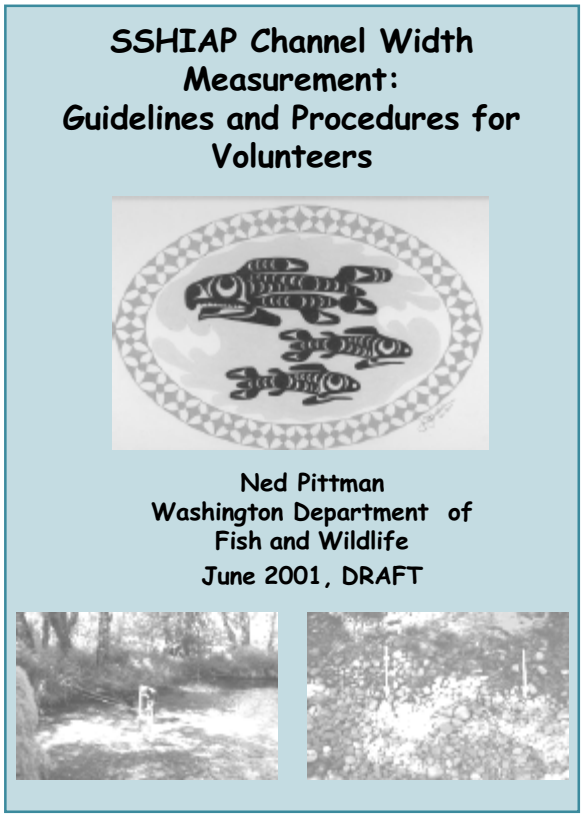
Examples of Filled-in Data Forms: Not provided

Key References: Provided in the document

Document No.: 108

SSHIAP Stream Width Protocol DRAFT

Citation: Pittman, N. 2001. SSHIAP Stream Width Protocol. DRAFT. Washington Department of Fish and Wildlife Habitat Program. Olympia, WA.



Source: Washington Department of Fish &Wildlife
Habitat Program
1111 Washington Street
Olympia, WA 98504
Contact: Ned Pittman
Phone: (360) 902-2568

Abstract: This document describes protocols for determining and measuring channel characteristics. The protocols outlined in this document were taken from other protocols (see Reference cited below) addressing methods for channel characteristics determination and measurement and adapted to fit the needs of volunteers across the Pacific Northwest. While this manual targets volunteers, it may also be used by experienced technician to ensure uniform data collection. The data collected through these protocols will be used in the statewide Salmon and Steelhead Habitat Inventory Program, which objectives are to provide detailed salmon and habitat information on a watershed scale in restoration and planning adaptive management. Among the channel characteristics that can be determined and measured using this protocols are: 1) bankfull width, bankfull wetted width, and bankfull depth.

Target Application: Management

Suitable for Volunteers: Yes

Training Recommended: Yes
Available: Yes
Where: Available quarterly at the WDFW Habitat Program
Contact: Ned Pittman
Phone: (360) 902-2568
E-mail: pittmnrp@dfw.wa.gov

Monitoring Focus: Measuring and determining bankfull width, depth and bankfull wetted width.

Geographic Scale: Stream reach, project site

Methods: Field

Level of Data Quality: Level 3 **&** 4

List of Equipment and Tools (*list*): Provided

Data Forms: Provided in the document (MS Access database maybe available on the CD in a user friendly interface)

Examples of Filled-in Data Forms: Provided in the document

Key References:

Platts. W., W. Megahan, and G. Ninshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. USDA Forest Service, Intermountain Forest and Range Exp. Station, Ogden, Utah. General Technical Report INT-138. May.

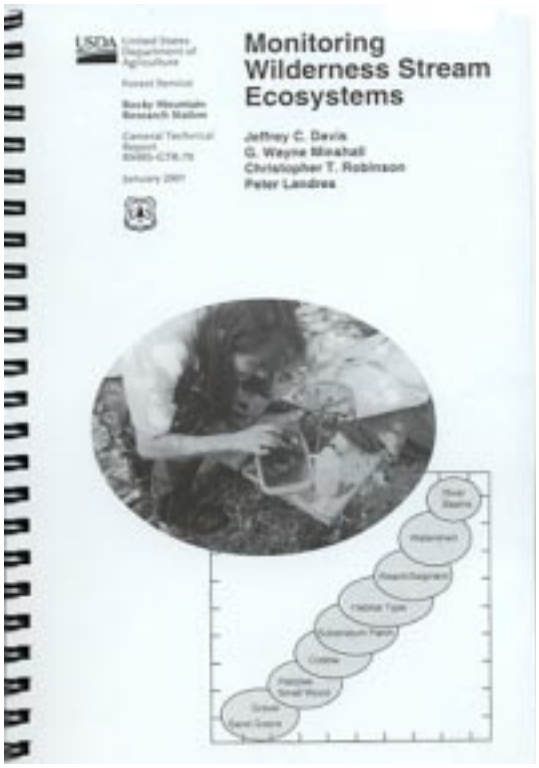
Pleus, A.E., D. Schuett-Hame, and L. Bullchild. 1999. TFW Monitoring Program method manual for the habitat unit survey. Prepared for the Washington State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-99-003.DNR #105. June.

Pleus, A. E., and D. Schuett-Hames. 1998. TFW Monitoring Program methods manual for the reference point survey. Prepared for the Washington Department of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-98-002. DNR #104. May.

Document No.: 109

Monitoring Wilderness Stream Ecosystems

Citation: Davis, J.C., G. W. Minshall, C. T. Robinson, and P. Landers. 2001. Monitoring Wilderness Stream Ecosystems. U.S. Dept. of Agriculture. General Technical Report RMRS-GTR-70.



Source: U.S. Dept. of Agriculture
Forest Service
Rocky Mountain Research Station
324 25th Street
Ogden, UT 84401

Abstract: This manual provides detailed guidance on how to acquire data on wilderness streams. It provides instructions on monitoring the entire range of structural and functional stream parameters (physical, chemical, and biological) in a 4-stage monitoring system that provides increasing detail and rigor at each successive stages. At stage 1 information is obtained on a basic set of parameters that describe stream ecosystems. Each following stage builds upon stage 1 by increasing the number of parameters and the detail and frequency of the measurements. Stage 4 supplements analyses of stream biotic structure with measurements of stream function: carbon and nutrient processes. This staged system offers maximum flexibility allowing modification for particular situations, goals, and needs. It is organized in a manner that, while ensuring the analysis of key factors, allows for modification to address particular objectives. Standard methods are presented that were selected or modified through extensive field application for use in remote settings.

This manual also addresses basic topics associated with initiation of a monitoring program. What stream components or factors should be measured; where the samples should be taken; how often should samples be collected; what are the differences between or among locations and streams detected?

Appendix C contains taxonomic macroinvertebrates' list.

Target Application: Management **&** Research

Suitable for Volunteers: No

Monitoring Focus: This manual includes techniques for monitoring: 1) environmental factors: temperature, solar radiation, substratum, water quality, discharge, current velocity; 2) biotic factors: large woody debris, macroinvertebrates, fish, algae, periphyton, ecosystem production/respiration, nutrient spiraling, secondary production, organic matter decomposition, benthic organic matter.

Geographic Scale: Stream reach, project site

Methods: Field

Level of Data Quality: Level 4

Equipment and Tools *(list)*: Appendix A of the document

Data Forms: Not provided

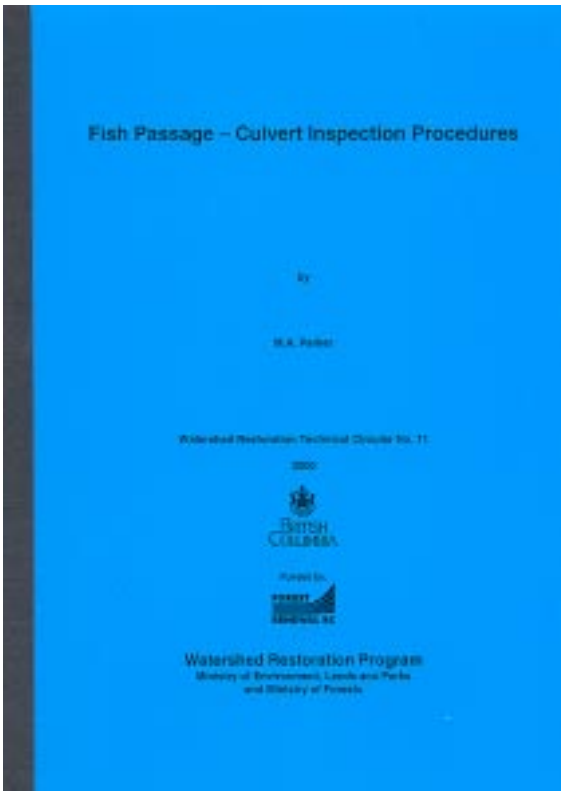
Examples of Filled-in Data Forms: Not provided

Key References: Page 102 of the document

Document No.: 110

Fish Passage - Culvert Inspection Procedures

Citation: Parker, M.A. 2000. Fish Passage - Culvert Inspection Procedures. Watershed Restoration Technical Circular No.11. Ministry of Environment, Lands and Parks and Ministry of Forest. British Columbia. 47 pp.



Source: Ministry of Environment, Lands and Parks
and Ministry of Forests
Watershed Restoration Program
400-640 Borland Street
Williams Lake, BC
Canada V2G 4T1

Abstract: The procedures in this manual have been developed to assess fish access at culvert bearing road crossings. These procedures may easily be incorporated into the Watershed Restoration Program with other assessment activities. The methods outlined in this manual determine connectivity of fish habitats on a watershed scale in order to address fish access issues associated with road crossings. The priorities identified by these procedures are then incorporated into the overall restoration planning. Even though this assessment has been developed for use in the Watershed Restoration Program and the eligible funding criteria established by Forest Renewal British Columbia, it is easily applied to other non-forestry locations and programs without modifications.

