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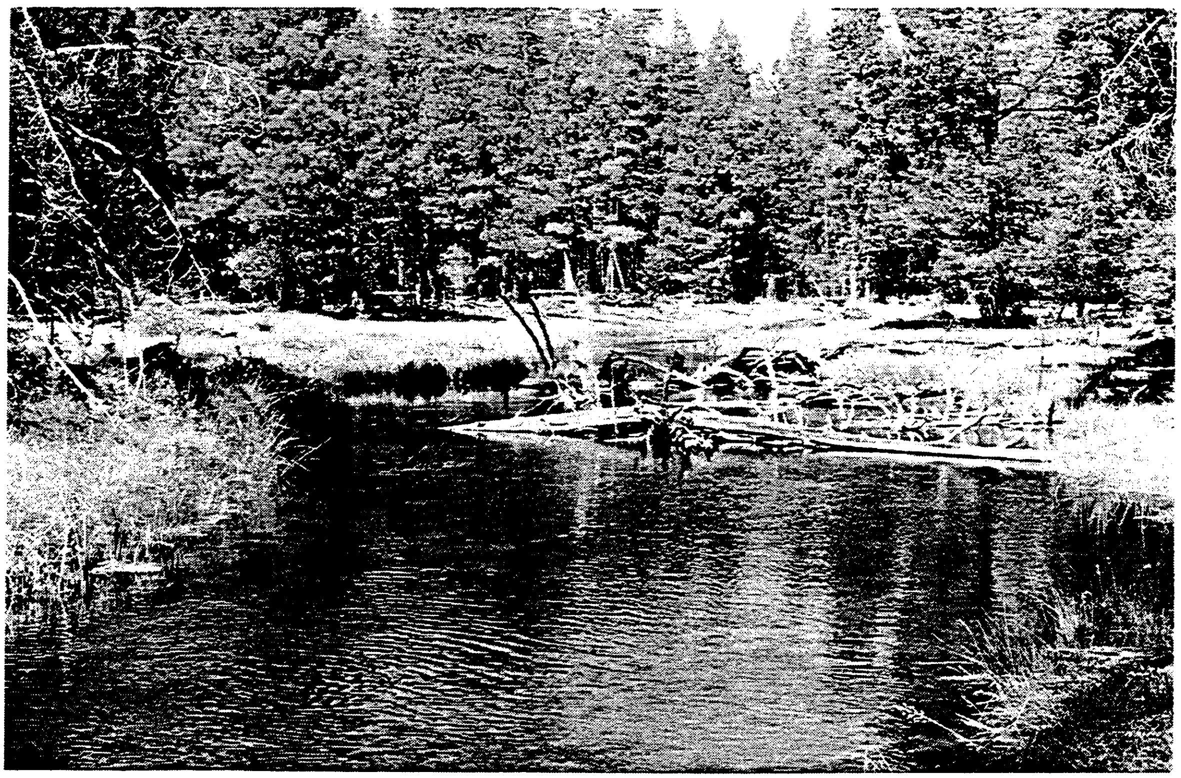
Stream Inventory Handbook
Level I & II

Appendix Reference in Text



Pacific Northwest Region

Region 6
1996~Version 9.6

STREAM INVENTORY HANDBOOK

Version 9.6

MAY 1996

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PACIFIC NORTHWEST REGION

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CHAPTER 1

STREAM INVENTORY HANDBOOK

INTRODUCTION/OVERVIEW

BACKGROUND: Periodic, recurring inventories are an integral part of the fish habitat and watershed management programs and form the foundation for effective program management. Inventories should produce comparable information, both between administrative units, as well as across time. They will generate the baseline information that will be used to support a variety of management activities, including, but not limited to; watershed analysis, timber sales, range allotments, special use permitting and fish habitat and watershed restoration programs. They will also serve as the basis for stream monitoring and evaluation programs. Specifically, inventories will identify existing aquatic and riparian conditions, identify factors limiting the productive capabilities of habitats, measure attainment of meeting stream habitat objectives, and help to assess cumulative watershed effects. The inventories can be used to monitor and refine Land Management Plan Standards and Guidelines.

The Pacific Northwest Region (Region 6) stream inventory is designed on a hierarchical scale to provide the user the opportunity to choose an inventory protocol which meets the data needs for the questions being asked. Level I is the basic in-office procedure which identifies standard attributes of the watershed/stream to be analyzed. Its primary objective is to document and consolidate sources of general knowledge of the stream system. Level II is an extensive stream channel, riparian vegetation and aquatic habitat condition inventory on a watershed-wide scale. The level II is to be used to determine the "pulse" or condition of a system. Level III is an intensive field inventory designed specifically to answer a particular question (i.e., monitoring, project level planning and project design, etc.). Level IV is a very intensive field inventory of stream or riparian conditions; water quality and quantity; riparian habitat; aquatic habitat; and fish populations. This level is used to address research or monitoring validation questions.

This handbook provides standards for both the level I (office inventory) and level II (field inventory). A level II inventory requires the completion of a level I as a prerequisite. The protocol identifies core attributes which are necessary to evaluate the condition of the stream (mandatory for collection), and non-core, forest optional attributes. Forests have the flexibility to add attributes to the protocol to meet their needs, however, unit costs and target allocations/accomplishments will be based on the regional protocol.

Region 6 has produced a recommended protocol for level III inventories, but the methods are not included in this handbook. By contrast, it is recognized that a standardized approach to level IV is inappropriate due of the large variation in data needs that exist. Therefore, procedures for level IV are open to development at the district, forest or research unit level.

The purpose of both the level I and level II inventories is to identify existing stream channel, riparian, and aquatic ecosystem conditions on a watershed scale. As inventories are completed and repeated over time, the information generated by them can be useful in measuring changes in stream channel conditions and determining attainment of habitat management objectives, provided stringent quality control administration occurs. In this context, the inventory can be applied as a basic "monitoring" tool.

INVENTORY ATTRIBUTES

Key attributes of the Region 6 Level I and II stream inventories were developed considering the following concepts:

Driven by questions that are to be addressed. Identification of management questions formed the basis for the content of the inventory. The ability to address questions consistently and comparably across units has been demanded of the United States Forest Service (USFS) by both users and managers of the resources. Inventory and analysis procedures were developed to provide the information necessary to answer those questions.

Contains a consistently applied set of core attributes. The Level I and II inventories contain data attributes that were identified by an interagency interdisciplinary team as the most critical for defining stream channel, riparian vegetation, and aquatic resource condition. The core data attributes are likely to be key elements in any future inventory process, and can be used to drive a number of aqautic/channel classification systems.

Quantifiable through direct observation. Where practicable, the level II inventory generates quantitative estimates of channel conditions and habitat attributes.

Statistically valid approach. The level II inventory meets assumptions for standard statistical analysis and results in estimates with known bounds of error for habitat unit dimensions. It follows a stratified random sampling design, and permits extrapolation of known, measured attributes throughout the watershed.

Repeatable. This protocol provides a statistically defensible method for evaluating and minimizing the observer bias inherent in the visually estimated dimensions for habitat units. Quantitative measures for streamflow, bankful channel dimensions, bank instability, and substrate are intended to further reduce surveyor bias and sampling error. These considerations are intended to reduce the inherent variability surrounding many of the attributes so that replication of sampled attributes will be meaningful across time and space.

Coordinated with other resource areas and management entities. The procedures for these inventories represent an integrated approach between USFS watershed and fisheries disciplines in defining stream channel, riparian vegetation, and aquatic resource conditions at the watershed scale. It has been reviewed and is compatible with similar aquatic inventories developed by state agencies, specifically the Oregon Department of Fish and Wildlife (ODFW) and Timber, Fish and Wildlife (TFW) in Washington State. It has been developed as the aquatic companion to the USFS Integrated Resource Inventory (IRI), and is comparable with other USFS stream inventories developed in Regions 1, 4, and 5. It contains the recently completed "Core Data Standards" developed by inter-agency team for implementation of the Northwest Forest Plan.

Cost efficient. The region-wide average cost to complete this survey is $1000 dollars per mile. Local conditions such as stream size, channel complexity, location, etc. and contracting of services contribute to a range of costs around this value. These estimates include data collection, data entry, analysis and report writing. Costs can be considerably higher as forests add attributes and are not considered in the annual allocation of funds

ESTABLISHING FOREST PRIORITIES

The stream inventory program is an institutionalized component of the fisheries and watershed programs. A rate of 10 percent of fish-bearing streams per year is prescribed and offers a program that is responsive to management needs. This infers a 10-year re-inventory recurrence interval for all fish-bearing streams.

Forests should consider the following factors in setting priorities for stream inventory:

* Tier 1 and Tier 2 Key Watersheds where Watershed Analysis is to be completed in the near future.
* Sensitivity of fish stocks present.
* Habitat/watershed vulnerability or sensitivity; watersheds that are particularly vulnerable or sensitive to management activities should be a high priority.
* Level of planned activity in the watershed.
* Management plan development (e.g., Wild and Scenic Rivers designation) or agency coordination/cooperation.
* Relative importance of a watershed in terms of fish production or use.
* "Representativeness" of a watershed to others for stratification and extrapolation of information to those systems that are lower priority.
* Size/feasibility of detecting change and managing that change (i.e., it is more difficult to detect change in larger systems and frequently more difficult to mitigate those effects).
* Wilderness or watersheds representing intact, hydrologically functioning systems; to be used in developing numeric ranges for attributes which quantify "Desired Future Conditions."

STREAM INVENTORY PROGRAM MANAGEMENT

Data Management: The Stream Management, Analysis, Reporting and Tracking (SMART) database program was developed as an ORACLE application on the Data General (DG) system to facilitate the sharing of information between units and to support Regional efforts to integrate Level II inventory information into the Geographic Information Systems (GIS) environment. Three different methods can be used to input data into the SMART database: the DG SMART program; the Stream Data Recorder (SDR) program; and importing an ASCII file through the walkabout Load subroutine. Regardless of which method is used to input data, all Level II stream inventory data will be stored within the corporate DG SMART database.

A series of standard summary tables has been developed within the SMART program. The tables provide the basic information necessary to characterize stream condition, habitat, and function. Forests and Districts are encouraged to do additional data analysis to explore specific habitat relationships and develop more effective ways of presenting the information. Additional analysis can be done most efficiently by downloading the stream inventory data into a PC environment.

PROGRAM ADMINSTRATION AND QUALITY CONTROL

Stream inventory data are increasingly used to make significant resource management decisions. As such, the reliability and credibility of the information is paramount. Past program reviews have identified potential problems in program management, and significant changes have occured to address these deficiencies. In order to ensure the highest quality of information is provided through the inventory, program and quality control standards have been developed. The following items should be viewed as minimum standards in the annual implementation of the program.

Program Adminstration

* Forest and District Program Managers ensure data are collected to standard, and are analyzed and reports written on a timely basis.

* Forest and District Program Managers will develop an operational understanding of the inventory protocols.

* Either the Forest Hydrologist, or Fisheries Biologist will attend the annual regional training session.

* Each Forest will establish a stream inventory quality control contact person.

* Each Forest will supplement regional training with forest level training and orientation to ensure understanding and proper application of the inventory procedures.

* Each Forest will develop a "test reach" as part of forest level training

Pre-Inventory Phase

-- Each survey member will be given a handbook for review and will be accountable for techniques and terms;
-- The context of the level II in the 4 level hierarchical inventory program will be understood;
-- Training in basic map and air photo interp for each surveyor will be documented;
-- Training in the use and maintenance of necessary equipment for each surveyor will be documented.

Field Inventory Phase -- Prior to the field season, all crews will have review on:

-- C-form variable review;
-- How to take a measured streamflow;
-- How to establish and place temperature recording devices;
-- How to make bankful determinations;
-- How to conduct a Wolman pebble count;
-- How to sample fish populations and correctly identify fish species.
-- How to check data sheets to catch chronic data entry mistakes
-- How to review/analyze observor bias in habitat dimension estimates.

Post Inventory Phase

--How to data error-check
--How to correctly label slides and photographs, and develop final inventory maps.
--How to analyze SMART reports
--How to write draft reports.

PRESENTATION OF INFORMATION

The report format for summarizing and presenting stream inventory data. It contains two basic components which provide information in a legible, understandable format to two distinct audiences: Line and Staff personnel within the USFS, and the technical specialists.

The executive summary highlights the condition and identifies the issues, concerns and opportunities within the watershed for line and staff. The target audience for the main body of the report is the technical specialist. It contains summaries of the quantitative data collected as well as field observations and the resulting conclusions on stream condition, habitat interrelationships, and potential factors limiting fish production. The information is summarized at both the reach scale and the basin scale.

The foundation for every report resides in sound interpretation of the available inventory information. Rather than merely a regurgitation of numbers and figures in the summary tables, interpretation should include investigating the interrelationships that exist between the data attributes (e.g., number of channel-width pools per mile, number of functional pieces of large woody debris (LWD) larger than 24 in. diameter per mile, stream reaches where stream temperature exceeds state standards). Correlations of pools per mile to riparian vegetation composition and amount of large woody debris can aid in identifying potential habitat deficiencies in systems as well as give an indication of potential rehabilitation potential.

Although basic data interpretation can be completed by the individuals conducting the stream survey, all reports should have journey level fish biologist or hydrologist review and concurrence. The section of the report addressing management implications should be written by the journey level professionals. A good understanding of the interrelationship of the physical and biological conditions of a stream is needed in order to develop sound, realistic management interpretations and recommendations.

HANDBOOK CONTENT

The Stream Inventory Handbook provides instructions for conducting the Level I and Level II stream inventories. It contains five primary sections: Office Procedures (Level I), Field Procedures (Level II), Reports, Appendices, and Forms.

Software User's Guides for the SMART database and for the handheld data recorders are issued as separate documents.

Office Procedures: This section contains the specific instructions for completing the office phase, or level I inventory. Information collected from the office phase is placed on Form A and Form B1. The purpose of completing Form A is to familiarize the surveyors with the historical use and natural history of the landscape drained by the inventoried stream. The purpose of completing Form B1 is to delineate preliminary stream reaches and create a field map which includes access points for the field inventory. The field phase (level II) will validate or amend the reaches first delineated on Form B1. Form B1 will be retained with the stream folder as documentation of the level I inventory.

Field Procedures: The field phase (level II) is the nuts and bolts of the stream inventory process. The level II utilizes Forms B2, C, C1, C2, and C3 which are used to gather information on the physical attributes of the stream and its riparian forest. Form B2 also has attributes which are derived from field data, but are more easily completed in the office. Form D documents fisheries information, Form E records stream discharge, and Form F is used to characterize the streambed substrate in riffles.