The data collected through this manual provides support to determination of fish passage as well as serving as quality assurance tool to be used for expert evaluation in determining if additional assessment is required. The procedures outlined in this manual are best completed by a qualified fisheries biologist due to the need of identifying fish species and subjectivity of evaluating the fish habitat to be gained by restoring access.

The assessment of fish passage barriers consists of four steps. The first two steps are office-based and are intended to narrow down a list of sites that need to be visited in the field. The next two steps are undertaken in the field to determine whether a full assessment including all data collection is to be carried out.

Target Application: Management

Suitable for Volunteers: No

Monitoring Focus: Evaluating fish passage barriers and prioritizing their replacement on the basis of fish habitat evaluation (channel classification, sediment source/degree, beaver activity) and fish presence. Culvert characteristics measured in this manual include: diameter, length, material, water velocity, shape, wetted width, slope, high water mark, water depth, and outfall drop.

Geographic Scale: Watershed

Methods: Office **&** Field

Level of Data Quality: Level 3

List of Equipment and Tools (*list)*: Not provided

Data Forms: Appendix 1 of the document

Examples of Filled-in Data Forms: Not provided

Key References: Page 33 of the document

Document No.: 111

Large Woody Debris Fish Habitat Structure Performance and Ballasting Requirements

Citation: D'Aoust, S.G., and R.G. Millar. 1999. Large Woody Debris Fish Habitat Structure Performance and Ballasting Requirements. Watershed Restoration Management Report No.8. Ministry of Environment, Lands and Parks and Minitsry of Forests. Vancouver, British Columbia. 119 pp.

Source: Department of Civil Engineering
The University of British Columbia
2324 Main Mall
Vancouver, BC
Canada, V6T 1Z4

Abstract: Many stream restoration efforts include placement of constructed large woody debris (LWD) and fish habitat structures. These structures are installed in stable channels to rehabilitate summer habitat and critical overwintering refuges in streams, thus attenuating stresses on the aquatic ecosystem until logged riparian areas naturally supply mature windfalls (Slaney and Martin 1997). This study addresses one of the main problems faced by restoration practitioners: the lack of physically based design guidelines for LWD habitat structures. The theoretical basis behind the design methodologies is presented for three types of LWD structures: 1) Single-LWD, 2) Single-LWD with intact rootwad, and 3) Multiple-LWD structures. A field verification program was undertaken to test the applicability of the theoretical basis and to refine the design guidelines. Over 80 LWD structures in seven streams of varying size were assessed after construction and again after the fall 1997 to spring 1998 floods. Results indicate that the design approach for single -LWD and single LWD with rootwad structures, based on a factor of safety against sliding failure, successfully predicted the stability of the structures during the past fall to spring floods. The stability of the multiple-LWD structures proved to be more complex to predict since a greater number of design and construction-related factors influence stability and drifting wood is frequently caught by the structures. Nonetheless, a design approach based on a safety factor against buoyant failure is recommended. Recommendations with respect to the design and construction of LWD structures are also presented as part of this study.

Target Application: Management & Research

Suitable for Volunteers: No

Monitoring Focus: This manual discusses the design methodologies for three types of LWD structures: 1) Single-LWD, 2) Single-LWD with intact rootwad, and 3) Multiple-LWD structures.

Geographic Scale: Basin, sub-basin, stream reach, project site

Methods: Office & Field

Level of Data Quality: Level 3

Equipment and Tools (*list*): Not provided

Data Forms: Structure assessment form on pages 79-82 of the document

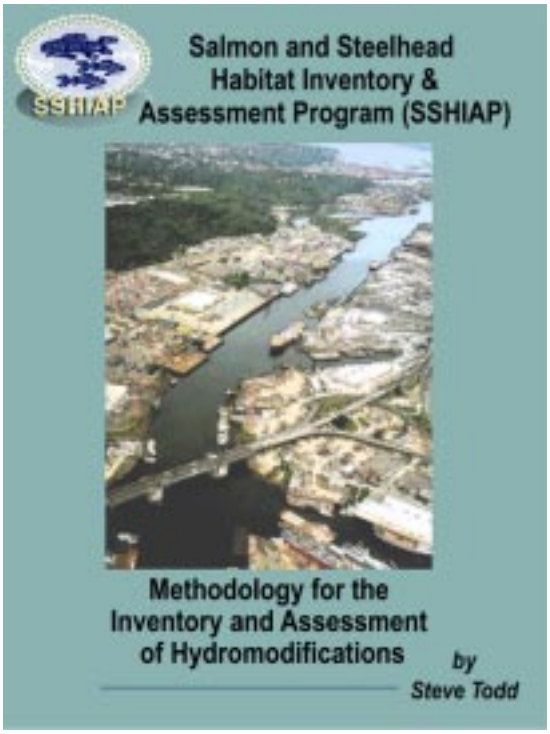
Examples of Filled-in Data Forms: Not provided

Key References: Pages 71-76 of the document

Document No.: 112

Methodology for Inventory and Assessment of Hydromodifications

Citation: Todd, S. 2001. Quantifying Obstructed Habitat: Hydromodifications. Salmon and Steelhead Habitat Inventory and Assessment Program. Northwest Indian Fisheries Commission. Olympia, WA. 14 pp.



Source: Salmon and Steelhead Habitat Inventory and Assessment Program (SSHIAP)
Northwest Indian Fisheries Commission
6730 Martin Way E.
Olympia., WA 98516
Internet: http://www.nwifc.wa.gov/sshiap/
Contact: Steve Todd
E-mail: stodd@nwifc.wa.gov

or: Washington Department of Fish & Wildlife
1111 Washington Street SE
Olympia, WA 98501
Internet: http://www.wa.gov/wdfw/hab/sshiap/
Contact: Eva Wilder
E-mail: wildeelw@dfw.wa.gov

Abstract: This document describes the SSHIAP methodology for the *inventory* and *assessment* of hydromodifications. It begins with a background of the significance of hydromodifications in freshwater habitats of the Northwest, then outlines the approach, objectives, processes, data sources, scope, scale, hydromodification categories, precision and accuracy, limitations of the methodology, and the use of its products.

The *inventory* module of the protocol is to identify the spatial distribution of different types of hydromodifications throughout all watersheds with a priority given to streams within the anadromous zone. The *assessment* module of the protocol is and assessment of the impact of these hydromodifications on salmonid habitat, involving quantitative summaries of streams and watersheds, and the examination of the relationships between hydromodifications and habitat structure and function.

The hydromodification inventory and assessment is primarily a mapping exercise involving a variety of sources, a geographical information system (GIS), and the SSHIAP relational database as both tools and potential products. This protocol is intended for SSHIAP staff to provide a consistent and repeatable method for hydromodification inventory and assessment.

Target Application: Management

Suitable for Volunteers: No

Monitoring Focus: Identification, inventory and assessment of hydromodifications.

Geographic Scale: Basin, sub-basin, reach

Methods: Office

Level of Data Quality: Level 2 or 3

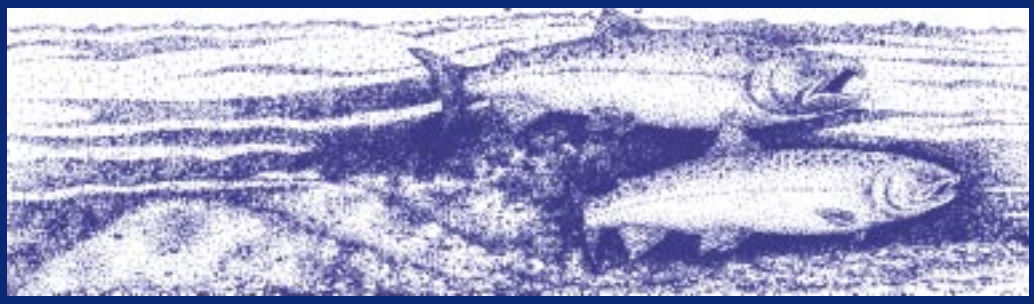
Equipment and Tools *(list)*: Provided in the document

Data Forms: Not provided

Examples of Filled-in Data Forms: Not provided

Recommended References: Provided in the document

APPENDIX I - GLOSSARY OF TERMS -



- Project Types
- Focus Types
- General Glossary

GLOSSARY
Definitions of Project Types

Users Note: The Project Type definitions in this glossary are organized by the four generalized project areas of Freshwater Habitat, Water Quality, Riparian and Upland Habitat, and Estuarine and Nearshore Marine.

Freshwater Habitat

Bank stabilization – Work related to stabilizing a streambank through planting vegetation (bioengineering), soil reinforcement, and/or minimal artificial streambank protection (such as a toe rock at the base of a slope) in order to minimize erosion and sedimentation. Bank stabilization projects should most closely mimic naturally stabilized banks within the vicinity of the project location.

Beaver populations (restoring/maintaining) - The purpose of restoring or maintaining beaver populations is to retain the primary function of beavers, that is, to deliver down wood to aquatic systems and produce small impoundments (<2 acres).

Bridge – A water-crossing (over-water structure) that retains or restores natural channel conditions; maintains ecological connectivity; avoids geologically unstable areas; considers cumulative culvert impact for direct loss of habitat; and minimizes streambank vegetation disturbance.

Carcass placement – In-stream or near-stream placement of fish carcasses to enhance nutrient levels (such as nitrogen) in the stream ecosystem, including the water column, sediments, vegetation, and biota.

Channel connectivity – Any work that results in connecting a new or reconnecting an existing stream channel to a larger stream system to improve fish habitat (i.e., improves fish passage, improves water flows, provides additional spawning or rearing habitat, etc.).

Channel reconfiguration – Any work to either create a new stream channel or redesign an existing stream channel to improve fish habitat (i.e., results in improved stream function, stream sinuousity, modi fied stream flows, etc.)

Complex log jams (also known as Engineered Log Jams, or ELJ's) – Permanent in-stream flow control structures based on the architecture of naturally occurring stable log jams in large river systems, designed to mimic natural log jams and remain fixed in the channel. They contain key pieces of wood large enough to alter the course of the river channel and capture additional wood, may provide bank protection, and provide fisheries habitat value by enhancing habitat complexity.

Controlling aquatic plants - Activities, including herbicide application and water drawdowns, to reduce or remove emergent or submergent plants usually associated with reservoirs or impoundments.

Creating/maintaining islands or rafts - Naturally occurring islands that result from high water levels cutting off peninsulas, and man-made rafts created from a variety of materials. Both rafts and islands are <2 acres. Also includes dredge spoil islands.

Culvert improvements – The removal and/or installation of either a new or replacement of a stream conduit structure to enable fish passage and stream function (e.g., water flow) under a stream crossing such as a road or a bridge.

Dam removal – Work to remove any human-made structure that results in an abrupt change in surface water elevation (e.g., a concrete water diversion structure, or a failed log control system along a stream). Dams are removed because they may impede fish and sediment passage.

Debris removal – Work to remove any non-living unwanted material at a restoration or acquisition site (e.g., human-made materials such as derelict vehicles and garbage, or natural materials such as landslide materials including soil and gravel).

Deflectors/barbs/vanes – An in-stream structure used to influence or redirect the flow, pattern, or hydraulics of a stream in order to reduce or increase the erosive forces acting on a stream bank or streambed. Generally involves placing material (such as boulders, rocks, gabions, logs, etc.) in a stream channel at specific locations to gain a specific effect.

Dike removal/setback – Work related to removing or moving away from the stream or marine shoreline a water-retaining structure that was originally built to control/divert stream flows and protect farmland or other property from flooding. Removal or setback is intended to promote natural stream or estuary flow (e.g., tidal action) and restore natural ecological functions.

Diversion dam - A human-made structure or installation to divert water from a stream, river or other surface water body for a specific purpose such as municipal, industrial, agricultural, hydroelectric generation, etc. A diversion dam project may include replacement or modification of a diversion dam to improve fish passage.

Engineered debris jam - Engineered debris jams (EDJs) are collections of large woody debris (LWD) that re-direct flow and provide stability to or create a downstream bar or island. Engineered debris jam construction may be patterned after stable natural log jams or may be anchored with man-made materials. Naturally occurring logjams in alluvial channels are usually formed by one or several key members (old growth trees with rootwads attached) which stabilize other debris that is "racked" against the key member(s). Debris jams extend above bankfull water surface and, when connected to a streambank, are hydraulically similar to groins.

Fish by-pass - Gravity fish screens (see definition below) that are installed downstream of the diversion headgate usually require a "fish bypass system" to collect fish from in front of the screen and safely transport them back to the stream. The fish bypass consists of an entrance/flow control section and a fish conveyance channel or pipeline. A portion of the diverted flow used to transport fish from in front of the fish screen back to the stream through the fish bypass system. Fish bypass flow requires positive hydraulic head differential between the water surface at the screen and the water surface at the bypass outfall to the stream.

Fish screen (gravity) and fish screen (pump) - A fish protection device installed at or near a surface water diversion headgate to prevent entrainment, injury or death of targeted aquatic species. Fish screens physically preclude fish from entering the diversion and do not rely on avoidance behavior like electrical or sonic fish barrier technology. Fish screens are categorized by: 1) diversion type (gravity vs pump), and 2) debris cleaning function ("active" or automatic vs "passive" or manual cleaning).

Fishway – A structure or system that is designed to facilitate fish passage. Components of a fishway may include: fish attraction features, a barrier dam, entrances, auxiliary water systems, collection and transportation channels, a fish ladder, an exit, and operating and maintenance standards. Fishways can be formal concrete structures, pools blasted in the rock of a waterfall, or log controls in the bed of a channel. Fishways can be divided into six classifications based on their hydraulic design and function: pool and weir; vertical slot; roughened channels; hybrid fishways; and mechanical fishways. Culverts (even if "fish friendly") do not count as fishways.

Headgate - A structure that uses gates to control the flow of water from a surface water source (such as a stream or lake) into a water conveyance facility (such as a canal, ditch or pipeline) that uses gravity to move water through, for irrigation or other purposes.

In-Channel Hydro-modifications - Complete or

partial in-channel modifications to allow for increased hydrologic connections and fish passage between fragmented habitats. Modifications in this category are in-stream or near-stream anthropogenic alterations to channels that impede flow, routing of wood and sediment, or passage of aquatic organisms. Examples include dams, bridge footings, dikes, berms, levees, road prisms, pilings, and seawalls. Restoration projects to improve passage and hydrologic connections between fragmented habitats can include removing structures and replacing old designs with new culverts, bridges, tide gates, fish ladders, or bypass alternatives.

In-stream flows (establish and maintain minimum flows) - These types of projects strive to identify optimum minimum in-stream flows for salmonid productivity then work towards maintaining flows to meet targets. Projects will often include strategies for reducing surface water diversions or ground water diversions for consumptive uses, removing impediments to hyporheic flow, or changing conditions at impoundment structures.

Log control (weir) – A log structure placed in the streambed to influence water flow, gradient, sediment, bed elevation, or other stream functions.

Log jam (engineered) - (see also *Engineered debris jams*)

LWD/boulders or other habitat forming elements - These projects introduce physical habitat components to stream channels in an effort to mimic natural inputs and resulting habitat features associated with these habitat elements. Large woody debris (LWD) and boulder supplements are two common examples of this project type.

Mobilization – Getting necessary equipment or supplies (earth-moving equipment, for example) moved to the project work site in order to begin construction/restoration work. Does not include procurement of supplies or equipment to be used during construction/restoration.

Off-channel habitat – Any work related to designing, building, and installing fish habitat separate from, but connected to, the main stream channel for the purposes of improving, creating, or connecting channels and ponds for fish to rear and spawn (including resting, feeding, etc.).

Peak flows (establish and restore the timing, frequency and magnitude of) - Projects that strive to modify or improve variables that influence the timing, frequency and magnitude of peak flows in targeted drainage areas. Activities include alterations to impoundments, improvements to watershed vegetation composition and maturity, wetland development or restoration, or storm water detention or retention.

Permits – Any work related to applying for and securing necessary construction permits from various governmental agencies in order to legally perform work on the project site(s).

Pipes & ditches – Metal pipes and man-made ditches constructed for the purpose of conveying water to or from a stream or well.

Plant removal/control – Work related to removing or controlling through manual, mechanical, or chemical means any unnecessary, non-native, and/or invasive vegetation on the site for the purposes of restoring the site for beneficial fish and wildlife habitat.

Project success monitoring – Any work related to collecting information about the effectiveness of the project over a specified period of time to determine whether the project is meeting the intended objective. For example, may include collecting data on certain parameters (water quality, fish use, etc.) and comparing this information to preproject data.

Reveg-plant installation – Work related to planting native vegetation along a waterbody or in a riparian zone to prevent soil erosion and landslides; discourage invasion of non-native vegetation; and provide important ecological functions to the waterbody, fish, and wildlife such as shading,

organic matter, filtration, etc.

Reveg-plant materials – The procurement of native vegetation used during planting and revegetation activities.

Rock control (weir) - A rock structure placed in the streambed to influence water flow, gradient, sediment, bed elevation, or other stream functions.

Roughened channel – Work related to increasing coarseness and texture in the stream channel using natural streambed materials such as baffles, rocks, boulders, or log structures in order to reduce water velocity and facilitate fish passage.

Signage – Work related to designing, building, and installing signs at a restoration or acquisition site to identify the site to the public (specifying site purpose, owner, and/or contact information); to provide information about the site to visitors (e.g.: interpretive signs describing wildlife, ecology, history, etc.); to provide parking information and directions to visitors (e.g.: parking lot signs); or to provide safety information to visitors (e.g.: hazard warnings).

Site maintenance (1 year or less) – Any work related to preserving the project work site as it was constructed in order to protect the original invest ment and intent of the project. May include weeding, repairs related to weather damage, vandalism, etc.

Spawning gravel placement – Any work related to introducing properly-sized fish spawning substrate (i.e.: gravel) to the channel. Includes streambed control structures to keep the gravel in place.

Traffic control – Any work related to managing vehicular travel in and around the work site during or after the project construction period (includes traffic signals). For example, traffic may need to be temporarily re-routed to avoid a construction area, or permanently re-routed.

Utility crossing – Work related to installing, connecting, reconnecting, or moving such utilities as electrical, phone, cable, natural gas, water, sewer lines, and irrigation pumps.

Woody debris structures – Any work related to design or engineering, procurement, and/or installation of wood structures in a stream channel or riparian area for the purposes of providing improved fish habitat and stream channel complexity.

Work site restoration – Work related to returning a work site to its original state after project construction work is completed. May include contouring the landscape to a proper angle of repose, reconnecting utilities, re-vegetation, fencing, etc.

Riparian and Upland Habitat

Alternate water source – Providing an upland water source for irrigation or livestock in order to prevent livestock from entering rivers and streams to drink water.