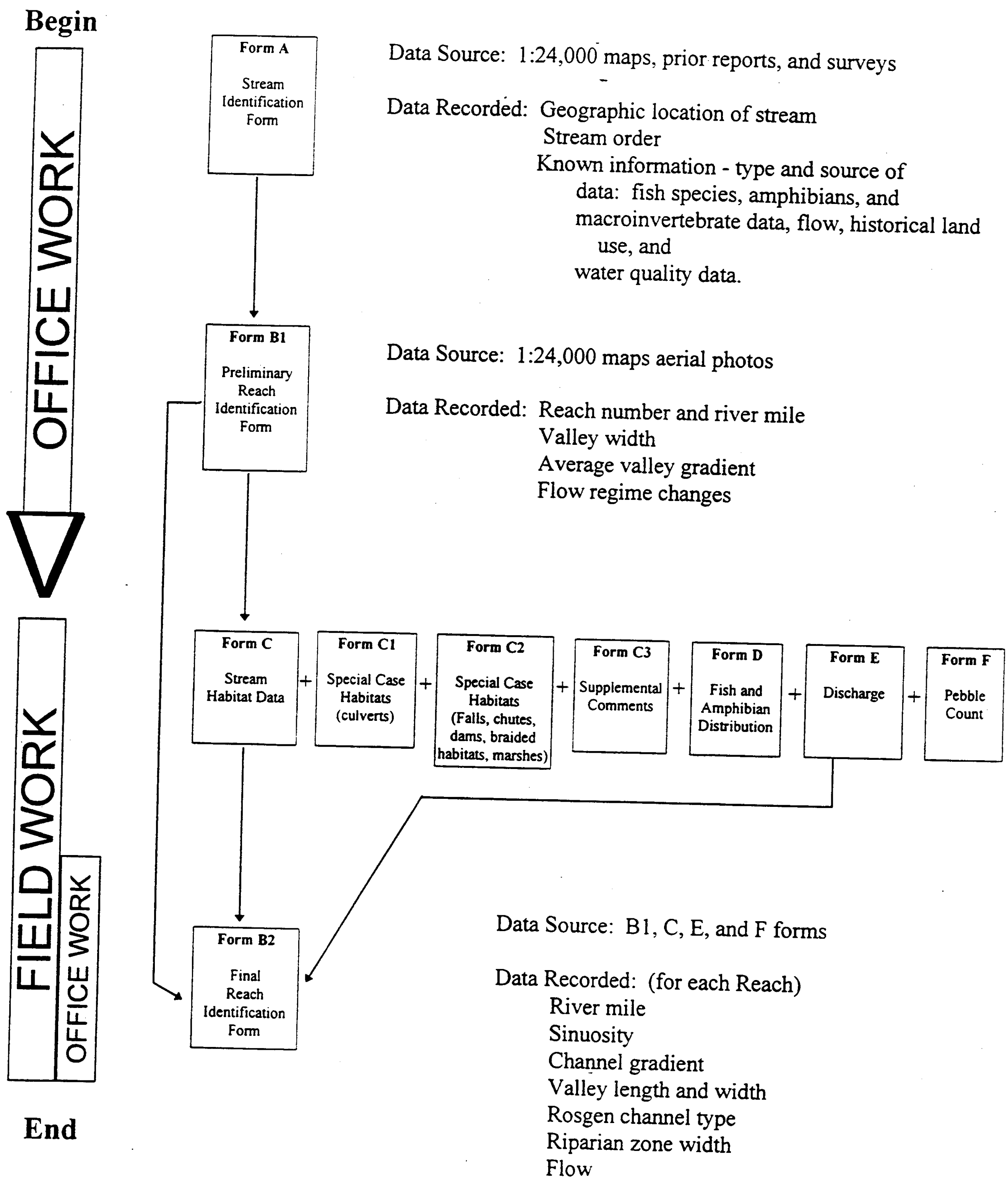
Report Format: Chapter 4 contains a suggested report writing format to follow in developing the final stream survey reports. Instructions for each subject area are provided.

Appendices: The appendices contain specific information that support a number of the data attributes collected in both the office and field phases.

Forms: A total of 10 forms are completed as part of the inventory. These clean copies are provided as masters from which to make your working copies. **Please note:** Waterproof, smudge-proof forms can be developed by using opaque transparencies rather than paper as the base medium. These are relatively inexpensive, and can be mass produced on most photocopy machines.

The following figure presents a view of the inventory process which includes a timeline and flow chart outlining the relationship between the suite of forms used in the course of completing a stream inventory

Figure 1: Flowchart showing the order that Data Forms are used



CHAPTER 2

STREAM INVENTORY HANDBOOK

OFFICE PROCEDURES: LEVEL I INVENTORY - IDENTIFICATION LEVEL

OBJECTIVES: The objective of the office phase is to provide the field crews with a general introduction to the stream targeted for inventory. This is accomplished through assembly and summarization of any data that has been previously collected for the basin. This information will be used to tentatively stratify the stream into stream order and stream reaches. A reach is a relatively homogeneous section of stream that contains attributes of common character. Review of the information compiled by the office phase will be extremely valuable in selecting sampling intervals for measured habitats, planning stream access logistics, summarizing initial hydrologic information, and initially identifying perennial and fish-bearing streams.

Aerial photo analysis and the use of maps of suitable scale (i.e., 1:24,000) will enable the survey team to identify, at an acceptable level of resolution, such attributes as: mapped sinuosity, vegetative types in riparian and upslope areas, watershed acres, floodplain widths, tributary confluences, and watershed characteristics. The maps created during this process will be of great value to the crews in the field. An effective field map(s) will show tributary streams, road crossings, access points, and general location of notable geologic features, and unique characteristics. These characteristics will be used by the field crew to accurately locate reach breaks and features in the basin.

STANDARDS: The office phase level I inventory will provide information only as accurate as the scale and accuracy of the maps, photos and previously collected data. Accuracy will also be affected by the human error introduced when measuring the attributes required. At a minimum, use 1:24,000 scale USGS topographic maps. Any measurements should be confirmed with a map wheel, dot grid, or other standard method of measurement.

EQUIPMENT/INFORMATION NEEDED:

* Topographic Maps/Aerial Photos--Scale of 1:24,000.
* Planimeter/Map Wheel
* Calculator
* Watershed Codes from FSH 2509.24
* Hydrological Data--flow, temperature, turbidity, macroinvertebrate, etc.
* Geological Information--Geological province, landform type, etc.
* Historical Land Use Information
* Past Stream Surveys--US Bureau of Fisheries, USFS, USDI Bureau of Land Management (BLM), State, etc.
* Level I Inventory Forms - Office Phase
  Form A - Stream Identification Form
  Form B1 - Preliminary Reach Identification Form

PROCEDURE: The office phase requires the completion of Forms A and B1. Much of the information for Form B1 can be collected from aerial photos, orthophotographs, and 1:24,000 scale USGS topographic maps. Each attribute is identified in **BOLD** text and is followed by instructions on how to measure or collect information on the attribute.

At the end of each attribute discussion, a character or numeric field length for each data attribute entered to the SMART database is given in the form: **(FL:3 (e.g., 99.9))**. In this example, SMART will accept a numeric-only entry for this attribute which cannot exceed 99.9 ft. in magnitude, but can include a measured value to the nearest tenth of a foot.

PLEASE NOTE THAT THE INSTRUCTIONS FOR COMPLETING THE HEADER FOR EVERY FORM USED IN THE LEVEL I AND LEVEL II INVENTORIES ARE LISTED ONLY IN THE SECTION OF CHAPTER 2 LABELED "FORM A INSTRUCTIONS." ATTRIBUTES A THROUGH H ARE THE SAME FOR EVERY FORM. Where additional header information is required, specific instructions are given for that form.

Should questions arise concerning any phase of the inventory process, consult with the local hydrologist and/or fisheries biologist. It is their role to supply answers and clear direction during the inventory process.

PRODUCTS: A level I inventory (office phase) shall be completed for every stream designated for a level II inventory. The level I process will produce:

* A listing of existing information previously collected on the stream and drainage basin
* A completed Form A
* A completed Form B1
* A draft copy of a 1:24,000 scale USGS topographic map of the target stream that shows preliminary reach breaks, access points, road crossings (culverts, bridges, etc.), known dams and diversions, and other points of interest that will help orient the field crews to the stream to be inventoried. Forests are encouraged to develop and adopt a consistent set of map symbols which encode channel and riparian conditions of concern to the management of each forest.

STREAM IDENTIFICATION - FORM A, R6-2500/2600-10.

FORM A INSTRUCTIONS

A. STATE: Enter the appropriate 2-letter code:

Oregon......OR
Washington..WA
California..CA
(FL:2 (e.g., ZZ))

B. COUNTY: Uses FS-ATLAS national standard. (FL:3 (e.g., 999))

C. FOREST: Enter appropriate two digit code for the Forest. (FL:2 (e.g., 99))

D. DISTRICT: Enter appropriate two digit code for District. (FL:2 (e.g., 99))

E. STREAM NAME: Enter the name of the stream, limiting the length of the name to 40 characters. Some Forests begin the stream name with the 5th field watershed code, followed by the stream name, followed by the year surveyed. (FL:40 (e.g., 95 Salmon Creek))

F. WATERSHED CODE: Refer to FSH (Forest Service Handbook) 2509.24 to determine the correct Hydrologic Unit Code for the watershed. Enter only the first four 2 digit fields (Hydrologic Region, Hydrologic Subregion, Accounting Unit, and Cataloging Unit). Refer to Appendix A for a more detailed explanation. (FL:8 (e.g., 99,99,99,99))

NFS CODE: Contact your hydrologist or GIS specialist for assistance in correctly identifying the NFS code. (FL:3 (e.g., 99,A))

If the section of stream to be inventoried does not begin at the mouth of the largest stream in an NFS Subwatershed, enter the map wheel-measured river miles from the mouth of the largest stream in that Subwatershed to the confluence with the stream targeted for inventory. This river mile distance is measured with a map wheel along the "blueline" stream channel defined on a 1:24,000 scale USGS topo map. Up to four mileage entries can be used to identify the specific stream if necessary. See Appendix A for a more detailed explanation on how to determine the stream mileage identifiers. (FL:4 (e.g., 999.99, 99.99, 99.99, 99.99))

G. USGS QUAD: Enter the name of the registered USGS Quadrangle containing the stream mouth or point where it leaves the Forest. This is the 1:24,000 (2.6-inch) scale USGS topograhic map. (FL:60 (e.g., Sinker Mountain))

H. SURVEY DATE: Enter the date the field survey began using the following format: DD-MMM-YY. (e.g., 01-JUL-95).

I. NAME: Persons filling out Form A will record the initial of their first name as well as their complete surname (e.g., J.Smith). NOTE: This attribute **WILL NOT** be entered into the SMART database version of Form A.

1. WATERSHED AREA: Calculate the area of the basin above the mouth of the target stream to the nearest 250 acres. If the inventory begins at the point upstream from the mouth, determine the drainage basin above that point. This measurement is made on a 1:24,000 scale USGS topographic map by first identifying the ridge lines that define the drainage basin, and then calculating the area using a dot grid or planimeter. Consult your GIS experts since they can calculate watershed area more accurately through digitizing the area. If GIS is available, record watershed area to the nearest 10 acres. (FL:6 (e.g., 999,990))

2. STREAM ORDER: Utilizing the Strahler method, identify stream order (see Appendix B) of the lowest most reach. A 1st order stream is the smallest fingertip "blueline" tributary. This can appear as either a dotted or solid "blueline" channel on a 1:24,000 scale USGS topographic map. (FL:1 (e.g., 9))

3. FISH AND AMPHIBIAN SPECIES AND DATA SOURCE: Starting from the left, record dominant or management-emphasis fish species as well as any threatened, endangered or sensitive amphibian species known to be in the basin. The species codes consist of the first two letters of the genus and the first two letters of the species names. See page 59 for a list of the standard species codes. If no data exist, write "Nothing on record." (FL:240(e.g., ONTS, ONKI, ONMY, ONCL))

4. FLOW DATA: Enter in narrative form, the historical flow data available for the stream. List all sources, such as USGS gauging stations, Forest monitoring sites, IFIM studies, etc., and dates data were collected. If no data exist, write "Nothing on record." (FL:240 (e.g., USGS Gaging Stn.

#14146500 is located 0.2 RM from mouth; ave. flow for JUL = 260 cfs)).

5. WATER QUALITY DATA: Review files for any quantitative physical or chemical data. Reference the type and source of information, and year data were collected. If no data exist, write "Nothing on record." (FL:240(e.g., ODFW max/min stream temp. during JUN-SEP: 1970-88))

6. MACROINVERTEBRATE DATA: Enter, in narrative form, the type and source of previous information on the presence, distribution, and abundance of macroinvertebrates in the stream to be inventoried. Examples include analysis conducted by the Aquatic Ecosystem Analysis Lab, local forest studies, etc. If no data exist, write "Nothing on record." (FL:240 (e.g., 1990 survey by Taxon, Inc. reported that chironomids comprised 65% of the biomass in pools and riffles, and the remaining 35% were split relatively evenly among six other insect taxa.))

7. PREVIOUS SURVEYS: Reference the source of the information, level of survey and year accomplished. If no data exist, write "Nothing on record." (FL:240 (e.g., 1965 Blue River RD survey of culverts included the three culverts on this stream.))

8. HISTORICAL LAND USE DATA: Record here any useful historical information you have accumulated regarding the stream (e.g., old photos, interviews on file, splash dams, mining, literature, etc.). Also review the Forest's Historical Land Use Atlas -- see an Archeologist for this document. If no data exist, write "Nothing on record." (FL:240 (e.g., Railroad built in 1930-33 for logging. Removed and rebuilt as sealed road in 1965, active logging in upland since 1965, and map of units by age of cut is available.))

9. COORDINATION: Verify participation or coordination with other agencies or interest groups for the present inventory. Explain the groups participating and their work to be accomplished. (FL:240 (e.g., WDFW will inventory the private land sections of the stream, has agreement with owners, will use R06 protocol))

10. COMMENTS: Use this space to elaborate on the above attributes. Note apparent watershed problems, special features or habitats, fish stocking information, management problems, studies, critical habitats, special land allocations, etc. (FL:240 (e.g., 45% of drainage basin is in private hands, permission has been denied for inventory of stream through Clark Timber Co. lands.))

PRODUCTS OF FORM A PROCESS

1. Completed Form A.
2. Review of available historical records and information on the drainage basin in which the stream to be inventoried is found.

STREAM HABITAT DATA FORM A   Page: ____ of ____
R6-2500/2600-10

A. State __________ B. County __________ C. Forest __________ D. District __________

E. Stream Name ____

F. Watershed Code ___, ___, ___, ___ NFS ___,____;____.____,____.____,___.___,___.____

G. USGS Quad ____

H. Survey Date ____-______-____ I. Name ______________________________
DD-MMM-YY

---

1. Watershed Area ________________________ Acres

2. Stream Order ________________________

3. Fish and Amphibian Species _____,_____,_____,_____,_____,_____,_____,_____
Data Source ____
____

4. Flow Data ____
____
____

5. Water Quality Data ____
____

6. Microinvertebrate Data ____
____

7. Previous Surveys ____
____

8. Historical Land Use Data ____
____

9. Coordination ____
____
____

10. Comments ____
____

PRELIMINARY REACH IDENTIFICATION - FORM B1, R6-2500/2600-20

Form B1 is used to stratify the stream into preliminary reaches. This will be done with information gleaned from the topographic maps, orthophotographs, aerial photographs, and/or GIS layers. Characteristics which should be used to initially select stream reach breaks are changes in: mapped valley width estimates, channel gradients, sinuosity, and streamflow due to large tributaries (see Figure 2). These reach breaks should closely correspond to Rosgen Level I alpha channel types (ie., A, B, C, D, E, F), but the minimum length for all reaches is 0.5 miles. Development of a longitudinal profile from the 1:24,000 scale USGS topographic map will identify major gradient changes for establishing starting and ending points for each reach.

These reach endpoints will be verified, refined or modified by the field crew during the level II (field phase) inventory, and these field-verified reaches will be accurately translated onto the field maps and/or aerial photographs. When the field portion of the reach inventory is complete, the information from Form B1 will be used to complete Form B2; once Form B2 has been completed, Form B1 will be retained in the stream folder as originally completed.