Erosion control (road) – Work related to minimizing or eliminating erosion impacts to a waterbody caused by upland roads. May include road removal or road resurfacing (e.g.: from pavement to gravel), adding or upgrading drainage structures, water bars, and stream crossings, re-vegetating cut and fill slopes. Also see Road abandonment/decommissioning below.

Erosion control (slope) – Work related to minimizing or eliminating erosion impacts to a waterbody caused by upland slope failure (e.g.: landslides) or drainage erosion. Specific work involves adding or upgrading drainage structures, water bars, upgrading ditches, removing or stabilizing fill material.

Floodplain restoration - Projects are targeted at restoration of the sinuosity and meander of natural stream channels, increasing of edge habitat com-

plexity, and/or re-connecting isolated channels. Typical restoration projects will strive to move, modify or eliminate impediments. Examples include dike removals or setbacks, rip-rap removal, bridge expansion, infrastructure relocation and modifications.

Impervious surface removal – Work related to removing any human-made structure from the ground that inhibits or prevents water from being absorbed into the soil (e.g.: asphalt parking lot, old building foundation, or road).

Livestock fencing – Work related to installing fencing material upland to prevent livestock from having access to a surface water buffer, surface water bank, or the waterbody itself. Also called "exclusion fencing."

Livestock stream crossing – Work related to building and installing a stream crossing structure (such as a bridge) for livestock to use that is intended to keep livestock from damaging the stream. The crossing should be designed so that it does not hinder fish passage in the stream.

Livestock water supply – Work related to building and installing an upland watering area for livestock to use to direct them away from using streams for their water supply.

Low/no till – An agricultural cultivation technique in which the soil is minimally disturbed (not tilled). Farmers instead apply detritus from previous crops on seedbeds to protect the seeds or drill the seeds directly into leftover stubble. The primary benefit of this practice is decreased soil erosion into streams.

Pipes & ditches – -metal pipes and man-made ditches constructed for the purpose of conveying water to or from a stream or well.

Plant removal/control – Work related to re moving or controlling through manual, mechanical, or chemical means any unnecessary, non-native, and/or invasive vegetation on the site for the purposes of restoring the site for beneficial fish and wildlife habitat.

Reveg-plant installation - Work related to planting native vegetation along a waterbody or in a riparian zone to prevent soil erosion and land slides; discourage invasion of non-native vegetation; and provide important ecological functions to the waterbody, fish, and wildlife such as shading, organic matter, filtration, etc.

Road abandonment/decommissioning – Any work related to taking a road out of service to minimize or eliminate erosion impacts to a waterbody. Includes removing road signs, road pavement or surface, and/or replacing impervious surfaces with vegetation or gravel to prevent further erosion.

Silvicultural manipulations of existing riparian trees - Projects are intended to establish or increase the growth rate of preferred species (usually conifer) in existing riparian forest. Techniques include thinning, patch cutting, and understory planting. Riparian areas dominated by hardwoods or dense stands of even-age conifer may be appropriate for these kinds of treatments depending on site conditions and stream channel characteristics.

Site maintenance – Any work related to preserving the project work site as it was constructed in order to protect the original investment and intent of the project. May include weeding, repairs related to weather damage, vandalism, etc.

Utility crossing - Work related to installing, connecting, reconnecting, or moving such utilities as electrical, phone, cable, natural gas, water, sewer lines, and irrigation pumps.

Wetland Creation/Enhancement - Construction of a wetland in an area that in the recent past has not been a wetland and has been isolated from an existing wetlands. Typically, wetland are created by excavation of upland soils to elevations that will support the growth of wetland species through the establishment of an appropriate hydrology. Enhancement of wetlands entails modification of

someof its features to increase one or more of its functions as defined by management objectives. Typically, this is accomplished by modifying site elevations or the proportions of open water.

Wastewater (disposing/assimilating) - Control ling waste water effluent discharge into lakes, streams, rivers, or nearshore marine waters.

Estuarine & Nearshore Marine Habitat

Aquaculture - Commercial production and harvest of fish (i.e., grown in net pens) and shellfish (e.g., oysters, geoducks, clams, and mussels). This also includes impacts associated with recreational harvest of shellfish.

Armoring (Shoreline) - Placement of rock, wood, or concrete at the water's edge to prevent shoreline erosion or bank failure. Bulkheads are sometimes placed in non-eroding areas.

Beach nourishment - Beach nourishment is the artificial depositing of a mixture of sand and gravel on beach areas that can result in increased epibenthic crusteacens, vegetation and natural sedimentation rates. Diverse uses, from residential sites to industrial cleanups, on small pocket beaches to large beach areas, especially gravel beaches in public parks. Nourishment is used for erosion control, recreational enhancement, mitigation for armoring, and for biological enhancement.

Beach restoration – Work related to improving the fish habitat of a marine beach area by encouraging natural, self-sustaining ecological processes. Work may include: removing contamination, removing structures, removing invasive or non-native vegetation, removing debris, enhancing beach substrate by adding natural materials (gravels, sand, etc.), planting native vegetation, re-grading beach profile, etc.

Bulkhead removal – Work related to removing human-made structures from the marine shoreline that were originally placed to prevent shoreline erosion and solidify and strengthen the shoreline profile. These structures, also known as bulkheads, can be made of wood, metal, rock, concrete, plastic, or other materials.

Culverts in levees, Installation – Installation culverts in levees to restore fish access and tidal inundation to upstream slough areas that were formerly openly tidal. Useful to restore estuarine habitat in other areas while maintaining some drainage function and flood protection to adjacent land, increasing quality and quantity of water and regularly inundated saltmarsh habitat. (see also *Tide gate removal/modification*).

Dike breaching/removal – The process of removing or breaking through all or part of a man-made dike to restore natural tidal exchange in an historical estuarine environment such as a river delta. Opens primary corridors for fish and wildlife, and recreates historical off-channel habitat. Results in sediment accretion, increased net primary production, increase in tidal elevation of salt marsh habitat, and emergence of estuarine wetland plants.

Dredging and filling (marine) - Mechanical or hydrological removal of bed materials (sand, gravel, mud) and their transport to a new location for the purpose of providing increased depth for boat and ship navigation. Filling is the placement of dredged material or upland materials in marine aquatic areas. In Puget Sound, fill materials are typically placed to create uplands for commercial purposes (e.g., marina, port developments). Fill material has been used to create dredge spoil islands along the lower Columbia River.

Eel grass, kelp, or other native vegetation planting or re-establishment – The process of restoring native marine or estuarine aquatic vegetation (such as eel grass or kelp) in the marine nearshore or estuarine environment in order to improve fish habitat (for food, cover, spawning). Restoration work may include removal of debris or

non-native vegetation and site preparation to facilitate survival of the native vegetation.

Flushing/partial passage – The removal of full or partial blockages to marine tidal water flushing.

Ghost net removal – The removal of derelict or abandoned fishing nets that pose a threat to fish and wildlife in the marine environment. Fishing nets are often submerged, partially submerged, or exposed along the shoreline, and removal procedures may vary depending on the location of the nets.

Harbor, marina, and ferry terminal development - Includes both the development and subsequent use of harbors, marinas, and ferry terminals. This category reflects both fresh and saltwater environments. Includes commercial shipping, associated cargo handling, and ferry transport. Recreational boat marinas and associated infrastructure (e.g., parking lots, floats, breakwaters, fueling stations). Commercial harbors and ferry terminals are typified by Elliott Bay, Port Angeles, and Bellingham Bay, Washington, and Newport, Coos Bay, and Portland, Oregon. Recreational marinas are typified by Olympia and Des Moines, Washington, and Astoria, Oregon. Impacts extend to include bilgewater and wakes from large ships.

Landfill removal – The removal of upland refuse (garbage and other disposed materials) contained in a municipal landfill that is posing a threat to marine nearshore habitats and ecological processes.

Nearshore subtidal enhancement – Introduction and distribution of substrate material in beach and nearshore areas (depth <20 m) for increasing macroalgae and cover for fish and invertebrates. The placement of pea gravel plots provides juvenile salmonid prey and oyster shell plots provide red rock crab, oyster, and shore crab habitat.

Plant removal/control – The removal/control of non-native plant species within the nearshore/marine environment. Includes the control of English Cordgrass *(Spartina anglica)* by mowing, hand pulling and herbicide treatment. Monitoring shows that *Spartina* can be significantly reduced with resulting higher plant species diversity.

Removal of overwater structures – Removal of docks, piers, and other structures that block light and limit migration patterns for young salmon. Removal of structures can allow marine plants and organisms to repopulate these areas.

Residential docks in marine and freshwaters - Floating and fixed docks, piers in marine and freshwater environments. Physical dimensions of docks tend to be about eight (8) feet wide and 50 to 100 feet long. Typical dock structures have associated pilings and deck surfaces.

Restoration of estuary and shoreline riparian areas – The planting of riparian areas associated with estuaries, shorelines, and tidal wetlands with native vegetation and monitor for post-project regeneration in comparison with a reference site. Intent of project is to re-establish natural woody vegetation and shoreline erosion control functions.

Soft shore protection – Use of indigenous materials such as gravel, sand, logs and root wads in designs that are flexible and mirror natural processes. Rebuilds high tide beach to provide protection of property and homes and to increase coastal sediment supply. Projects that benefit nearshore habitats include woody debris, shading, re-vegetation and increased shoreline complexity.

Tidal channel reconstruction – The reconstruction/restoration of tidal channels historically removed from the confluence of a riverine delta and estuarine system.

Tide gate removal/modification – the physical removal or modification of tidegate(s) to restore or improve passage for fish and/or other species through tidally influenced channels, and to restore the natural tidal flushing within the estuarine environment.