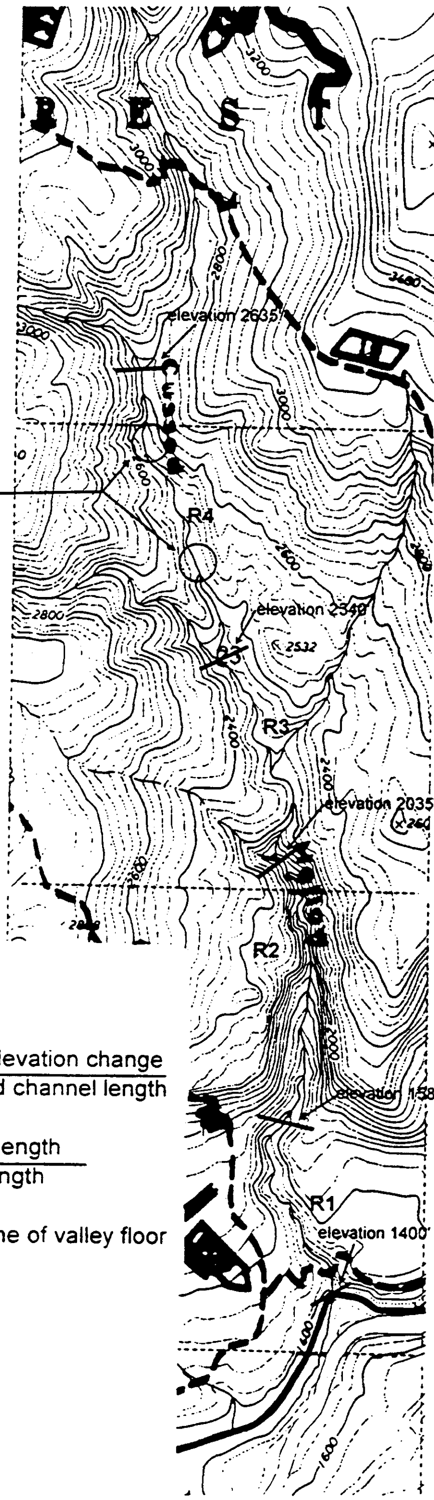
NOTE: Form B1 data will not be entered into the SMART data base.

FORM B1 INSTRUCTIONS

Fill out a Form B1 for each stream reach:

NOTE: INSTRUCTIONS FOR COMPLETING FORM BI HEADER (ATTRIBUTES A - H) ARE LISTED ON THE FORM A INSTRUCTIONS)

Figure 2: River basin characteristics derived from a 1:24,000 scale USGS topographic map



General area where you will do the pebble count in R4. (i.e., 1/3 and 2/3 of reach length.)

R4
Stream Channel length = 3872 ft.
Valley length = 3520 ft
avg. valley gradient = (2635-2340) / 3872 x 100 = 8%
sinuosity = 3872/3520 = 1.1

R3
Stream Channel length = 2816 ft.
Valley length = 2640 ft
avg. valley gradient = (2340-2035) / 2640 x 100=12%
sinuosity = 2816/2640 = 1.1

R2
Stream Channel length = 3520 ft
Valley length = 3168 ft
avg. valley gradient = (2035-1585) / 3520 x 100=13%
sinuosity = 3520/3168 = 1.1

R1
Stream Channel length = 2288 ft.
Valley length = 1936 ft
avg. valley gradient = (1585-1400) / 1936 x 100=10%
sinuosity = 2288/1936 = 1.2

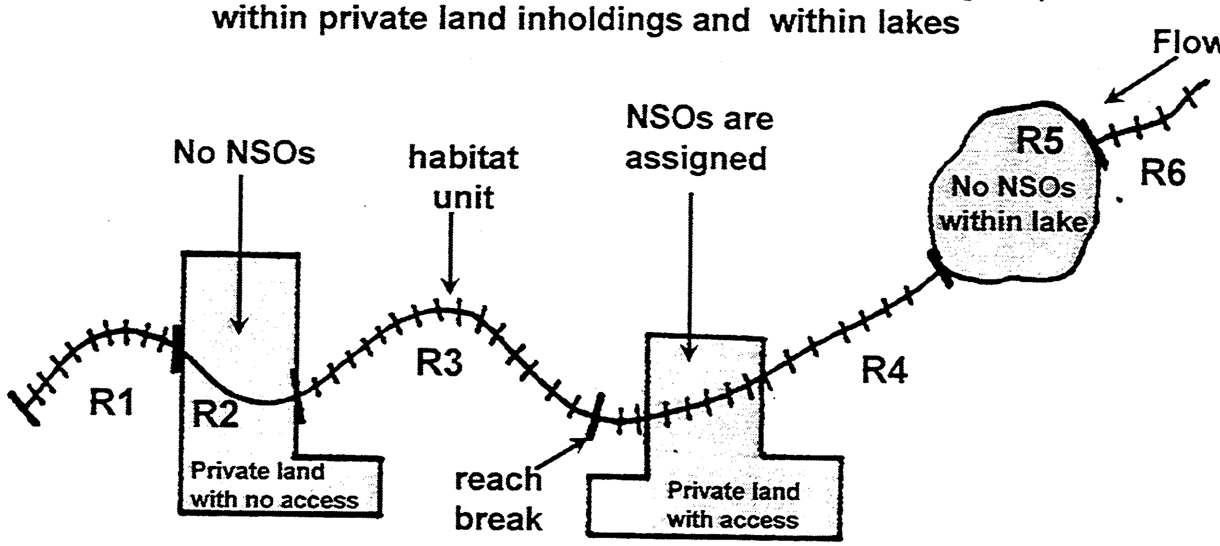
mapped channel gradient= $\frac{\text{elevation change}}{\text{mapped channel length}}$

sinuosity = $\frac{\text{mapped channel length}}{\text{mapped valley length}}$

mapped valley length = midline of valley floor

1. REACH NUMBER: Enter the reach number beginning at the lowest point of the proposed inventory. Number the reaches sequentially in an upstream direction. If access is denied to portions of the stream which are privately owned, treat the private land section as a separate reach (see Figure 3). If permission to inventory the private land is secured, do not break out that portion of the stream as a separate reach. Whenever a lake occupies a valley section between two portions of the stream to be inventoried, treat the lake as a separate reach in a fashion identical to private land/no access. The pool behind a beaver dam is not a lake, and this pool is not considered as a separate reach. The pool upstream of a beaver dam is simply a pool habitat. Use standard geomorphic characteristics as described above to delineate the reach breaks in all other cases.

Figure 3: Example of how NSOs are assigned (or not assigned) within private land inholdings and within lakes



2. MAPPED VALLEY WIDTH ESTIMATE: Enter the estimated average width of the floodplain or valley bottom as determined from the 1:24,000 scale USGS topographic map. An estimate is made for each reach.

3. FLOW REGIME CHANGE: Note any large tributaries to the inventoried stream. These may offer excellent reach breaks if the tributary drains a basin similar in area to the drainage basin of the inventoried stream upstream of the confluence with the tributary. Reaches can be stratified by significant changes in flow, while other variables remain the same. Enter yes <u>Y</u> or no <u>N</u> if this is used for reach delineation purposes.

4. MAPPED CHANNEL LENGTH: Using a map wheel, determine the "blueline" channel length between the preliminary reach breaks for each reach.

5. MAPPED CHANNEL GRADIENT: Use GROSS changes in gradient to develop preliminary channel reach breaks. Long homogeneous lengths of similar gradient may delineate a reach. However, other parameters can temper the stratification. For Form B1, gradient will be calculated by dividing the elevation gain (high elevation contour minus low elevation contour) by the mapped channel length for each reach.

6. VALLEY FORM [Forest Option]: Enter appropriate code (1-10) that best describes the valley form. Examples are: Wide, glaciated U-shaped valley; Steep, narrow V-shaped valley; Broad, flat plain; Alluvial outwash; etc. (See Appendix E).

7. MAPPED SINUOSITY: Enter the estimated sinuosity for the delineated reach. This is calculated by dividing the mapped length of stream defined by the reach endpoints by the mapped straight line valley length between the same reach endpoints.

PRODUCTS OF FORM B1 PROCESS

1. Completed Form B1.
2. Field-ready 1:24,000 scale USGS topographic map identifying preliminary reach breaks, private land holdings, and potential access points.

STREAM HABITAT DATA FORM B1 Page: ____ of ____
R6-2500/2600-11

A. State __________ B. County __________ C. Forest __________ D. District __________
E. Stream Name ______________________________
F. Watershed Code ___, ___, ___, ___ NFS ____,____.____,____.____,____.____,____.____
G. USGS Quad ______________________________
H. Survey Date ____-______-____
DD-MMM-YY

1. Reach Number ____ RM _____ to _____ 2. Mapped Valley Width Estimate ________ 3. Flow Regime Change ______________ 4. Mapped Channel Length ____________ 5. Mapped Channel Gradient ___________ 6. Valley Form ______________________ 7. Mapped Sinuosity __________________	1. Reach Number ____ RM _____ to _____ 2. Mapped Valley Width Estimate ________ 3. Flow Regime Change ______________ 4. Mapped Channel Length ____________ 5. Mapped Channel Gradient ___________ 6. Valley Form ______________________ 7. Mapped Sinuosity __________________
1. Reach Number ____ RM _____ to _____ 2. Mapped Valley Width Estimate ________ 3. Flow Regime Change ______________ 4. Mapped Channel Length ____________ 5. Mapped Channel Gradient ___________ 6. Valley Form ______________________ 7. Mapped Sinuosity __________________	1. Reach Number ____ RM _____ to _____ 2. Mapped Valley Width Estimate ________ 3. Flow Regime Change ______________ 4. Mapped Channel Length ____________ 5. Mapped Channel Gradient ___________ 6. Valley Form ______________________ 7. Mapped Sinuosity __________________
1. Reach Number ____ RM _____ to _____ 2. Mapped Valley Width Estimate ________ 3. Flow Regime Change ______________ 4. Mapped Channel Length ____________ 5. Mapped Channel Gradient ___________ 6. Valley Form ______________________ 7. Mapped Sinuosity __________________	1. Reach Number ____ RM _____ to _____ 2. Mapped Valley Width Estimate ________ 3. Flow Regime Change ______________ 4. Mapped Channel Length ____________ 5. Mapped Channel Gradient ___________ 6. Valley Form ______________________ 7. Mapped Sinuosity __________________

CHAPTER 3

STREAM INVENTORY HANDBOOK

FIELD PROCEDURES: LEVEL II INVENTORY - AQUATIC ECOSYSTEM INVENTORY

OBJECTIVES: The Level II inventory is the basic tool for determining the quality and quantity of aquatic habitat, and to obtain estimates of basic riparian and hydrologic conditions. The objective of the Level II inventory is to provide a generally quantitative characterization of aquatic (fish/water) and riparian conditions at a watershed scale.

STANDARDS: Standards for the field phase are intended to obtain consistent quantitative data. Specific standards for the procedure to accomplish the level II inventory are listed below. Data collected shall be at least as accurate as specified in the Region 6 protocol presented in this handbook. All the attributes described in this protocol are mandatory, unless clearly stated as a "forest option."

1. The observer is the field crew person assigned to make the visual distance estimates (habitat length, width and depth). The observer must continue to make the estimates until they have a mimum of 10 pools and 10 riffles measured. Once this minimum is met, they may change to the recorder at the start of the next reach. **DO NOT CHANGE THE OBSERVER MIDWAY THROUGH A REACH! IF A CHANGE IN OBSERVER IS NECESSARY, CHANGE AT THE START OF A NEW REACH BREAK! IF THE STREAM TO BE SURVEYED IS RELATIVELY SHORT (LESS THAN 2.0 MILES), IT IS IMPERATIVE THAT THE SAME OBSERVER MAKE ALL THE DISTANCE ESTIMATES FOR THE ENTIRE STREAM.** Following these directions is critical for establishing the correction factor for visual estimates vs. actual measurements for each observer.

2. **To develop statistically valid correction factors, a minimum of 10 pools and 10 riffles will be measured for each observer on each stream.**

3. On longer streams, where the required number of measured units will be met, the minimum sampling frequency for pool and riffle units will be 10 percent. **On shorter streams, the frequency of measured units may need to be greater than 10 percent to achieve the necessary number of measured units as specified in #2 above.**

4. If a certain habitat type is uncommon (e.g., pools) 100 percent of those habitat units may have to be measured to achieve the required 10 measured units/habitat type. Consultation with the district hydrologist and/or fisheries biologist is highly recommended during the process of choosing a sampling frequency.

5. The first unit of each habitat type to be measured will be selected randomly. For example, if the team decides to measure pools at a frequency of 1:5, five playing cards (ace through five) are shuffled by the recorder. The observer then selects one of the cards **WITHOUT LOOKING AT**

THE CARD'S VALUE, and the recorder records the card picked. To continue the example, if the recorder picks the "two," the first pool measured is the second pool in the survey (P2), and every fifth pool after the second pool is also measured (P7, P12, P17, P22, etc.). In a similar fashion, the sampling frequency for riffles is decided and the first measured riffle is randomly chosen. **There shall be no sampling of measured habitats at a frequency less than 10 percent. Do not roll dice to determine random starts.**

6. A long-term recording thermograph shall be in placed at the starting point (downstream most point of the survey in reach 1) and operating correctly between mid-June and late-September. The thermograph shall be calibrated before installation and shall be placed in the deepest part of the channel to ensure submersion as flows drop. The chosen site should not occur near the inflow from a cold spring to ensure good temperature mixing. A hand-held thermometer reading shall be taken at the time the thermograph is installed.

7. A system of photographs shall be established for the stream reach. The beginning, ending, and representative habitat types for each reach shall be photographed and documented, with a reference to NSO and habitat type photographed entered in the "Comments" section of Form C (or entered on Form C3).

8. A working map will be developed during the office procedure that will facilitate and expedite the field procedures' portion of the survey. This working map has been described in CHAPTER 2, OFFICE PROCEDURES:LEVEL I INVENTORY - IDENTIFICATION LEVEL (pages 8 and 9) of this manual. Field notes and observations shall be noted on this map, since this map will serve as the foundation for a final survey map to be included in the stream inventory report.

EQUIPMENT NEEDED:

* Level II Survey Forms (Forms B2, C, C1, C2, C3, D, E, F), as appropriate
* 30 cm ruler for Wolman Pebble Counts
* Pencils
* Clipboard
* 1:24,000 scale USGS topographic maps
* USGS quadrangle maps, orthophotographs, GIS stream layer maps, and aerial photographs
* 150-foot tape measures (an additional 150-foot tape measure may be necessary if the surveyed stream's flood prone zone is wider than 200 ft)
* Good quality, heavy duty scale stick or stadia rod
* Camera
* Water velocity meter
* Long-term recording thermographs for each inventoried stream
* Thermometer
* Abney level, hand level, or peep site
* Plastic strip flagging and grease pencil/marker for use as needed
* Waders/Hip boots with felt or corkers
* First Aid kit...a bee sting kit is a recommended element
* Polarized sunglasses
* Hardhat
* Radio
* Snorkel, mask, wetsuit or drysuit
* Backpack electroshocker
* Bankful pins and tension clamps (for measuring bankful dimensions)

PROCEDURES: There are three phases needed to complete a Level II survey: (1) preplanning before starting field work (see level I), (2) field measurements (field phase) which include reach location data, and (3) riparian data for every reach sampled (Forms B2, C, C1, C2, C3, D, E, and F). The Form B2 also has an office component which is described in the instructions for that form. (3) data entry, analysis and summarization or reporting.

PRODUCTS:

The level II inventory should produce:

* Completed Form B2's for each reach delineated during the field phase which will include a determination of the Rosgen alpha channel type for each reach.
* Completed entries to the appropriate field forms for each habitat assigned an NSO.
* At least one streamflow determination near the downstream end of the inventoried stream.
* An accurate field map (1:24,000 scale USGS topographic series) which labels reaches, tributaries, and other significant features discovered during the field phase.
* A completed stream data file in SMART which includes all entries made to Forms A, B2, C, C1, C2, C3, and D).
* A coherent stream inventory report that includes an executive summary, a basin summary, reach summaries, summary data tables; all of which should lead to sound data analysis and recommendations; these recommendations are an essential element of any level II inventory.

FINAL REACH IDENTIFICATION - FORM B2, R6-2500/2600-21

The purpose of Form B2 is to delineate the FINAL reach boundaries for the inventoried stream. The majority of the attributes on this form are calculated in the office and these are: mapped river mile, mapped valley length, mapped channel gradient, mapped sinuosity value, and Rosgen alpha level I channel type. A few of the attributes on this form are to be completed in the field as soon as the reach endpoint is determined, and these are: reach number, beginning and ending NSO's of the reach, inner riparian zone width, the observer, the recorder, and the completion date for the reach. Additionally, while still in the field, describe the reasons for ending the present reach in the "Comments" section of this form. (Additional comments can be entered to Form C3 if space is inadequate to address the reach delineation.)

It is mandatory that the field data for Form B2 shall be entered IN THE FIELD as soon as the reach endpoint is determined.

Reaches shall begin and stop on specific habitat units (i.e., pools and riffles) that are part of the mainstem stream, and have accompanying natural sequence order numbers (NSO's). After those terminal units have been identified, final reach stratification can occur.

It is imperative to stop or start all reaches at habitat units that can be specifically identified on the ground. The reach endpoints and the endpoint of the entire inventory must be permanent, fixed features which in the future can again be found (e.g., stream tributary confluence, waterfall, road crossing, cliff, etc.).

Again note that each observer must measure a minimum of 10 habitats of each habitat type **and** 10 percent of each habitat type they have observed per stream; hence, the number of observed/measured pairs is independent of stream reach. Once an observer has committed to calling a reach, they must complete it.

Fill out a Form B2 For Each Stream Reach:

NOTE: INSTRUCTIONS FOR COMPLETING THE FORM B2 HEADER (ATTRIBUTES A - H) ARE LISTED ON THE FORM A INSTRUCTIONS

FORM B2 INSTRUCTIONS

1. **OBSERVER/RECORDER**: Using a first initial and surname format (e.g., S.SWEET), enter the name of the observer. This person must make all the visual estimates of habitat width and length for the entire reach. Enter the name of the person recording for the reach using the same format.

2. **DATE**: Enter the date that the level II inventory on the reach was completed. Use the format DD-MMM-YY (e.g., 23-JUL-95).

3. **REACH NUMBER**: Enter the reach number beginning at the downstream end (or startpoint) of the inventoried stream, and incrementing the reaches sequentially in an upstream direction. (FL:3 (e.g., 999))

4. **NATURAL SEQUENCE ORDER (NSO)**: Enter the starting and ending NSOs for each reach **(e.g., Reach 1 = NSO 1-55, then Reach 2 = NSO 56-126, etc.).** This information is extracted from Form C, following final reach delineation. In the case of private land where no access has been granted, DO NOT assign any NSO's for the reach (enter 0), resume sequential NSO numbers at the next reach. The following is an example of a stream crossing private land in which access has been denied: Reach 1, NSO = 1-203; Reach 2 (Private), NSO = (enter 0); Reach 3 (Public), NSO = 204-365, etc.). (FL:4 (e.g., 9999))

5. **FLOW**: Enter actual measured flow recorded in cubic feet per second. At a minimum, take one measured flow in the first reach near the starting point of the survey. If a tributary contributes greater than 20% of the main channel flow, note approximate amount of flow in "Comments" and start a new reach break. If subsequent measured flows are taken, they should be measured near the downstream end of each reach. See Appendix F for instructions on determining streamflow. Record streamflow to the nearest 0.01 cfs. (FL:6 (e.g., 9999.99))

6. **MAPPED RIVER MILE**: Enter river mile (RM) at both the starting and ending point of each reach. Use designated Environmental Protection Agency (EPA) river reach miles if available; if not, begin the mileage mark at the mouth of the stream, starting with RM-0 unless starting point is not at the mouth. The ending river mile of the lower reach is the beginning river mile of the adjacent, upstream reach, (eg., Reach 1, RM 0-1.1; Reach 2, RM 1.1-4.0; Reach 3, RM 4.0-5.2). Map wheels will be used to calculate river miles, and the intent is to follow the "blue line" channel course as drawn on the 1:24,000 scale USGS topographic map. Reach length must be at least 0.5 river miles long. Record to the nearest 0.1 RM. (FL:5 (e.g., 9999.9))

7. **MAPPED VALLEY LENGTH**: The mapped valley length will be determined following the reach delineation completed in the field. This is a valley line distance between the two endpoints of the reach, utilizing the 1:24,000 scale USGS topographical map and map wheel. The distance is determined by using the map wheel to trace an imaginary midline of the valley floor from the startpoint of the reach to the endpoint of the reach. Record the value to the nearest 0.1 miles. (FL:3 (e.g., 99.9))

8. **MAPPED CHANNEL GRADIENT**: Calculate the mapped channel gradient for the reach

from a 1:24,000 scale USGS topographic map once the final reach boundaries have been delineated. Subtract the river mile estimate for the upstream end of the reach from the river mile estimate for the downstream end of the reach to determine the mapped stream channel length. Estimate the elevations at the upstream and downstream endpoints of the reach by reading the contours on the map. Calculate the gradient by subtracting the lowest elevation from the highest, and dividing that elevational change by the mapped stream channel length. Mapped stream channel length is a distance measured by tracing the "blueline" stream channel on a 1:24,000 scale USGS topographic map measured in feet. (FL:2 (e.g., 99))

9. MAPPED SINUOSITY VALUE: Sinuosity is calculated for each reach using a 1:24,000 scale USGS topographic map. Divide the estimated value for mapped stream channel length discussed in the previous paragraph by the mapped valley length discussed in the above #5. Since a stream channel is at least as sinuous as its valley floor, the value derived must be equal to or greater than 1.0. Record the value to the nearest 0.01. (FL:4 (e.g., 99.99))

10. MAPPED VALLEY WIDTH ESTIMATE: Enter an estimate of the average valley floor width for the reach. The estimate is derived from a 1:24,000 scale USGS topographic map. Valley floor width is the horizontal distance between the side slopes of the surrounding hills or mountains that confine the valley. The objective is an estimate within 10 percent of the actual average valley floor width for the reach. Record the estimate to the nearest 10 ft. (FL:4 (e.g., 9990))

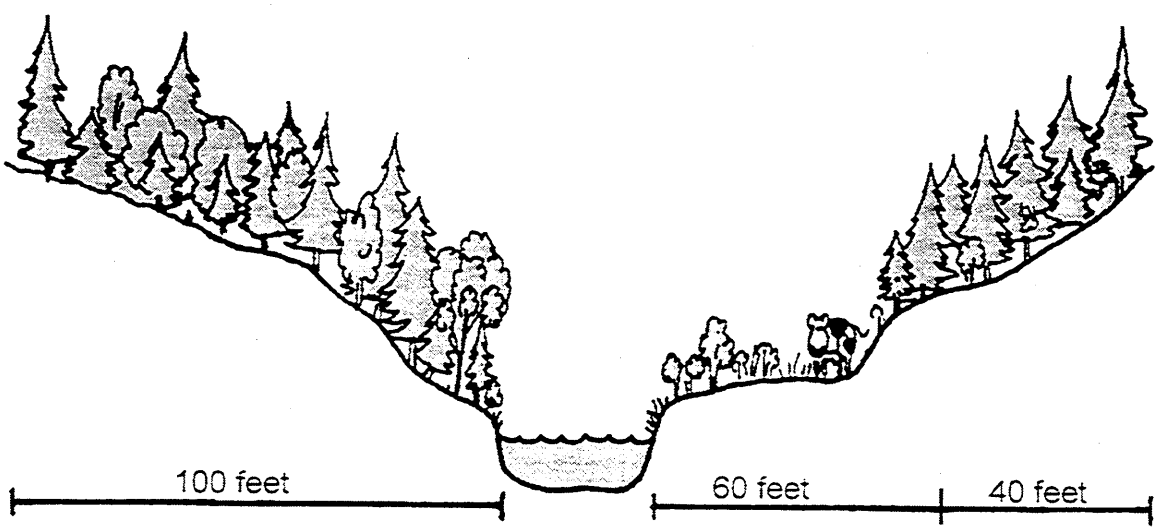
11. ROSGEN CHANNEL TYPE: Enter the Rosgen Classification Alpha Code for the stream reach. The methodology is defined in "A Classification of Natural Rivers" published by Catena, 1994.

12. INNER RIPARIAN ZONE WIDTH: The riparian zone investigated in this inventory is an area on either bank which is 100 ft. wide. The inner riparian zone is the portion of that 100 ft. which is characterized by a vegetative condition that is different from the remainder of the riparian zone. It is often the case that vegetation changes dramatically as the distance from the bankfull channel increases. True water-adapted plants may only occur very near the wetted channel. Alternatively, the inner riparian zone may describe an area in which ground-disturbing flows occur with sufficient frequency that mature conifers are quite rare, and a distinct hardwood zone is identifiable. The estimate of inner riparian zone width is the average width along both banks from bankfull to the distinct change in vegetation. The outer zone is calculated by subtracting the inner zone from 100 feet. For example, if the inner zone is estimated to be 60 ft. wide, then the outer riparian is 40 ft. wide (see Figure 4). Forests have the option to designate a single riparian zone, and in such a case, enter 100 ft. as the inner riparian zone width. (FL:3 (e.g., 100))

13. COMMENTS: Write down any comments important to the aquatic or riparian resources. This is a good place to clarify some of the entries made to Form B2. In particular, a description of the reasons for ending the reach should be included, as should a description of the location (NSO and Habitat Type Number) of any thermographs placed in the reach. Other comments may include left and right bank designations used for the survey, an estimate of juvenile fish habitat availability, a list of amphibians or other wildlife observed in the reach, the general condition of the upland slopes, and how well shaded is the reach's wetted channel.
(FL:240 (e.g., Broke reach at trib contributing 30% to flow = T13, near riparian grazing widespread and shade provided by trees is spotty, 3 steelhead redds discovered on flanks of point bars))

14. VALLEY FORM [Forest Option]: Enter valley form code which best describes the average condition for the reach. The designations are based on valley floor width and the gradients of the valley sideslopes. See Appendix D for figure. (FL:2 (e.g., 10))

Figure 4: Examples to help you decide how to designate the inner riparian zone width



Example 1: no clear vegetation zones are apparent, so use one zone = 100 feet if the condition is the same on both bank's vegetation zones.

Example 2: Designate an inner vegetarian zone if you expect to encounter a change in vegetation due to elevation (e.g. terraces), altered habitat (roads), or other management activities (harvest, grazing).

Remember that during the survey, both sides of the stream will have the same inner vegetation zone width for the entire reach.

STREAM HABITAT DATA FORM B2 Page: ____ of ____
R6-2500/2600-21

A. State __________ B. County __________ C. Forest __________ D. District __________

E. Stream Name ______________________________

F. Watershed Code ___, ___, ___, ___ NFS___,___;___.___,___.___,___.___,___.___

G. USGS Quad ______________________________

H. Survey Date ____-______-____
DD-MMM-YY

1. Observer/Recorder ____________________	1. Observer/Recorder ____________________
2. Date ____-____-____	2. Date ____-____-____
3. Reach Number _______ RM _____ to _____	3. Reach Number _______ RM _____ to _____
4. Natural Sequence Order (NSO) from_______to______	4. Natural Sequence Order (NSO) from_______to______
5. Flow ____________________	5. Flow ____________________
6. Mapped River Mile ____________________	6. Mapped River Mile ____________________
7. Mapped Valley Length ____________________	7. Mapped Valley Length ____________________
8. Mapped Channel Gradient ____________________	8. Mapped Channel Gradient ____________________
9. Mapped Sinuosity Value ____________________	9. Mapped Sinuosity Value ____________________
10. Mapped Valley Width Estimate __________	10. Mapped Valley Width Estimate __________
11. Rosgen Channel Type ____________________	11. Rosgen Channel Type ____________________
12. Inner Riparian Zone Width __________	12. Inner Riparian Zone Width __________
13. Comments ____________________	13. Comments ____________________
14. Valley Form ____________________	14. Valley Form ____________________

STREAM HABITAT DATA - FORM C, R6-2500/2600-22

The Stream Habitat Data Form - The following items should be recorded on Form C for the reaches to be surveyed. Each Forest should establish a standard for "right bank" and "left bank" orientation (see Appendix E for discussion). This orientation shall remain consistent over the forest once established. NOTE: the USGS standard establishes orientation while looking downstream.

There are four potential estimated dimensional attributes. They are habitat length, average habitat width, maximum habitat depth, and maximum depth at pool tail crest. The first three attributes will be measured at every "nth" unit ("nth units" are also referred to as "measured units"). Maximum depth at pool tail crest will be measured at every "nth" pool. The measured information will be placed in the data categories on Form C directly below each corresponding estimated value for that habitat unit. In addition, items 16-31 are to be entered on the same line of Form C as the measured values for the "nth" habitat units.

NOTE: INSTRUCTIONS FOR COMPLETING THE FORM C HEADER (ATTRIBUTES A - H) ARE LISTED ON THE FORM A INSTRUCTIONS

FORM C INSTRUCTIONS

I. REACH NUMBER: Reaches shall be numbered sequentially, with the first reach beginning at the downstream startpoint of the survey, usually at the mouth of the stream, with each succeeding reach's startpoint coinciding exactly with the previous reach's endpoint (e.g., 1, 2, 3, etc.).

THE FINAL REACH BOUNDARIES MAY CHANGE FOLLOWING VERIFICATION DURING THE FIELD PHASE. PRIOR TO COMPUTER DATA ENTRY, FINAL DELINEATION MUST OCCUR, AND THE TRUE REACH NUMBER BE ASSIGNED TO THE RESPECTIVE HABITAT UNITS.

When starting a new reach, record the data on a new Form C. This will facilitate data entry, and minimize data entry errors.

MAKE SURE NSOs LISTED ON FORM B2 COINCIDE WITH THE NSOs ON THE FORM C COMPLETED FOR EACH REACH BEFORE YOU BEGIN DATA ENTRY TO THE SMART DATABASE.

J. SAMPLING FREQUENCY: Enter the frequency of sampling the "nth" or measured habitat unit. For example, if sampling pool and riffle habitat types at a 20% frequency, enter 1/5 (1/5 = 20/100 = 20%) for both habitat types.

The Sampling frequency must be sufficient to ensure at least 10 pools and 10 riffles AND 10 percent of all pools and all riffles are sampled as measured habitats for each observer on each stream.

On longer streams where the required numbers of measured units can be met, a minimum of 10% of pool and riffle units is recommended. Shorter streams may require a much greater sampling frequency to achieve the necessary number of measured units. If a certain habitat type is uncommon (i.e., pools under certain stream conditions), it is possible that 100 percent of those habitat units must be measured to achieve the minimum 10 measured units of both habitat types.

Refer to #5 of the **"STANDARDS"** section in the beginning of this chapter for a discussion of how to randomly designate the first pool and first riffle to be treated as "nth" or measured habitats.

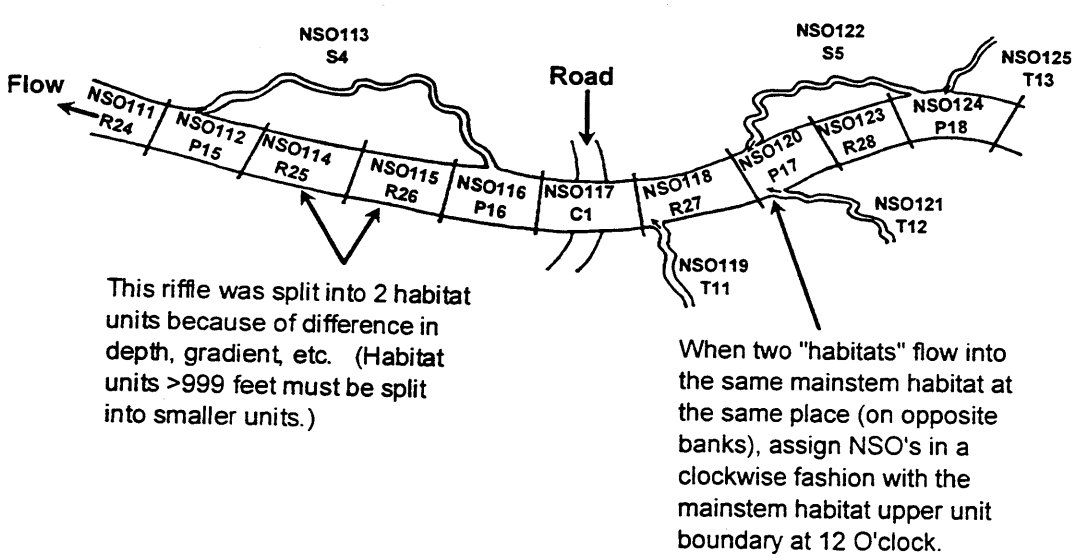
The asterisk (*) on Form C denotes the additional categories that require entries for measured units. **DO NOT** fill in these data categories in the rows for non-measured (estimated) habitat units.