Toxic spills in fresh and saltwater - This activity reflects spills or depositions of chemicals into freshwater and marine habitats. This is typified by,

but not limited to, petroleum spills, railroad car incidents, semi-truck turnovers, and marine Superfund sites (e.g., Commencement Bay, Elliott Bay, Washington). Toxic chemicals are represented primarily by hydrocarbons, dioxins, petrochemicals, fertilizers, pesticides, and heavy metals. This category does not include spill and deposition sites that are entirely terrestrial-based.

Underwater marine structures creation - The active creation of underwater structures, normally involving placement of large concrete and rock substrates. Objective is to provide vertical relief to create habitat structures for various marine fish and shellfish. These underwater reef structures could be 50 feet wide, 200 feet long, and 10 feet tall. The structures are located primarily in Puget Sound, Washington. Note to readers: Oil exploration and associated drilling platforms are currently prohibited off the Oregon and Washington coastlines, and thus are not considered in this assessment.

Water Quality

Nutrient loading (remove, reduce or modify sources of) - Projects are directed at improving or modifying the nature and magnitude of nutrient transport, cycling and utilization within the stream system. In some cases this can entail projects that are targeted toward reducing the amount of nutrients reaching waterways, such as bio swales or filter strips. Other projects might be targeted toward increasing available nutrients such as using salmon carcasses to nourish oligotrophic water bodies.

Sediment collection ponds – Man-made structures or excavations in or near waterways for the purpose of collecting sediment eroded from uplands or stream channels.

Thermal loading (remove or reduce sources of) - Projects targeted at reducing the temperature of local water bodies to meet target values for the viability and productivity of salmonids. Projects can focus on point source or non point sources of thermal loading.

Toxic loading (remove or reduce sources of) - Projects targeted at reducing levels of toxic substances in local water bodies to meet target values established under Clean Water Act regulations. Projects can focus on point source or non point sources of toxic inputs.

Toxic spills in fresh and saltwater - This activity reflects spills or depositions of chemicals into freshwater and marine habitats. This is typified by, but not limited to, petroleum spills, railroad car incidents, semi-truck turnovers, and marine Superfund sites (e.g., Commencement Bay, Washington). Chemicals are primarily represented by hydrocarbons, dioxins, petrochemicals, fertilizers, pesticides, and heavy metals. This category does not include spill and deposition sites that are entirely terrestrial-based.

GLOSSARY
Definitions of Focus Types

Bank Shape - The shape of the streambank, which typically indicate the condition and overall health the stream channel. Monitoring the shape of the bank and the presence of undercuts banks (areas where the bank overhangs the stream) allows to detect scouring or erosion occurring in a given area.

Bank and Shoreline Cover – Structural materials (boulders, logs, or stumps), channel features (ledges, vegetation), that provide protection for aquatic species along the banks of streams and shorelines of other water bodies.

Bank Stability – Index of firmness or resistance to disintegration of a bank based on the percentage of the bank showing active erosion and the presence of protective vegetation, woody material, or rock.

Bank Stabilization – Placement of materials such as riprap, logs, gabions, and planting of vegetation to prevent bank erosion.

Barrier Assessment – The physical approach of assessing potential obstructions to fish passage. Fish barriers may be either man-caused or natural.

Biomonitoring Fish Community – Measure of the richness of the fish community (No. of fish taxa) as indicators of long-term and broad habitat conditions.

Biomonitoring Macroinvertebrates – Measure of the diversity (including taxonomic identification) and production of the benthic community as indicators of localized, water quality conditions.

Biomonitoring Periphyton – Measure of the diversity (including taxonomic identification) and production of periphyton as an indicator of biotic integrity. Periphyton is identified as attached microflora growing on the bottom, or on other submerged substrates.

Biomonitoring Phytoplankton – Measure of diversity and production of phytoplankton (including taxonomic identification) as indicators of biotic integrity. Phytoplankton is identified as small plants, generally smaller than 2 mm and without strong locomotive ability that are suspended in the water column and carried by currents or waves that may make daily or seasonal movements in the water column

Channel Classification – System used to group or identify streams possessing similar features using geomorphic features (e.g., gradient and confinement), water sources (e.g., spring creek), associated biota (e.g., trout zone).

Confinement (natural) - The extent that the valley floodplain of the reach is confined by natural features. It is determined as the ratio between the width of the valley floodplain and the bankfull channel width. Note: this attribute addresses the natural (pristine) state of valley confinement only.

Gradient – Average gradient of the main channel of the reach over its entire length.

Cover Composition and Abundance – The type and amount of cover available to salmonids in streams.

Cover Density – The amount of cover available to salmonids in streams per unit, as of area.

Effectiveness Monitoring – Monitoring strategies that are designed to judge the effectiveness of a project or silvicultural prescription.

General Vegetation – Measurement of the general type and amount of vegetation growing near banks of a stream, or body of water (including swamps, marshes, seaweed beds, eelgrass meadows, kelp forest, near-stream vegetation, and riparian zone), including maturity and vertical and horizontal diversity, continuity of the vegetated areas within the buffer zone, connectivity to wetlands, and measure of riparian function that has been altered within the

reach.

Gravel Availability - Areas that have sufficient amount of gravel areas for salmon spawning and rearing. Monitoring for gravel availability entails measuring the extent and the size of dominant gravel particles.

Gravel Composition – Percentage of fine sediment within pool tail-outs and riffles.

Gravel Embededness – Degree to which gravel and larger sizes particles (boulder, cobble, rubble) are surrounded or covered by fine sediment.

Gravel Rehabilitation - Re-establishment of streambed conditions to ideal spawning habitat. Typically gravel rehabilitation occurs in concurrence with hillslope restoration. Gravel rehabilitation techniques include gravel cleaning, gravel placement, or installation of gravel catchment structures.

Gravel Scour – Natural process associated with bedload sediment transport. This localized erosion of substrate from the streambed occurs when water velocities are high. Other factors influencing the scour besides the duration and magnitude of peak flows are LWD loading, runoff from impervious surfaces, splash damming, or stream channelization processes.

Habitat Function – Biological and physical attributes of a given habitat that influence survival rates of fish and wildlife occupying that habitat. In this document, addressed are only direct habitat functions (e.g., light, temperature, substrate, community richness), and not indirect ones (e.g., primary production by plants).

Hydromodifications – Man-made structures within or adjacent to the stream channel constrict flow (as at bridges) or restrict flow access to the streams floodplain (due to streamside roads, revetments, diking or levees) or the extent that the channel has been ditched or channelized.

Large Woody Debris Surveying – The measurement of the amount of large wood within the reach. The term "large wood" refers to any large piece of relatively stable woody material having a diameter greater than ten centimeters and a length greater than two meters that intrudes into the stream channel.

Macrohabitat Classification – The measurement and classification of stream macrohabitat features that are relevant to the salmonid lifecycle or watershed health. The features of the macrohabitat include:

Channel month maximum width – Average width of the wetted channel during peak flow month (average monthly conditions). If the stream is braided or contains multiple channels, then the width would represent the sum of the wetted widths along a transect that extends across all channels. Note: Categories are not to be used for calculation of wetted surface area; categories here are used to designate relative stream size.

Channel month minimum width – Average width of the wetted channel. If the stream is braided of contains multiple channel, then the width would represent the sum of the wetted widths along a transect that extends across all channels. Note: Categories are not to be used for calculation of wetted surface area; categories here are used to designate relative stream size.

Habitat type/backwater pools – Percentage of the wetted channel surface area comprising backwater pools.

Habitat type/beaver ponds – Percentage of the wetted channel surface area comprising beaver ponds. Note: these are pools located in the main or side channels, not part of off-channel habitat.

Habitat type/large cobble/boulder riffles – Percentage of the wetted channel surface area comprising large cobble/boulder riffles (see Platts et al. 1983 for definitions).

Habitat type/off-channel habitat factor – A multiplier used to estimate the amount of off-channel habitat based on the wetted surface area of the all combined in-channel habitat.

Habitat type/ pool tail-outs/glides – Percentage of the wetted channel surface area comprising pool tail-outs and glides.

Habitat type/primary pools – Percentage of the wetted channel surface area comprising pools, excluding beaver ponds.
Habitat type/small cobble/gravel riffles – Percentage of the wetted channel surface area comprising small cobble/gravel riffles (see Platts et al. 1983 for definitions).
Channel Length - Length of the primary channel contained with the stream reach – Note: this attribute will not be given by categories but rather will be a point estimate. Length of channel is given for the main channel only – multiple channels do not add length.

Nutrient Subsidy – Relative abundance of anadromous salmonid carcasses within the watershed (e.g., HUC 5 level) that can serve as nutrient sources for juvenile salmonid production, stream/lake health, and other wildlife.

Photodocumentation – techniques associated with extracting and properly storing useful habitat information from ground-based and aerial photography to aid in evaluating field data and making management decisions regarding the photographed sites.

Rearing Habitat Availability – Areas that are suitable for salmonid rearing. A species-specific approach is required to determine such locations as salmonids rear in differing locations by species. Other parameters that should be considered are: food source, temperature, stream flow, cover, etc.

Reference points – Permanent locations along a stream system that are representative of local conditions that may be evaluated over time for trend analysis OR permanent locations that may be relocated during subsequent surveys to ensure the accuracy of data collected relative to prior survey(s).

Restoring Habitat – Taking actions to bring habitat back to a former or original condition :returning it to a state of ecological productivity and useful structure, using techniques similar or homologous in concept (e.g., boulders replacing root masses); producing conditions more favorable to a group of organisms or species complex, especially that economically and aesthetically desired of native flora and fauna, without achieving the undisturbed condition.