1. NATURAL SEQUENCE ORDER (NSO): Enter a unique natural sequence order number for each habitat unit. NSO's should be entered in the same order as habitat units are encountered in the field survey, beginning with the first habitat unit and incrementing sequentially as new habitats are encountered moving upstream, (e.g., 1, 2, 3,...).

The numbering sequence shall remain consistent between reaches, (if Reach 1 ends at NSO #203, then Reach 2 shall begin at NSO #204). The only exceptions to this are a Private land reach where access has not been granted or a lake which occupies a middle segment of the surveyed stream channel (see Figure 3). In this case, a reach number is assigned to the private land or lake, but no NSO's are identified. Sequential number of NSO's resume in the <u>next</u> upstream reach, (eg., if Reach 2 is private land, no access, then NSO's are as follows: Reach 1 = NSO 1-203; Reach 2 = NSO none; Reach 3 = NSO 204-251...).

All side channels (S) and tributaries (T) should be treated as individual habitat units and assigned individual NSO numbers. They should be assigned the next incrementally higher NSO than the main channel habitat unit into which they flow. When multiple habitat units (tributaries and side channels) converge upon the mainstem habitat at exactly the same place, number them in a clock-wise order while facing upstream (see Figure 5). (FL:4 (e.g., 9999))

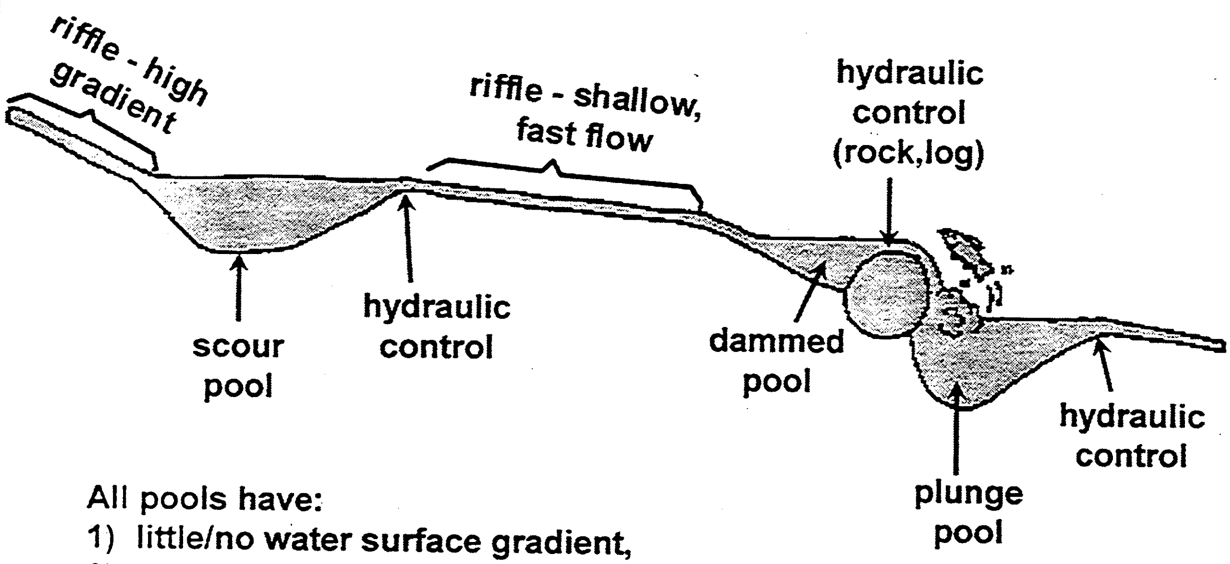
Figure 5: How to designate habitat unit NSOs for a stream with side channels and tributaries



2. HABITAT TYPE AND NUMBER: Enter the habitat unit type and number for each unit. Valid habitat codes include:

P = Pool
R = Riffle
S = Side Channel
T = Tributary
D = Dry Main Channel
C = Culvert (Form C1)
F = Special Cases (chute, falls, dam, marshlands, braided channel (Form C2)

Figure 6: Basic characteristics of a pool/riffle system



All pools have:
1) little/no water surface gradient,
2) a hydraulic control which spans channel, and
3) a residual pool depth.

Habitat type numbers will be ordered sequentially as the inventory progresses upstream. Both NSO's and habitat numbers are lowest near the (downstream) startpoint of the inventory, regardless of habitat type. The reach number has no bearing on how numbers are assigned to habitats. The NSO and habitat numbering increases in magnitude in an upstream direction. (e.g., if Reach 1 ends at P25, the next pool encountered would be in Reach 2 and would carry the label P26.)

In order to consider a habitat type as a separate unit, the habitat length must be equal to or greater than the wetted width. The ONLY exceptions to this rule are special case habitats and channel-spanning plunge pools (see Figure 6).

Plunge pools of this type, typically are located downstream of a debris jam or log which spans the wetted channel. Such a condition causes a pool to be scoured during high flow events. These pools must span the width of the wetted channel, but they need not be longer than their average width.

For all habitats other than channel-spanning plunge pools, if the wetted length of a habitat unit (measured along the thalweg) is not greater than the average wetted width, do not consider it as a separate unit. For extremely long habitat units, (e.g., riffles approaching 900 feet in length) consider stratifying them into smaller more manageable lengths. Splitting very long riffles into smaller, consecutive riffles is necessary because the SMART database has a habitat length limit of 999 ft. Assign each of the sections of riffle a **different** NSO and habitat number (e.g., a survey team decides to split a 1245 ft. Section of a stream into three consecutive riffles: a 455 ft. riffle (NSO 20, R10), a 530 ft. riffle (NSO 21, R11), and a 260 ft. riffle (NSO 22, R12)).

A measured habitat unit is **NOT** assigned its own NSO. Rather, the NSO assigned to the estimated habitat unit is shared by the measured habitat unit as well. Measured habitats are **NOT** unique habitats. Prefix each measured habitat unit with an "M" so that these are apparent during data entry. (Example: NSO 45, P23 = estimated habitat, NSO 45, MP23 = measured values for the same habitat). Only pool (P) and riffle (R) habitat types will have estimated/ measured pairs. The SMART database will treat dimensional attributes of length, width and depth for all other habitat types as if the values are measured (i.e., they will have a correction factor of 1.0).

For side channels (S), enter only wetted length, average wetted width, and maximum depth. A side channel is characterized by a stable island separating the mainstem channel from the secondary (side) channel. The stable island is characterized by woody plants other than willow which are estimated to be at least five-years old. In reaches characterized by meadows, a well-developed layer of soil atop the island indicates a stable secondary (side) channel. These stable secondary channels offer very important rearing habitat for juvenile salmonids. Do not assign an NSO to dry side channels. Do not break out individual habitat units (pools, riffles) within side channels. If a flowing side channel has a dry section, record the channel's total length as the sum of the dry and wet sections, and in "Comments" record the estimated length of dry side channel section. Also record in "Comments" both the bank of the mainstem channel into which the side channel flows, and the upstream mainstem habitat where the origin of the side channel is located. Count LWD in the medium and large size classes.

Consider braided channels to be Special Case habitats. Identify the main channel in a braided channel section as the channel carrying the largest portion of the streamflow during the survey. This is a visual estimation. Identify habitats along this mainstem channel as discussed above for pools and riffles. Treat the parallel secondary channels as a special case habitat. Braided channels are characterized by unstable islands subject to movement during normal high flows. These islands do not support woody plants other than willows, and they lack a developed soil layer. Herbaceous plants and willows can colonize on unstable islands, and as such are poor indicators of a channel's stability during normal high flow conditions. See the instructions in this chapter for **"Special Cases-Other-Form C2"** for a complete discussion on how to record the habitat dimensions in the secondary braids.

For Tributaries (T), enter the length, average width, and maximum depth of the first habitat unit of the tributary. Record the tributary's water temperature and the time it was taken. Estimate a percent of flow contributed by the tributary to the mainstem streamflow below the tributary. In "Comments," record the estimated flow contribution as well as which bank the tributary intercepts. If possible, identify the tributary on the field map, and label with the appropriate NSO and tributary sequence number.

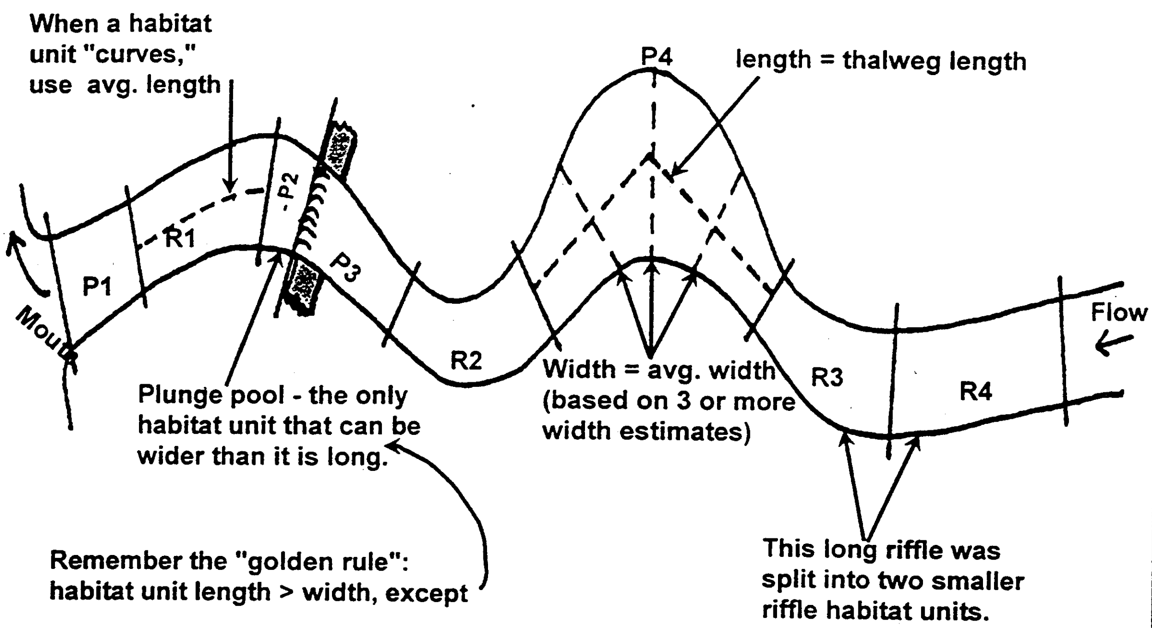
For Dry Main Channels (D), enter only the length of the inventoried mainstem stream channel which is dry at the time of the survey. Enter 0 for wetted width. Count LWD in the medium and large size classes, and enter into comments.

Special Case habitats (falls, chutes, dams, marshlands and braided channels) are assigned an NSO and their own "F" habitat sequence number. Culverts are given an NSO and flagged as "C" habitats; they are also sequentially numbered. Enter the appropriate NSO and habitat sequence type and number to Form C, but the remaining information is gathered on different forms; the Form C1 for culverts and Form C2 for the other special case habitats. Instructions for completing the appropriate forms are found in this chapter under the headings **"Special Cases - Culverts - Form C1" and "Special Cases - Other - Form C2."** (FL:5 e.g., MP999)

3. HABITAT LENGTH: Enter the wetted length for each habitat unit. This is an ocular estimate of the habitat length along the thalweg. The observer will estimate habitat length at each unit. Measured (or nth) habitat units are inventoried as if they are estimated habitats, and after the estimated attributes are recorded, only then can the recorder inform the observer that the habitat is a measured habitat. The team then measures the habitat's length along the thalweg, but only the recorder is permitted to know the actual measurement. The estimated and measured values for habitat length shall be reported to the nearest foot. (FL:3 (e.g., 999))

4. HABITAT WIDTH: Enter the ocularly estimated average wetted width for each habitat unit. The observer decides where to measure habitat width in the measured (nth) habitat units, but the measured value is known only by the recorder. Enter the estimated and measured values for habitat width to the nearest foot, or to within 10 percent of the actual average width, whichever is smaller (see Figure 7). (FL:4 (e.g., 999.9))

Figure 7: Habitat unit width and length measurements



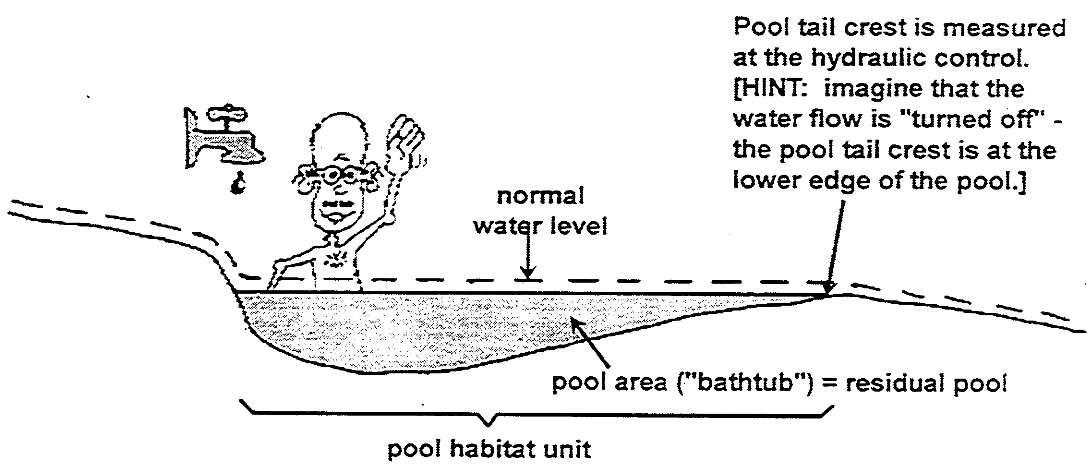
5. MAXIMUM DEPTH: Enter the measured maximum depth for each habitat to the nearest 0.1 ft. The maximum depth will be measured wherever that depth is less than 4 ft. In those habitats in which maximum depth exceeds 4 feet, an estimate of maximum depth will be made. Because the maximum depth is measured in every unit, enter this dimension as both "estimated" and "measured vlaues" for maximum depth in measured (nth) habitat units. This will artificially generate a correction value of 1.O for maximum depth in the SMART database. Maximum depth can be easily measured in most habitat units with a scale stick if the depth is less than 4 feet. (FL:3 (e.g., 99.9))

6. AVERAGE DEPTH [Forest Option]: Estimate the average depth in riffles only. This is an ocular estimate, and implementation is a forest-level decision.

7. DEPTH AT POOL TAIL CREST: Enter the maximum measured depth to the nearest 0.1 ft. at the pool tail crest for every pool habitat unit. This location is at the point where the water surface slope breaks into the downstream riffle or plunges to a pool below the upstream pool. Measure the maximum depth at this point along the width of the hydraulic control feature that forms the pool. The hydraulic control can be viewed as a dam holding back the pool's water. This "dam" is rarely a straight line across the downstream end of the pool, rather it usually forms an irregular curve.