Shoreline Animal Damage - Intensive animal use of streamside areas, typically resulting in destabilization of streambanks, sloughing and mass erosion of bank material, trampling of edge habitats, and consumption of riparian vegetation.

Soil Compaction – Compaction of soil by grazing animals or other landuse/managment practices in the riparian zone, resulting in reduction of vegetative productivity and bank stability needed to protect the stream. Compaction of soil in the riparian zones often results in reduced aeration, due to more saturated soils in those areas.

Spawning Habitat Availability – Areas that are suitable for salmonid spawning. A species-specific approach is required to determine the proper spawning gravel size class, the proper depth of flow, the proper water velocity, and the proper water temperature.

Stream Channel Rehabilitation - A method of rehabilitation (see *Rehabilitation*) and enhancing salmonid population to improve the overwintering habitat including channel stabilization, energy dissipation, and sediment storage. Channel rehabilitation techniques include LWD and boulder placement, creation of riffles and poll sequences.

Stream Discharge – Rate at which a volume of water flow past a point per unit of time, usually expressed as cubic meters per second or cubic feet per second. Stream discharge is monitored at various intervals:
Flow/change in interannual variability in high flows – A measure of between year variation in magnitude of high flow levels and/or the extent of change in overall high flow level during a month relative to and undisturbed watershed of comparable size, geology, and geography (or as would have existed in the pristine state).
Flow/change in the interannual variability in low flows – A measure of between year variation in the severity of low flow discharge during

a month. Variation in low flows as applied here is relative to and undisturbed watershed of comparable size, geology, and geography (or as would have existed in the pristine state).

Flow/intra daily (diel) variation – Variability in flow level during a daily period. This attribute is informative mainly for regulated rivers or when flow patterns are influenced by storm water runoff.

Flow/intra-annual flow pattern – The average extent of intra-annual flow variation during month – a measure of a stream's "flashiness" during a season

Hydrologic regime/natural – The natural flow regime within the reach of interest. Flow regime typically refers to the seasonal pattern of flow over a year; here it is inferred by identification of flow sources. This applies to an unregulated river or to the pre-regulation state of a regulated river.

Hydrologic regime/regulated – The change in the natural hydrograph caused by the operation of hydroelectric facilities in a watershed. Definition does not take into account daily flow fluctuations (see flow-intra-daily variation attribute).

Water withdrawals – The number and relative size of water withdrawals within the stream reach.

Stream Morphology - Techniques associated with measuring channel cross-section (e.g.,channel width, depth).

Structural complexity – Relates to the riparian forest adjacent to a stream, an indication of forest structure relative to canopy and understory conditions.

Substrate (pebble counts) - Substrate measurement techniques used to relate land activities to stream habitat quality. Pebble counts act to describe the sediments that may be transported by a particular watershed area.

Total Suspended Solids - total dissolved and suspended solids in water. In stream water, dissolved solids consist of calcium, chlorides, nitrate, phosphorus, iron, sulfur, and other ions - particles that pass through a filter with pores of around 2 microns in size. Suspended solids include silt and clay particles, plankton, algae, fine organic debris, and other particulate matter that do not pass through 2 micron size filter.

Turbidity – Turbidity refers to relative clarity of a water body; measurement of the extent to which light penetration in water is reduced from suspended materials such as clay, mud, organic matter, color, or plankton.

Water Temperature – The degree of coldness or hotness, usually related to a zero at the melting point of ice (Celsius scale).

Temperature/daily maximum (by month) – Maximum water temperature within the stream reach during a month.

Temperature/daily minimum (by month) – Minimum water temperatures within the stream reach during a month.

Temperature/spatial variation – The extent of water temperature variation within the reach as influenced by inputs of groundwater.

Water Chemistry

Alkalinity – Measure of the power of a solution to neutralize hydrogen ions (H^{+}), usually expressed as the equivalent concentration (mg/L) of calcium carbonate ($CaCO_3$).

Dissolved Oxygen – Average dissolved oxygen within the water column for the specified time interval.

Metals/in water column – The extent of dissolved heavy metals within the water column.

Miscellaneous toxic pollutants/water column – The extent of miscellaneous toxic pollutants (other than heavy metals) within the water column.

Nutrient enrichment – The amount of nutrient enrichment consisting of such items as ammonia, nitrogen, phosphorous.

GLOSSARY
General Terms

Channel complexity - Desrcibes salmon habitat. A complex channel contains a mixture of habitat types that provide area with different velocity and depth for use by different salmon life stages. In contrast, a simple channel contains more uniform flow and few habitat types.

Disturbance - Events that affect landscapes, from regions (and watersheds) to sites. They include floods, wildfires, landslides, and volcanoes. They may vary in intensity from small-scale to catastrophic, and in frequency from a few years to many decades or hundreds of years. Natural disturbance regime is the regime that occured historically.

Ecosystem Diagnosis and Treatment (EDT) - is a method that uses a "rule-based" system that focuses on habitat as the unit of analysis, and estimates salmon performance by using an analytical model that predicts the numbers of fish supported by the habitat over the salmon's life history. It is an "expert system" that captures the state of existing knowledge including areas of incoplete or missing data.

Fishway - Passageway, often and ascending series of pools, designed to permit passage of salmon over dams, diversions, or other obstructions.

Floodplain - The low area adjoining a stream or river channel that overflows at times of high river flow.

Flow/hydrology - Includes several components of the natural flow regime of streams and rivers, such as; volume is the amount of surface flow; frequency is how often a flow above a given magnitude recurs; duration is the period of time a specific flow condition persists; timing is the regularity or consistency of specific flow conditions; and rate of change is how quickly amount of flow increases or decreases. All of these components are important to the ecological integrity of rivers, streams, adjacent floodplains, and estuaries.

Gabion - Wire cage or basket filled with rocks or stone used to stabilize banks and to enhance aquatic habitat.

Habitat access - Unobstructed upstream and downstream movement of fish of all life stages.

Habitat-forming processes - Physical agents of landscape pattern formation and maintenance (i.e., the natural rates of delivery of water, sediment, heat, organic materials, nutrients, and otehr dissolved materials).

Historic - Conditions prior to pre-European settement. Acutal data on those conditions are generally limited, but retrospective analyses can lead to reconstruction and estimation of those conditions.

Imprevious Surface - Surface (pavement) that does not allow, or greatly decreases, the amount of infiltration of precipitation into the ground.

Off-channel Habitat - Ponds, oxbows, sloughs, and other backwater areas with cover that provide high-quality rearing habitat for juvenile salmon.

Reach - A defined section of a river or stream channel.

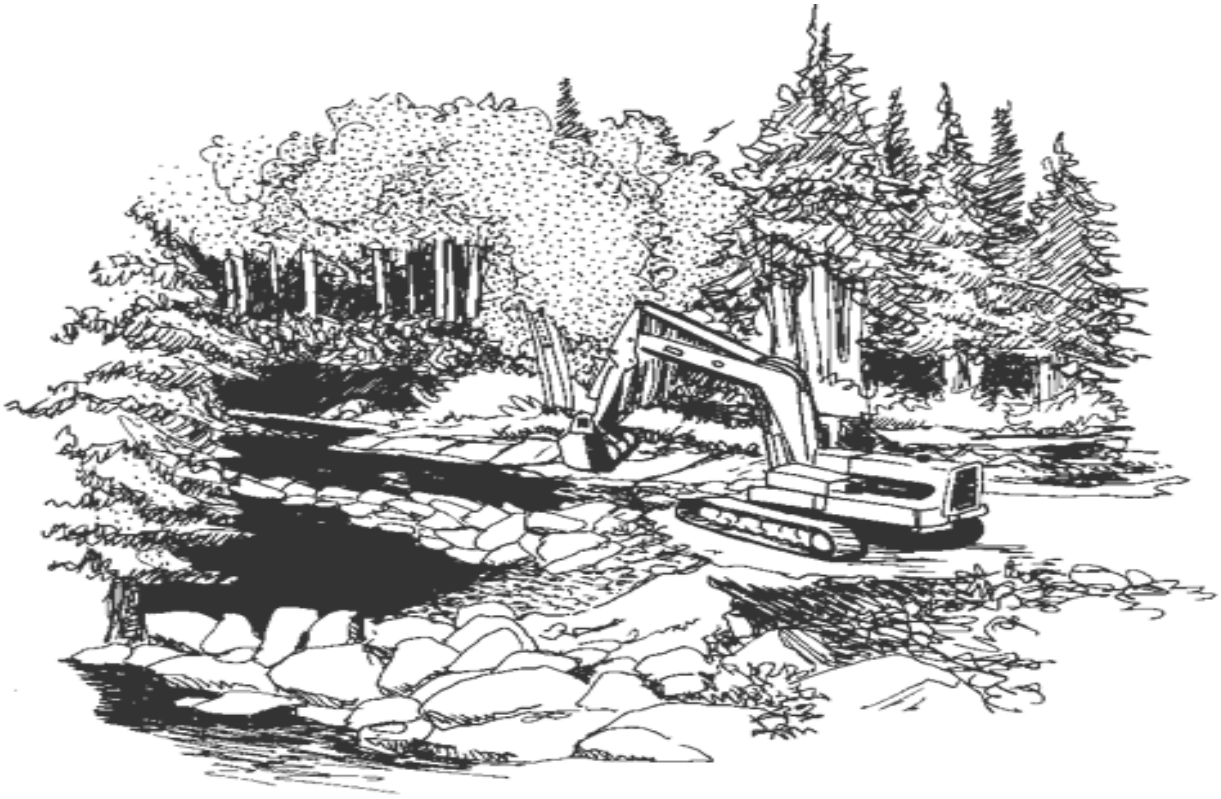
Refugia or Salmon Strongholds - Areas where salmon populations are healthy and habitat for juvenile salmon.