To identify the location of the maximum depth along the hydraulic control (pool tail crest), visualize a condition in which streamflow has almost stopped, but a trickle of water is still exiting the pool (see Figure 8). That point is the maximum depth at the pool tail crest. This measurement is for calculating residual pool volume (e.g., maximum depth minus pool tail crest depth = maximum residual pool depth). The depth will be measured at each pool unit and estimated wherever the maximum depth at pool tail crest exceeds 4 feet. (FL:3 (e.g., 99.9))

Figure 8: How to visualize where the pool tail crest occurs



8, 9, 10, 11, 12. STREAMBED SUBSTRATE [Forest Option]: Enter the ocularly estimated percent that each size class of substrate comprises of the wetted streambed area. This estimate is made only after the observer has walked the length of the entire habitat. If any of the size classes of substrate listed below constitute at least 10 percent of the area of the streambed, record the percent in the appropriate column, in increments of 10 percent, each size class supplies to the surface of the streambed. Each forest has the option to collect estimates of streambed substrate or to disregard these qualitative attributes.

Caution: There is a tendency for observers to over-estimate the percent of streambed which is cobble or greater in size. Surveyors under-represent the contribution to area made by the edgewater streambed which tends to be comprised of smaller substrate than found in deeper portions of the habitat.

Use the following size classes:

SA = Sand, Silt, and Clay	(<0.08 in.................<2 mm.)	(smaller than "BB")
GR = Gravel	(0.08 - 2.5 in....... 2 - 64 mm.)	("BB" to tennis ball size)
CO = Cobble	(2.5 - 10 in........64 - 256 mm.)	(tennis ball size to basketball size)
BO = Boulder	(10.0 - 160 in....256 - 4096 mm.)	(Basketball to small car)
BR = Bedrock		

(FL:3 (e.g., 100))

13, 14, 15. PIECES OF LWD: Enter the number of pieces of large woody debris (LWD) within the bankfull channel for each habitat unit. The presence of LWD in the bankfull channel decreases the force of high flow events, tends to capture substrate, offers cover for fish and refuge from the force of storm events. Large woody debris also slows the movement of organic matter (leaves, twigs, and drifting macroinvertebrates) allowing aquatic organisms to more efficiently process and retain the nutrients available in organic debris.

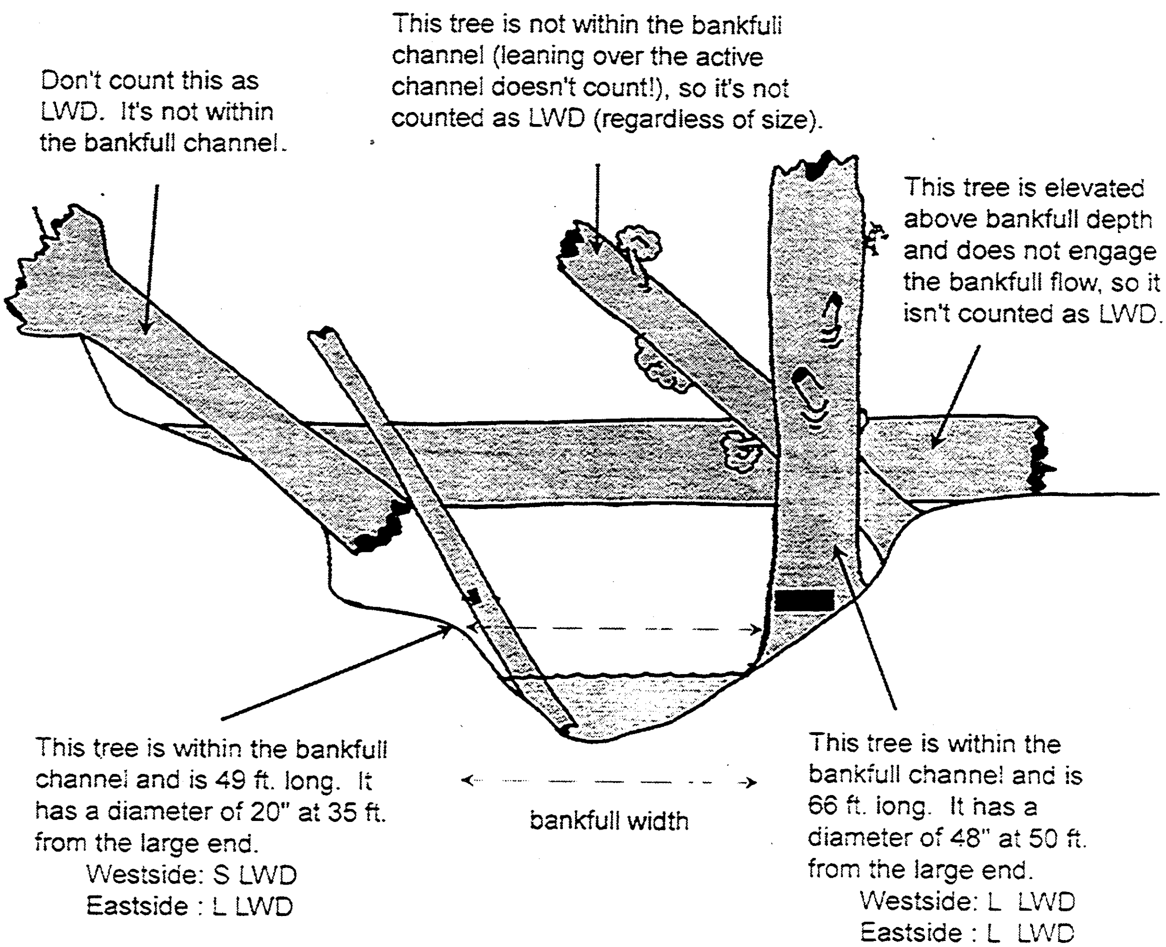
To be included, live or dead trees must interact with the streamflow at bankfull conditions. If a log or tree leans over the bankfull channel or spans the wetted channel, but does not interact with the streamflow during bankfull conditions, do **NOT** count it as LWD (see Figure 9). Leaning trees (i.e., potential LWD) are **NOT** included in the LWD entered to the SMART database. The approximate numbers of potential LWD (i.e., leaning trees or channel-spanning logs above bankfull flow) are appropriately recorded in "Comments" only.

Enter the number of pieces of large woody debris in each of the three size classes; Small, Medium, and Large. Use the following minimium diameter and length criteria:

East Side Forests (east of the High Cascades):
(13) S = Diameter > 6 in, at a length of 20 ft. from the large end (Forest option)
(14) M = Diameter > 12 in, at a length of 35 ft. from the large end (Mandatory)
(15) L = Diameter > 20 in, at a length of 35 ft. from the large end (Mandatory)

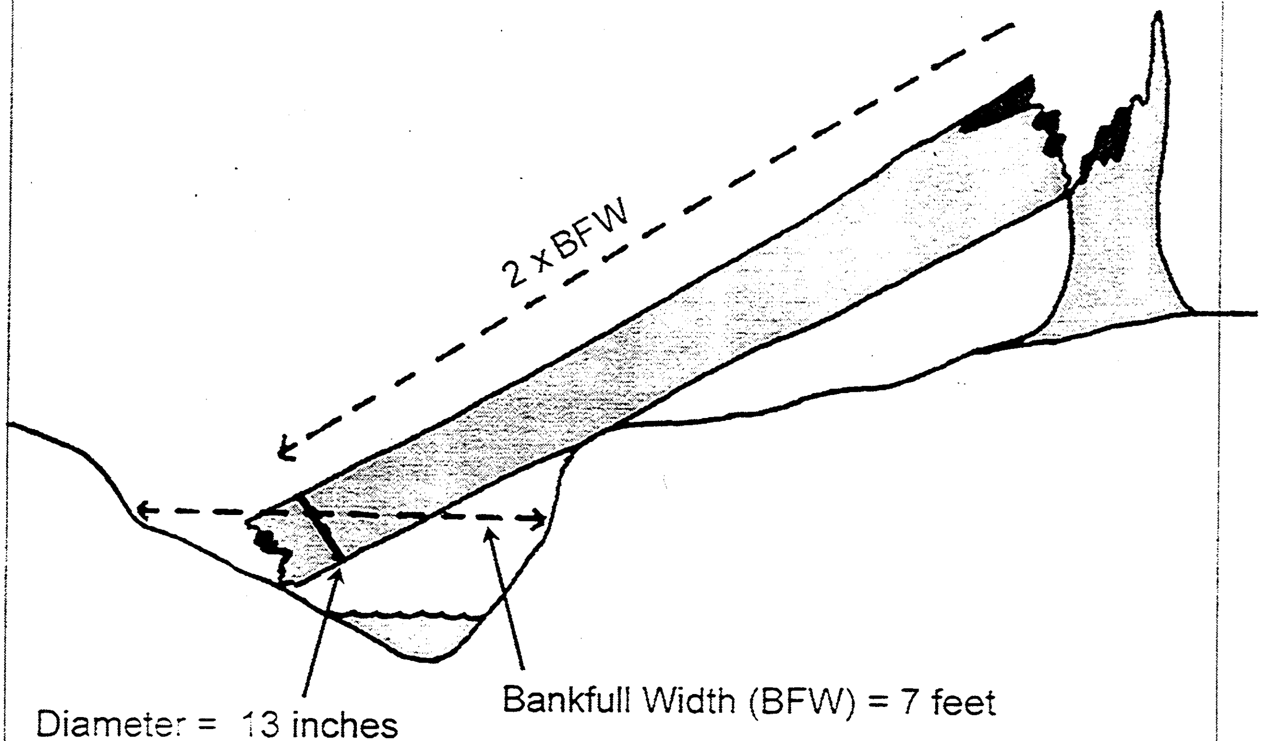
West Side Forests (west of the High Cascades):
(13) S = Diameter > 12 in, at a length of 25 ft. from the large end (Forest option)
(14) M = Diameter > 24 in, at a length of 50 ft. from the large end (Mandatory)
(15) L = Diameter > 36 in, at a length of 50 ft. from the large end (Mandatory)

Figure 9: Classifying a tree as large woody debris (LWD) is dependent on whether or not the tree is at least partly within the bankfull channel.



If a piece of large wood does not meet the length criteria listed above, but is longer than twice the average bankfull width for the reach, count the piece in the appropriate size class. Measure the minimium diameter at a distance from the large end equal to twice the average bankfull width for that habitat unit. The diameter size criteria do not change regardless of the length of the piece of large wood (see Figure 10).

Figure 10: Large woody debris (LWD) is present in small streams if a tree's length is greater than 2 x BFW.



This tree is 15 ft. long, which doesn't meet the normal minimum length criteria for LWD. But, because it is at least twice the BFW it is counted as LWD, based on the diameter size at a distance from the large end equal to twice the BFW of the habitat unit.

For this example (diameter = 13"):
Eastside: M LWD
Westside: S LWD

Make note of logjams, and rootwads in the bankfull channel under "Comments". It is important to remember that LWD in any log jam that occurs in a habitat type treated as a Special Case habitat will not be recorded in the SMART database if entered ONLY in the "Comments" section of Form C2. Therefore, those pieces must be recorded with the normal habitat (e.g., pools, riffles, etc.) immediately upstream or downstream. Make a clarifying note in the "Comments" that the surveyors have "loaded" LWD into a respective habitat type. (FL:2 (e.g., 99))

The following instructions (16 through 31) refer to measured (nth) habitat attributes ONLY.

16. BANKFULL WIDTH (BFW): Enter the MEASURED bankfull width at each measured (nth) riffle. Select sections of riffles that have a straight and relatively narrow channel since such sites offer the clearest bankfull indicators. The banks along the site selected for measuring BFW must be free of obstructions which cause high flow backwater across the entire channel. Bankfull is defined as the high streamflow event occurring on average every 1.5 years. This streamflow forms and maintains the channel over time.

Bankfull is identified by interpreting a combination of any or all of the following bankfull indicators: a change in vegetation (i.e., from none to some, or from herbaceous to woody); a stain line visible on bare substrate; a change in the scour line (exposed roots, etc.); a change in bank topography (a change in slope of the bank above the water's edge); a change in partical size above the water's edge (one of the best indicators); a line of debris on the ground (but NOT debris hanging in vegetation!). An area with an undercut bank is a very poor choice for bankfull determination since bank slumping will give a false reading of bankfull conditions.

Stretch a measuring tape taught, level, and perpendicular to the thalweg across the channel between clear bankfull indicators identified along both banks. Enter the measurment of BFW to the nearest 0.1 ft. (FL: 4 (e.g., 999.9))

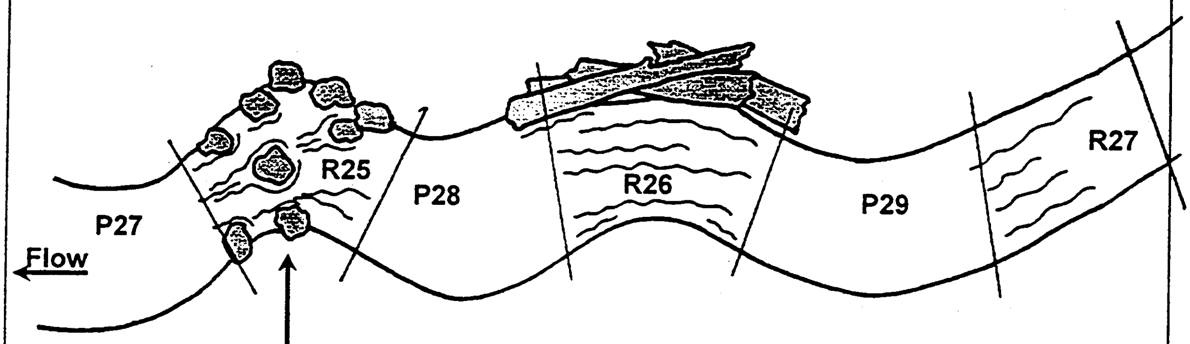
If clear indicators of bankfull flow are absent, treat the next riffle as the measured riffle, and reset the sampling scheme for measured riffles based on the change.

For example, assume the survey team is sampling every sixth riffle as a measured (nth) riffle, and R23 is the next designated measured riffle. However, R23 occurs on a channel bend, and the team determines there is no appropriate place along R23 to identify bankfull conditions; Therefore the next riffle R24 becomes a measured habitat (MR24), and an appropriate site is chosen along R24 for bankfull measurements. The next measured riffle will be R30 (24 plus 6) and the sampling scheme for measured riffles then becomes R24, R30, R36, etc. See Figure 11 for a different example.

If there is any chance that a minimum number of 10 measured riffles may not be recorded for the stream, or that the minimum sampling frequency of 10 percent of all riffles may be compromised, an increase in the frequency of sampling riffles should be initiated, and this will require randomly choosing the next riffle to be a measured (nth) riffle. See #6 of the "**STANDARDS**" section at the beginning of this chapter for a discussion and example of the methods for randomly choosing the first habitats to sample as measured (nth) habitats.
(FL:4 (e.g., 999.9)

Figure 11: An example showing what to do if a "measured riffle" does not have any clear indicators of bankfull width

Assume you randomly selected R5 as your first measured riffle and you are using a 1:5 (i.e., 20%) frequency. This established the sequence of R5, R10, R15, R20, R25, etc., as measured riffles.



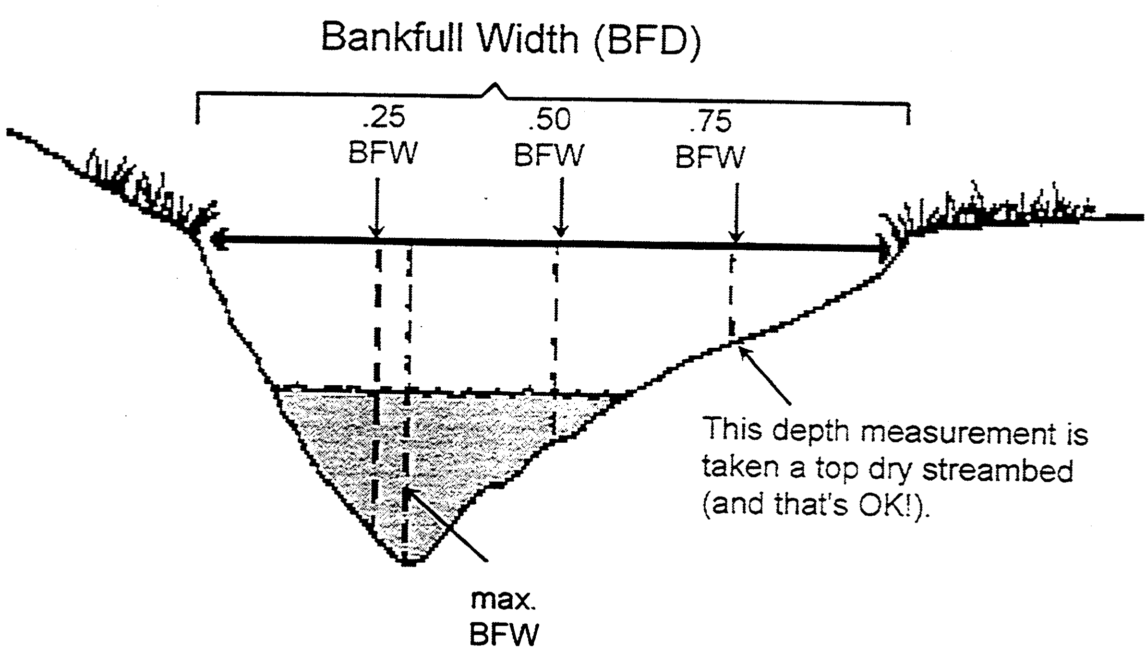
Oh, oh - R25 is the" Nth" riffle where you're supposed to measure bankfull. But you discover there are no clearly visible bankfull indicators. When that happens, go to the next riffle where bankfull indicators are present. In this example, R26 is also not acceptable because of a debris jam on the left bank. So you continue to the next riffle, where you find clearly visible bankfull indicators. Therefore, R27 is measured. You now need to **reset your sequence** of measured riffles to R27, R32, R37, etc. You have to reset the sequence of measured riffles everytime you have to skip a "predetermined measured riffle."

CAUTION: If sampling at a frequency of 1 in 10 (10%) and you skip more than one inappropriate riffle, you may need to increase the sampling frequency.

17, 18, 19. BANKFULL DEPTH: At each nth riffle, measure the bankfill depth at 25 percent of BFW, 50 percent of BFW, and 75 percent of BFW. This is the measured height from the streambed to the taut tape stretch along the bankfull width. The measurement will be made at the same location as the site for bankfull width (BFW).

It is expected that some of these measurements will be made outside of the wetted channel atop dry streambed since the surveys are performed under low streamflow conditions. See Figure 12 for a visual depiction of the process. (FL:3 (e.g., 99.9))

Figure 12: Where to measure bankfull depths (BFD) in order to determine the average BFD and maximum BFD



Average BFD = depth @ (.25 BFW + .50 BFW + .75 BFW)/3
Maximum BFD = depth along same measuring tape distance

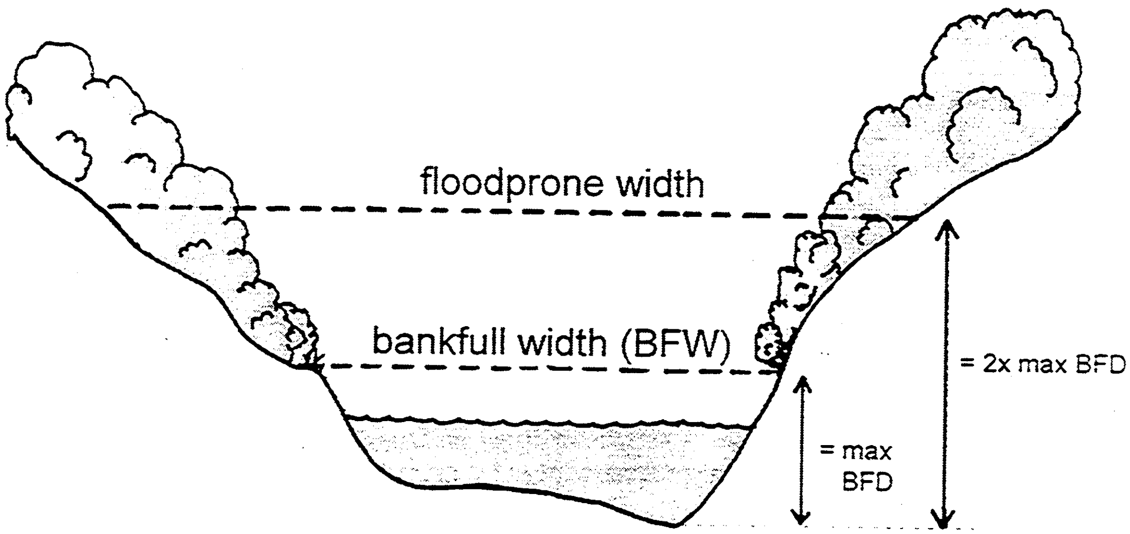
20. MAXIMUM BANKFULL DEPTH (max BFD): At the same time average bankfull depth is determined, measure and record the maximum bankfull depth along the stretched tape. This will inevitably be found along the thalweg in the wetted channel. It is simply the maximum elevation measured between the tape measure and the streambed. Record the measured value to the nearest 0.1 ft (See Figure 12). (FL:3 (e.g., 99.9))

21. FLOODPRONE DEPTH: The floodprone depth is determined by doubling the maximum bankfull depth (max BFD). The floodprone depth is the maximum depth in the channel during a flood which occurs approximately every 50 years. Record twice the max BFD as the floodprone depth, to the nearest 0.1 ft (see Figure 13). (FL:3 (e.g., 99.9))

22. FLOODPRONE WIDTH: The floodprone width is determined by establishing elevations along the valley floor equal to the floodprone depth atop both sides of the valley (see Figure 13). The floodprone width is the width of the valley floor inundated during a flood which occurs approximately every 50 years. To determine floodprone width pieces on both sides of the channel, flagging could be temporarily tied to vegetation at a height equal to the floodprone depth, and a tape stretched level at that elevation across the valley floor until the tape touches the ground on either side of the stream.

If the floodprone width is less than 2.5 times the bankfull width at that location, measure to the nearest foot. If the floodprone width is greater than 2.5 times the bankfull width at that location, simply estimate the floodprone width. The ratio of floodprone width to bankfull width is referred to as the entrenchment ratio, and this ratio is integral to defining Rosgen reaches.
(FL:3 (e.g., 999)

Figure 13: How to determine the floodprone width



Steps to determine floodprone width:

1) Measure max bankfull depth (BFD) (on the bankfull transect).

2) Determine floodprone depth = 2 x max BFD.

3) Stretch tape across stream at height of floodprone depth, (Keep that tape level!) and measure distance between floodprone streambanks = floodprone width.

[Note: entrenchment ratio = (floodprone width)/(bankfull width)]

23, 24, 25. RIPARIAN VEGETATION (INNER ZONE)

23. CLASS: Enter the existing riparian vegetation successional class within the inner zone of each measured (nth) habitat unit. Use the following diameter codes to describe the riparian successional class (see Appendix I for illustration and definitions of successional stages). It is rare for riparian forests to consist of a single successional (i.e., seral) class. The task is to define from an overhead (i.e., bird's-eye) view which successional class occupies the most overstory area within the inner zone width along both banks of the measured habitat. It is the average of both banks' condition.

DIAMETER CLASS

NV = No Vegetation (bare rock/soil, dbh NA)
GF = Grassland/Forb Condition (dbh NA)
SS = Shrub/Seedling Condition (1.0 - 4.9 in. dbh)
SP = Sapling/Pole Condition (5.0 - 8.9 in. dbh)
ST = Small Trees Condition (9.0 - 20.9 in. dbh)
LT = Large Trees Condition (21 - 31.9 in. dbh)
MT = Mature Trees Condition (> 32 in. dbh)

If no overstory layer is present and the dominant vegetation in the inner zone is in seral class GF, enter GF for (seral) Class. If the dominant vegetation in the inner zone is in seral class SS, enter SS for (seral) Class. (FL:2 (e.g., SP))

The width of the inner riparian zone is variable by reach and specified on Form B2. Once a width for the zones has been established, that distance must be maintained throughout the reach.

24. OVERSTORY: Enter the dominant overstory species of vegetation growing in the inner zone for each measured (nth) habitat unit, using the species codes listed below. Again, the task is to define from an overhead (i.e., bird's-eye) view which species occupies the most overstory area within the inner zone along both banks of the measured habitat. It is the average of both banks' condition.

If the seral class in the inner riparian is SP, ST, LT, or MT, use the following codes to identify the dominant overstory species. Forests may add to this list to include additional vegetation species. At a minimum, HX and CX will be used to denote hardwoods and conifers. (FL:3 (e.g., HA)

Hardwood:
HA = Alder
HB = Bigleaf maple
HC = Cottonwood, ash, poplar
HD = Dogwood
HE = Elderberry
HL = Liveoak, canyon
HM = Madrone
HO = Oak, Oregon white, California black
HQ = Quaking aspen
HT = Tanoak
HV = Vine Maple

Conifer:
CA = Subalpine fir, mountain hemlock, whitebark pine
CC = Cedar, western red
CD = Douglas fir
CE = Subalpine fir - engelmann spruce
CF = Fir, silver and noble
CH = Hemlock, western
CJ = Juniper
CL = Lodgepole pine, shore pine
CM = Mountain Hemlock
CP = Ponderosa pine, Jeffrey Pine
CQ = Western white pine

HW = Willow
HX = Other/unknown

CR = Red fir
CS = Spruce, sitka
CT = Port Orford cedar
CW = White fir, grand fir
CY = Yew
CX = Other/Unknown

If there is no clear dominant species of tree in the overstory layer, then enter one of these three conditions as dominant: shrub/seedling, grass/forb, or no vegetation.

SHRUB SEEDLING HEIGHT [Forest Option]: Wherever shrub seedling is the dominant successional vegetative class, forests have the option of designating the height class of the shrub seedling class wherever no dominant overstory species is present. For example, if shrubs between 5 and 10 feet tall are the dominant successional class in the inner zone, the entry for dominant overstory species would be SS3. Shrub height classification is an optional field and applies only to seral class SS. Use the following categories:

1 = 0 ft. - 2 ft.
2 = 2 ft. - 5 ft.
3 = 5 ft. - 10 ft.
4 = > 10 ft.
((FL:3 (e.g., SS4))

25. UNDERSTORY: Enter the dominant understory species growing in the inner riparian zone for each measured (nth) habitat unit, using the species codes listed below. Each forest must decide what defines the understory, and how to estimate conditions in this riparian vegetative layer. Contrasting views of understory include what species are likely to replace the canopy dominants with time and presently are sapling/pole vs. what is the vegetative site potential where the understory is likely to be small shrubs.

Examples:

The examples depend on how forests interpret the understory component of riparian vegetation.

Eastside - If seral stage in the inner zone is Grassland/Forb, with grasses dominant with a few shrubs 3 feet tall: the entries for Class/Overstory/ Understory might be GF/SS2/GF. If seral stage is shrub/seedling dominant, with shrub/seedlings 30 feet tall and alder subdominant the riparian vegetation might be categorized as SS/SS4/HA.

Westside - Seral stage is large trees with Douglas fir dominant in the overstory and western hemlock dominant in the understory, the designation for riparian condition might be LT/CD/HA.

26, 27, 28. RIPARIAN VEGETATION (Outer Zone)

26. CLASS: Enter the existing riparian vegetation successional (i.e., seral) class within the outer zone of each measured (nth) habitat unit. Use the diameter codes described in #23 (see Appendix I for illustration and definitions of successional stages). The task remains the same as described for the inner riparian zone. Define from an overhead (i.e., bird's-eye) view which seral class occupies the most overstory area within the outer zone width along both banks of the measured habitat. It is the average of both banks' condition. Whenever a single riparian zone is designated, it is considered an inner zone of 100 ft. In such a case the outer zone width is zero and no entries are necessary. (FL:2 (E.G., SP))

27. OVERSTORY: Enter the dominant overstory species of vegetation growing in the outer riparian zone for each measured (nth) habitat unit, using the species codes listed for #24 and #25. Again, the task is to define from an overhead (i.e., bird's-eye) view which species occupies the most overstory area within the outer riparian zone along both banks of the measured habitat. It is the average of both banks' condition. Forests again have the option to designate the height class of shrub/seedling wherever that seral class is the dominant overstory component (see #24 for description). (FL:3 (e.g., CC))

28. UNDERSTORY: Enter the dominant understory species growing in the outer riparian zone for each measured (nth) habitat unit. Use the species codes listed for #24 and #25. It is the task of individual forests to define the characteristics of the understory of interest to them. (FL:3 (e.g., SS2))

29, 30. WATER TEMPERATURE:

29. DEGREE: Take stream temperatures within the main stream channel at every measured unit. Enter to the nearest Fahrenheit degree.

NOTE: Temperatures should be recorded for ALL measured units.

Stream temperatures should also be recorded for each tributary unit which is assigned an NSO. (FL:2(e.g., 68))

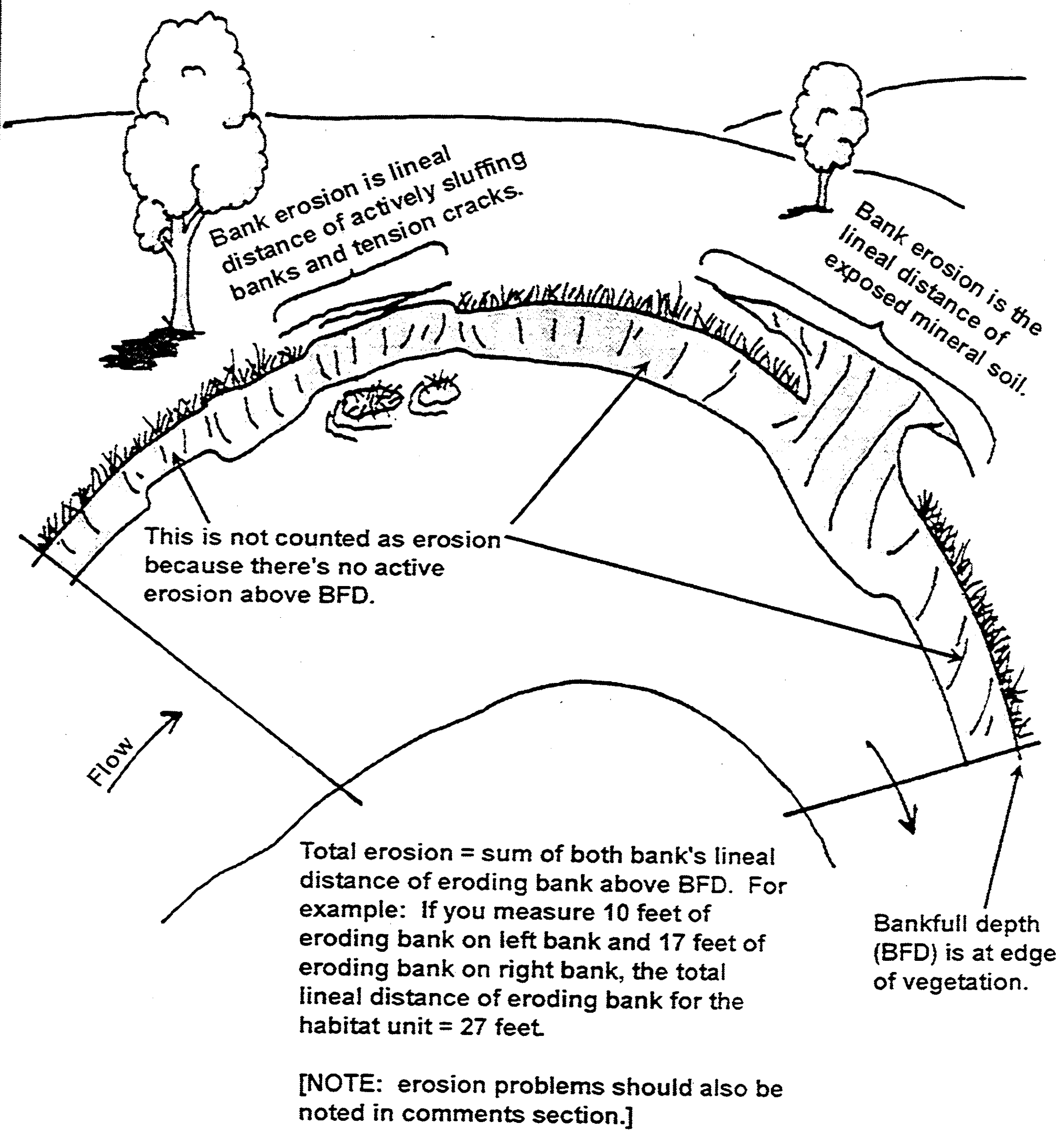
30. TIME: Enter the military time when temperatures are taken, and record the time to the nearest hour. (FL:4 (e.g., 1400))

It bears repeating for emphasis that every stream to be surveyed shall have a long-term thermograph installed in a pool near the startpoint of the inventoried stream that will record water temperatures from mid-June through late-September.