Riparian Zone - The area between a stream or other body of water and the adjacent upland slopes. This zone is identified by soil characteristics and distinctive vegetation. It includes wetlands, the near-shore vegetation surrounding lakes, the portions of

flood plains and valley bottoms that support riparian vegetation. The riparian zone also includes those portions of the upland which have the potential to deliver large woody debris (LWD) to the stream channel.

Watershed Assessment - A scientifically-based approach to understanding how a watershed works: technical efforts that describe ecological processes, potentials, functions, and conditions at multiple spatial and temporal scales, to identify and analyze causes and effects after a period of change.

Weir - A device across a stream to raise the water level or divert its flow.



APPENDIX II - Complete Listingof all documents examined in this report, listed by Project Type and Focus Type

Freshwater

Project Type	Focus Type	Document Number
• Bank Stabilization • Channel Connectivity	Bank and Shoreline Cover	31, 44, 46, 51, 75, 76, 102, 105
	Bank Shape	31, 46, 56, 76, 80, 98
	Bank Stability	26, 31, 44, 56, 59, 75, 80, 81, 98, 102
	Biomonitoring Fish Community	15, 19, 22, 37, 45, 51, 53, 55, 59, 67, 72, 75, 76, 81, 82, 83, 85, 90, 91, 102, 105, 109
	Biomonitoring Macroinvertebrates	12, 16, 17, 18, 19, 20, 21, 44, 57, 58, 59, 60, 61, 66, 72, 75, 76, 81, 83, 84, 85, 86, 87, 90, 105, 109
	Biomonitoring Periphyton	19, 72, 75, 76, 81, 83, 90, 109
	Cover Composition and Abundance	13, 31, 34, 44, 46, 51, 107
	Cover Density	16, 46
	Freshwater Macrohabitat Classification	1, 2, 9, 11, 12, 13, 14, 15, 6, 16, 17, 22, 31, 34, 37, 44, 45, 46, 51, 56, 59, 63, 64, 74, 75, 76, 80, 81, 83, 85, 86, 88, 91, 99, 100, 101, 102, 105, 106
	Gravel Composition	3, 6, 11, 13, 14, 15, 16, 17, 34, 46, 53, 55, 56, 59, 80, 81, 99, 105, 109
	Gravel Embededness	31, 37, 46, 56, 73, 81, 101, 105, 109
	Gravel Scour	4, 6, 11, 13, 14, 15, 17, 74
	Nutrient Subsidy	62, 104
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Spawning Habitat Availability	5, 15, 33, 44, 45, 76, 91
	Stream Discharge	7, 11, 16, 17, 44, 14, 15, 22, 31, 32, 33, 34, 46, 63, 75, 80, 81, 109
	Structural Complexity	46, 62, 111
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
	Water Temperature	8, 14, 15, 16, 17, 21, 35, 37, 40, 44, 45, 46, 51, 56, 75, 76, 80, 101, 102, 106, 109
• Beaver Populations Maintaining/Restoring	Macrohabitat Classification	1, 2, 9, 11, 12, 13, 14, 15, 6, 16, 17, 22, 31, 34, 37, 44, 45, 46, 51, 56, 59, 63, 64, 74, 75, 76, 80, 81, 83, 85, 86, 88, 91, 99, 100, 101, 102, 105, 106
• Bridge • Headgate • Roughened Channel • Pipes and Ditches	Bank Stability	26, 31, 44, 56, 59, 75, 80, 81, 98, 102
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Restoring Habitat	62, 111
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
• Carcass Placement	Biomonitoring Fish Community	15, 19, 22, 37, 45, 51, 53, 55, 59, 67, 72, 75, 76, 81, 82, 83, 85, 90, 91, 102, 105, 109
	Biomonitoring Macroinvertebrates	12, 16, 17, 18, 19, 20, 21, 44, 57, 58, 59, 60, 61, 66, 72, 75, 76, 81, 83, 84, 85, 86, 87, 90, 105, 109
	Biomonitoring Periphyton	19, 72, 75, 76, 81, 83, 90, 109
	Nutrient Subsidy	62, 104
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
	Water Temperature	8, 14, 15, 16, 17, 21, 35, 37, 40, 44, 45, 46, 51, 56, 75, 76, 80, 101, 102, 106, 109
• Channel Reconfiguration	Bank Shape	31, 46, 56, 76, 80, 98
	Bank Stability	26, 31, 44, 56, 59, 75, 80, 81, 98, 102
	Macrohabitat Classification	1, 2, 9, 11, 12, 13, 14, 15, 6, 16, 17, 22, 31, 34, 37, 44, 45, 46, 51, 56, 59, 63, 64, 74, 75, 76, 80, 81, 83, 85, 86, 88, 91, 99, 100, 101, 102, 105, 106

Freshwater

Project Type	Focus Type	Document Number
• Channel Reconfiguration	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Rearing Habitat Availability	33, 98
	Stream Discharge	7, 11, 16, 17, 44, 14, 15, 22, 31, 32, 33, 34, 46, 63, 75, 80, 81, 109
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
	Water Temperature	8, 14, 15, 16, 17, 21, 35, 37, 40, 44, 45, 46, 51, 56, 75, 76, 80, 101, 102, 106, 109
• Culvert Installation • Culvert Removal • Dam Removal • Debris Removal • Dike Removal • Deflectors/Barbs	Bank Stability	26, 31, 44, 56, 59, 75, 80, 81, 98, 102
	Bank Shape	31, 46, 56, 76, 80, 98
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Rearing Habitat Availability	33, 98
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
	Water Temperature	8, 14, 15, 16, 17, 21, 35, 37, 40, 44, 45, 46, 51, 56, 75, 76, 80, 101, 102, 106, 109
• Diversion Dam	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Stream Discharge	7, 11, 14, 15, 16, 17, 22, 31, 32, 33, 44, 46, 63, 75, 80, 81, 109
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
• Fish By-Pass • Fish Screen • Fishways	Barrier Assessment	23, 46, 98, 103, 110
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Stream Discharge	7, 11, 16, 14, 15, 17, 22, 31, 32, 33, 44, 46, 63, 75, 80, 81, 109
	Rearing Habitat Availability	33, 98
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
• In Channel Hydromodifications	Biomonitoring Phytoplankton	90
	Freshwater Macrohabitat Classification	1, 2, 9, 11, 12, 13, 14, 15, 6, 16, 17, 22, 31, 34, 37, 44, 45, 46, 51, 56, 59, 63, 64, 74, 75, 76, 80, 81, 83, 85, 86, 88, 91, 99, 100, 101, 102, 105, 106
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Water Temperature	8, 14, 15, 16, 17, 21, 35, 37, 40, 44, 45, 46, 51, 56, 75, 76, 80, 101, 102, 106, 109
• Log or Rock Control (weir)	Bank Stability	26, 31, 44, 56, 59, 75, 80, 81, 98, 102
	Fish Passage	23, 62, 80, 91, 98, 103, 110
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Stream Channel Rehabilitation	62, 92, 93, 111
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
	Water Temperature	8, 14, 15, 16, 17, 21, 35, 37, 40, 44, 45, 46, 51, 56, 75, 76, 80, 101, 102, 106, 109
• Off-Channel Habitat	Biomonitoring Fish Community	15, 19, 22, 37, 45, 51, 53, 55, 59, 67, 72, 75, 76, 81, 82, 83, 85, 90, 91, 102, 105, 109
	Biomonitoring Macroinvertebrates	12, 16, 17, 18, 19, 20, 21, 44, 57, 58, 59, 60, 61, 66, 72, 75, 76, 81, 83, 84, 85, 86, 87, 90, 105, 109
	Gravel Embededness	31, 37, 46, 56, 73, 81, 101, 105, 109
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Rearing Habitat Availability	33, 98

Freshwater

Project Type	Focus Type	Document Number
• Off-Channel Habitat	Rearing Habitat Availability	33, 98
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
	Water Temperature	8, 14, 15, 16, 17, 21, 35, 37, 40, 44, 45, 46, 51, 56, 75, 76, 80, 101, 102, 106, 109
• Project Success Monitoring	Habitat Function	24
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
• Plant Removal/Control • Revegetation	Bank and Shoreline Cover	31, 44, 46, 51, 75, 76, 102, 105
	Bank Stability	26, 31, 44, 56, 59, 75, 80, 81, 98, 102
	Bank Stabilization	29, 62
	Cover Composition and Abundance	13, 31, 34, 44, 46, 51, 107
	Cover Density	16, 46
	Effectiveness Monitoring	10, 16, 111
	General Freshwater Vegetation	6, 14, 15, 22, 26, 27, 30, 31, 32, 34, 37, 38, 44, 46, 51, 56, 59, 75, 80, 81, 90, 91, 93, 94, 96, 99, 101, 105
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Structural Complexity	46, 62, 111
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
	Water Temperature	8, 14, 15, 16, 17, 21, 35, 37, 40, 44, 45, 46, 51, 56, 75, 76, 80, 101, 102, 106, 109
• Spawning Gravel	Gravel Availability	5, 15
	Gravel Composition	3, 6, 11, 13, 14, 15, 16, 17, 34, 46, 53, 55, 56, 59, 80, 81, 99, 105, 109
	Gravel Embededness	31, 37, 46, 56, 73, 81, 101, 105, 109
	Gravel Rehabilitation	62
	Gravel Scour	4, 6, 11, 13, 14, 15, 17, 74
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
• Creating/maintaining Islands or Rafts • Traffic Control • Utility Crossing • Work Site Restoration • Signage • Site Maintenance	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
• Woody Debris Structures and Complex Log Jams	Bank Stability	26, 31, 44, 56, 59, 75, 80, 81, 98, 102
	Channel Classification	9, 46, 51, 64, 75, 88, 91, 92, 97, 99, 101, 102, 105, 106, 107, 108
	Macrohabitat Classification	1, 2, 9, 11, 12, 13, 14, 15, 16, 17, 22, 31, 34, 37, 44, 45, 46, 51, 56, 59, 63, 64, 74, 75, 76, 80, 81, 83, 85, 86, 88, 91, 99, 100, 101, 102, 105, 106
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Rearing Habitat Availability	33, 98
	Reference Points	6, 11
	Stream Morphology	2, 4, 6, 11, 14, 15, 16, 31, 34, 44, 45, 46, 51, 59, 63, 64, 74, 80, 92
	Substrate (pebble count)	4, 11, 14, 16, 31, 34, 37, 46, 51, 75, 76, 81, 101
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
	Water Temperature	8, 14, 15, 16, 17, 21, 35, 37, 40, 44, 45, 46, 51, 56, 75, 76, 80, 101, 102, 106, 109

Riparian/Upland

Project Type	Focus Type	Document Number
• Erosion Control (Road) • Erosion Control (Slope) • Impervious Surface Removal	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Water Temperature	8, 14, 15, 16, 17, 21, 35, 37, 40, 44, 45, 46, 51, 56, 75, 76, 80, 101, 102, 106, 109
• Floodplain Restoration • Low/No Till • Road Abandonment and/or Decommissioning • Silvicultural Manipulation of Existing Trees • Site Maintenance (1year or less) • Utility Crossing	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
• Freshwater Plant Removal/Control • Revegetation	Bank and Shoreline Cover	31, 44, 46, 51, 75, 76, 102, 105
	Bank Stability	26, 31, 44, 56, 59, 75, 80, 81, 98, 102
	Bank Stabilization	29, 62
	Cover Composition and Abundance	13, 31, 34, 44, 46, 51, 107
	Cover Density	16, 46
	General Freshwater Vegetation	6, 14, 15, 22, 26, 27, 30, 31, 32, 34, 37, 38, 44, 46, 51, 56, 59, 75, 80, 81, 90, 91, 93, 94, 96, 99, 101, 105
	Effectiveness Monitoring	10, 16, 111
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Structural Complexity	46, 62, 111
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
	Water Temperature	8, 14, 15, 16, 17, 21, 35, 37, 40, 44, 45, 46, 51, 56, 75, 76, 80, 101, 102, 106, 109
• Livestock Fencing • Livestock Stream Crossing • Livestock Water Supply	Bank Stability	26, 31, 44, 56, 59, 75, 80, 81, 98, 102
	Biomonitoring Macroinvertebrates	12, 16, 17, 18, 19, 20, 21, 44, 57, 58, 59, 60, 61, 66, 72, 75, 76, 81, 83, 84, 85, 86, 87, 90, 105, 109
	Biomonitoring Periphyton	19, 72, 75, 76, 81, 83, 90, 109
	Gravel Embededness	31, 37, 46, 56, 73, 81, 101, 105, 109
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Shoreline Animal Damage	46, 105
	Soil Compaction	56
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
• Pipes and Ditches	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Restoring Habitat	62, 111
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
• Wetland Creation/Enhancement	Biomonitoring Fish Community	15, 19, 22, 37, 45, 51, 53, 55, 59, 67, 72, 75, 76, 81, 82, 83, 85, 90, 91, 102, 105, 109
	Biomonitoring Macroinvertebrates	12, 16, 17, 18, 19, 20, 21, 44, 57, 58, 59, 60, 61, 66, 72, 75, 76, 81, 83, 84, 85, 86, 87, 90, 105, 109
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 75, 59, 76, 77, 98, 99, 101
	Rearing Habitat Availability	33, 98
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98

Estuary/Nearshore/Marine

Project Type	Focus Type	Document Number
• Aquaculture • Landfill Removal	Biomonitoring Fish Community	24, 71
	Biomonitoring Phytoplankton	25
	Biomonitoring Macroinvertebrates	36, 39, 71, 89
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 47, 51, 59, 75, 76, 77, 98, 99, 101
	Turbidity	16, 17, 21, 24, 25, 45, 46, 70, 76, 81, 95, 98
	Water Chemistry	12, 15, 16, 17, 21, 22, 25, 34, 40, 41, 42, 43, 44, 45, 46, 48, 50, 51, 52, 53, 54, 55, 56, 59, 65, 69, 70, 72, 75, 76, 81, 83, 86, 90, 95, 109
• Armoring (Shoreline)	Biomonitoring Fish Community	24, 71
	Biomonitoring Macroinvertebrates	36, 39, 71, 89
	Macrohabitat Classification	24, 25, 29, 39, 49, 71
	Habitat Function	24
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 47, 51, 59, 75, 76, 77, 98, 99, 101
	Turbidity	16, 17, 21, 24, 25, 45, 46, 70, 76, 81, 95, 98
• Beach Nourishment • Beach Restoration • Dredging and Filling (marine) • Tide Gate Removal/Modification • Tidal Channel Reconstruction	Biomonitoring Macroinvertebrates	36, 39, 71, 89
	Biomonitoring Fish Community	24, 71
	Macrohabitat Classification	24, 25, 29, 39, 49, 71
	General Estuary Vegetation	24, 25, 28, 39, 71
	Habitat Function	24
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 47, 51, 59, 75, 76, 77, 98, 99, 101
	Turbidity	16, 17, 21, 24, 25, 45, 46, 70, 76, 81, 95, 98
	Water Chemistry	12, 15, 16, 17, 21, 22, 25, 34, 40, 41, 42, 43, 44, 45, 46, 48, 50, 51, 52, 53, 54, 55, 56, 59, 65, 69, 70, 72, 75, 76, 81, 83, 86, 90, 95, 109
• Bulkhead Removal • Flushing/partial Passage • Harbor, Marina, and Ferry Development • Underwater Marine Structures	Biomonitoring Fish Community	24, 71
	Biomonitoring Phytoplankton	25
	Biomonitoring Macroinvertebrates	36, 39, 71, 89
	Macrohabitat Classification	24, 25, 29, 39, 49, 71
	Habitat Function	24
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 47, 51, 59, 75, 76, 77, 98, 99, 101
• Culverts in Levees, Installation • Dike Breaching/Removal • Ell Grass, Kelp, or Other Native Vegetation Planting • Residential Docks in Marine and Freshwater	Biomonitoring Fish Community	24, 71
	Biomonitoring Phytoplankton	25
	Biomonitoring Macroinvertebrates	36, 39, 71, 89
	Macrohabitat Classification	24, 25, 29, 39, 49, 71
	General Estuary Vegetation	24, 25, 28, 39, 71
	Habitat Function	24
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 47, 51, 59, 75, 76, 77, 98, 99, 101

Estuary/Nearshore/Marine

Project Type	Focus Type	Document Number
• Estuary Plant Removal/Control	General Estuary Vegetation	24, 25, 28, 39, 71
	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 47, 51, 59, 75, 76, 77, 98, 99, 101
	Water Chemistry	12, 15, 16, 17, 21, 22, 25, 34, 40, 41, 42, 43, 44, 45, 46, 48, 50, 51, 52, 53, 54, 55, 56, 59, 65, 69, 70, 72, 75, 76, 81, 83, 86, 90, 95, 109
	Water Temperature	8, 14, 15, 16, 17, 21, 35, 37, 40, 44, 45, 46, 51, 56, 75, 76, 80, 101, 102, 106, 109
• Ghost Net Removal	Biomonitoring Fish Community	24, 71
• Removal of Overwater Structures	Macrohabitat Classification	24, 25, 29, 39, 49, 71
	Habitat Function	24
• Residential Docks in Marine and Freshwater	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 47, 51, 59, 75, 76, 77, 98, 99, 101
• Soft Shore Protection	Biomonitoring Fish Community	24, 71
	Macrohabitat Classification	24, 25, 29, 39, 49, 71
	Habitat Function	24
• Toxic Spills in fresh and saltwater	Water Chemistry	12, 15, 16, 17, 21, 22, 25, 34, 40, 41, 42, 43, 44, 45, 46, 48, 50, 51, 52, 53, 54, 55, 56, 59, 65, 69, 70, 72, 75, 76, 81, 83, 86, 90, 95, 109

Water Quality

Project Type	Focus Type	Document Number
• Nutrient Loading (remove, reduce or modify sources • Toxic Loading (remove or reduce sources of) • Toxic Spills in fresh and saltwater • Wastewater	Total Suspended Solids	17, 46, 78, 81, 95
	Turbidity	16, 17, 21, 25, 44, 46, 70, 76, 81, 95, 98
	Water Chemistry	12, 15, 16, 17, 21, 22, 25, 34, 40, 41, 42, 43, 44, 45, 46, 48, 50, 51, 52, 53, 54, 55, 56, 59, 65, 69, 70, 72, 75, 76, 81, 83, 86, 90, 95, 109
	Water Temperature	8, 14, 15, 16, 17, 21, 35, 37, 40, 44, 45, 46, 51, 56, 75, 76, 80, 101, 102, 106, 109
• Sediment Collection Ponds	Photodocumentation	6, 11, 13, 14, 15, 16, 17, 25, 47, 51, 59, 75, 76, 77, 98, 99, 101
	Total Suspended Solids	17, 46, 78, 81, 95
• Thermal Loading (remove or reduce sources of)	Water Temperature	8, 14, 15, 16, 17, 21, 35, 37, 40, 44, 45, 46, 51, 56, 75, 76, 80, 101, 102, 106, 109

Appendix III- Index

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