31. BANK STABILITY: Measure and sum the lineal distance of actively eroding bank along both sides of every measured (nth) habitat unit. Bank stability is a measure of actively eroding banks at an elevation above the bankfull depth. An eroding bank is characterized by any one, or a combination of the following factors: bare exposed colluvial or alluvial substrates, exposed mineral soil, evidence of tension cracks, or active sloughing (see Figure 14). Record to the nearest foot. (FL:3 (e.g., 999))

32-36. OPTIONAL FIELDS [Forest Option]: Place any additional information collected at habitat units in these columns. Forests may need to set up a separate data table in Oracle or other database to analyze this information.

Figure 14: Bank stability is the sum of the lineal distance of actively eroding banks on both sides of each measured habitat unit.



STREAM HABITAT DATA FORM C
R6-2500/2600-22

A. State ________ B. County ________ C. Forest ________ D. District ________ E. Stream Name ____________________

F. Watershed Code ___, ___, ___, ___ NFS ___, ___; ___.___, ___.___, ___.___, ___.___ G. USGS Quad ____________________

H. Survey Date ___-_____-___ I. Reach Number ________ J. Sampling Frequency ____________

DD-MMM-YY

Nat Seq Ord (NSO)	Hab Type & Num	Hab Len	Hab Wid	Max Dep	Ave Dep (Forest Option)	Dep at Pool Crest	Streambed Substrate (Forest Option)					Pieces of LWD			* Bankfull Width (BFW)	* Bankfull Depth			* *Max Bank full Depth (max BFD)	* Flood prone Depth	* Flood prone Width	* Riparian Vegetation (Inner Zone)			* Riparian Vegetation (Outer Zone)			* H_2O Temp		* Bank Stability	Optional Fields (Forest Option)				
							SA	GR	CO	BO	BR	S	M	L		1/4	½	3/4				Class	Over story	Under story	Class	Over story	Under story	Degree	Time						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36

SPECIAL CASES - CULVERTS - FORM C1, R6-2500/2600-23

This form is intended to document specific information on road crossings encountered during the survey. Culverts are also to be noted on the general Form C as a "C" habitat type.

NOTE: INSTRUCTIONS FOR COMPLETING THE FORM C1 HEADER (ATTRIBUTES A - H) ARE LISTED ON THE FORM A INSTRUCTIONS.

1. **REACH NUMBER**: Enter the reach in which the culvert is located. (FL:3 (e.g., 999))

2. **NSO NUMBER**: Enter the NSO number assigned to the culvert and entered on Form C. (FL:4 (e.g., 9999))

3. **CULVERT NUMBER**: Enter the number of the culvert. Like other habitats, they are sequentially numbered from downstream to upstream and every culvert is assigned a "C" as the prefix to the culvert number. (FL:4 (e.g., C999))

4. **TYPE OF STRUCTURE**: Indicate the type of culvert by circling the appropriate cross sectional sketch. (FL:10 (e.g., open arch))

5. **LENGTH OF STRUCTURE**: Enter the length of the culvert measured from the outlet to the inlet. Record to the nearest 0.1 ft. (FL:5 (e.g., 999.9))

6. **DIAMETER OR WIDTH**: Enter the measured diameter or width of the structure. If an arch, open arch, box, or open box, measure maximum width. (FL:4 (e.g., 999.9))

7. **CULVERT GRADIENT**: Enter the measured gradient as a percent slope using a hand level, abney level or peep site. Measurement of slope using a clinometer is not acceptable. (FL:3 (e.g., 999))

8. **BAFFLES PRESENT**: Record Y for Yes, N for No to indicate the presence or absence of baffles in the culvert. (FL:1 (e.g., N))

9. **JUMPING DISTANCE HEIGHT**: Enter the measured height of the distance from the surface of the stream to the culvert's lip at the downstream end of the culvert. (Fl:2 (e.g., 99))

10. **POOL PRESENT**: Indicate whether a pool is present below the outlet of the culvert. Such a pool need not span the width of the wetted channel. (FL:1 (e.g., Y))

11. **POOL DIMENSIONS**: Enter the estimated average length, average width and maximum depth of the pool, if present, adjacent to and downstream of the culvert's outlet. Record all dimensions to the nearest foot. (Length/FL:3 (e.g., 999); Width/FL:2 (e.g., 99); Depth/FL:2 (e.g., 99))

12. **WIDTH OF STREAM ABOVE CULVERT**: Measure and record the average wetted width of first habitat unit above the structure. Record to the nearest foot. (FL:2 (e.g., 99))

13. **OBSERVER/RECORDER:** Enter the Observer and Recorder's names as initial of first name and surname (e.g., J.Cool).

STREAM HABITAT DATA FORM C1
(CULVERTS)
R6-2500/2600-23

Page: ____ of ____

A. State __________ B. County __________ C. Forest __________ D. District _____

E. Stream Name ______________________________

F. Watershed Code ___, ___, ___, ___ NFS ___,___;___.___,___.___,___.___,___.___

G. USGS Quad ______________________________

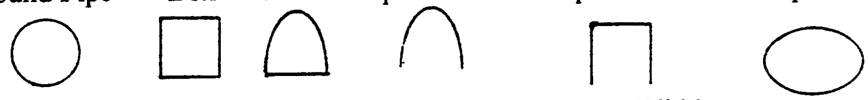
H. Survey Date ____-______-____
DD-MMM-YY

---

1. Reach # _______ 2. Natural Sequence Order # _______ 3. Culvert # _______

4. Type of Structure (circle)

Round Pipe | Box | Arch | Open Arch | Open Box | Elliptical



5. Length of Structure _____________ (ft) 6. Diameter or Width ___________ (ft)

7. Gradient ______________ 8. Baffles Present ______________

9. Jumping Distance Height _________ 10. Pool Present ______________

11. Pool Dimensions L_____W_____D_____

12. Width of Stream above Culvert ____________________

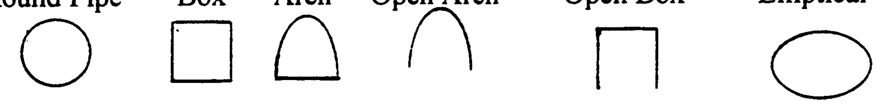
13. Observer/Recorder ______________________________

---

1. Reach # _______ 2. Natural Sequence Order # _______ 3. Culvert # _______

4. Type of Structure (circle)

Round Pipe | Box | Arch | Open Arch | Open Box | Elliptical



5. Length of Structure _____________ (ft) 6. Diameter or Width ___________ (ft)

7. Gradient ______________ 8. Baffles Present ______________

9. Jumping Distance Height _________ 10. Pool Present ______________

11. Pool Dimensions L ____W_____D_____

12. Width of Stream above Culvert ____________________

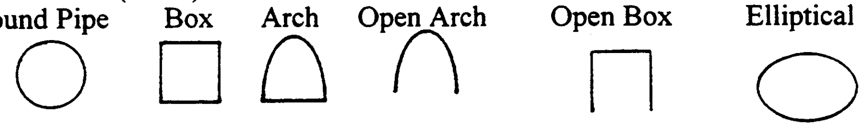
13. Observer/Recorder ______________________________

---

1. Reach # _______ 2. Natural Sequence Order # _______ 3. Culvert # _______

4. Type of Structure (circle)

Round Pipe | Box | Arch | Open Arch | Open Box | Elliptical



5. Length of Structure _____________ (ft) 6. Diameter or Width ___________ (ft)

7. Gradient ______________ 8. Baffles Present ______________

9. Jumping Distance Height _________ 10. Pool Present ______________

11. Pool Dimensions L_____W_____D_____

12. Width of Stream above Structure ____________________

13. Observer/Recorder ______________________________

SPECIAL CASES - OTHER - FORM C2, R6-2500/2600-24

This form is intended to document specific information on falls, chutes, dams, marshlands and braided channels encountered during the inventory. These are aquatic habitats that do not fit the standard habitat types entered on Form C.

Definitions:

FALLS: An essentially vertical drop in the channel bed that results in a waterfall. This is considered a fast water unit. It is a forest level decision as to what height of the drop constitutes a Special Cases habitat.

CHUTES: A section of the channel, usually constrained by bedrock, that results in a funnelling of streamflow through a narrow constriction. This is considered a fast water unit.

DAMS: Specific human-made structures to impound water.

MARSHES: A water-saturated, poorly drained wetland area either permanently or periodically inundated with water. It has no discernable bankfull channel.

BRAIDS: The secondary channels which weave through a section of stream lacking a well defined channel. Unstable islands flank the braids, and these islands are usually below bankfull depth. Vegetation on these unstable islands is typically either non-woody (or very young seedlings) or willow. Bankfull flow will frequently cut new braids across these unstable islands. These secondary channels offer very poor conditions for juvenile salmonids.

NOTE: INSTRUCTIONS FOR COMPLETING THE FORM C2 HEADER (ATTRIBUTES A - H) ARE LISTED ON THE FORM A INSTRUCTIONS.

1. REACH NUMBER: Enter the reach in which the Special Cases habitat occurs. (FL:3 (e.g., 999))

2. NSO NUMBER: Enter the NSO number for the Special Cases habitat type as entered to Form C. (FL:4 (e.g., 9999))

3. HABITAT NUMBER: Enter the number of the Special Cases habitat. Like all other habitat types, Special Case habitats, of the five types listed above, are incremented sequentially in an upstream direction and each Special Cases habitat carries an "F" habitat prefix before the habitat number. (FL:4 (e.g., F999))

4. SPECIAL CASE TYPE: Circle the type of Special Cases habitat encountered. See definitions above for each type. (FL:5 (e.g., Chute))

5. STREAM SURVEY MILE: Enter the mapped river mile location of the Special Case habitat. River miles begin at the mouth of the inventoried stream. This mapped distance is completed in the office after the field inventory of the Special Cases habitat has been completed. Record to the nearest river mile. (FL:4 (e.g., 9999))

6. TOPOGRAPHIC ELEVATION: Enter the elevation of the Special Case habitat identified from the closest contour line on the 1:24,000 scale USGS topographic field map. The topographic elevation is also determined in the office after the field inventory of the habitat has been completed. (FL:4 (e.g., 9999))

7. **SIZE**: Enter the length, width, and height of the feature. If a falls, enter only the height. If a braided channel, estimate the total length of the primary channel. All dimensions can be recorded to the nearest 0.1 ft. (Length/FL:5 (e.g., 9999.9; Width/FL:5 (e.g., 9999.9); Height/FL:5 (e.g., 9999.9))

8. **GRADIENT**: Where applicable, enter the gradient of the Special Case habitat in percent slope, to the nearest percent. This can be determined most easily by dividing the height of the Special Cases habitat by the habitat's length (rise/run). (FL:3 (e.g., 999))

9. **POOL PRESENT**: Indicate whether a pool is present immediately downstream of the feature. Such a pool need not span the wetted channel (i.e., it need not meet the protocol for a habitat pool). (FL:1 (e.g., Y))

10. **POOL DIMENSIONS**: If a pool is present, enter the measured wetted dimensions for length, average width and maximum depth. Record all dimensions to the nearest foot. (Length/FL:2 (e.g., 99)); Width/FL:2 (e.g., 99)); Depth/FL:2 (e.g., 99)

11. **OBSERVER/RECORDER**: Enter the Observer and Recorder's names using first initial and surname (e.g., J.Cool).

12. **COMMENTS**: Enter any pertinent comments for the feature. (FL:240 (e.g., falls is actually a series of three steps with no intervening pools))

STREAM HABITAT DATA FORM C2
(FALLS, CHUTES, DAMS, MARSHES, BRAIDS)
R6-2500/2600-24

Page: ____ of ____

A. State __________ B. County __________ C. Forest __________ D. District ____

E. Stream Name ______________________________

F. Watershed Code ___, ___, ___, ___ NFS ___,___;___.___,___.___,___.___,___.___

G. USGS Quad ______________________________

H. Survey Date ____-______-____

DD-MMM-YY

---

1. Reach # _______ 2. Natural Sequence Order # _______ 3. Habitat # _______
4. Special Case Type (circle)

Falls Chutes Dams Marshes Braids

5. Stream Survey Mile ____________ (ft) 6. Topographic Elevation ___________
7. Size: Length _____________ Width ___________ Height ______________
8. Gradient ______________ 9. Pool Present ________________
10. Pool Dimensions: L_____ W_____ D______
11. Observer/Recorder ______________________________
12. Comments ______________________________

---

1. Reach # _______ 2. Natural Sequence Order # _______ 3. Habitat # _______
4. Special Case Type (circle)

Falls Chutes Dams Marshes Braids

5. Stream Survey Mile ____________ (ft) 6. Topographic Elevation ___________
7. Size: Length _____________ Width ___________ Height ______________
8. Gradient ______________ 9. Pool Present ________________
10. Pool Dimensions: L_____ W_____ D______
11. Observer/Recorder ______________________________
12. Comments ______________________________

---

1. Reach # _______ 2. Natural Sequence Order # _______ 3. Habitat # _______
4. Special Case Type (circle)

Falls Chutes Dams Marshes Braids

5. Stream Survey Mile ____________ (ft) 6. Topographic Elevation ___________
7. Size: Length _____________ Width ___________ Height ______________
8. Gradient ______________ 9. Pool Present ________________
10. Pool Dimensions: L_____ W_____ D______
11. Observer/Recorder ______________________________
12. Comments ______________________________

COMMENTS - FORM C3, R6-2500/2600-25

The function of the Comments form is to provide additional space, if needed, for any comments concerning habitat condition, observed biota, riparian condition, upland condition, etc. that won't fit in the "Comments" space provided on each of the field forms (Forms B2, C, C1, C2, and D.). Consider developing codes for recurring comments (such as RW for a root wad); this will assist in querying data at a later time.

NOTE: INSTRUCTIONS FOR COMPLETING THE FORM C3 HEADER (ATTRIBUTES A - H) ARE LISTED ON THE FORM A INSTRUCTIONS)

1. **REACH NUMBER**: Enter the number of the reach where the observation is made. (FL:3 (e.g., 999))

2. **NATURAL SEQUENCE ORDER (NSO)**: Enter the Natural Sequence Order for the habitat which is the focus of the comment as listed on Form C. (FL:4 (eg.9999))

3. **HABITAT TYPE AND NUMBER**: Enter the habitat type and number of the habitat which is the focus of the comment as listed on Form C. (FL:5 (e.g., MR999))

4. **COMMENTS**: Enter your comments regarding any of the above evaluations and photos; or geomorphological, hydrologic, or biological observations here. For culverts use Form C1, and for falls, chutes, dams, marshes, and braided channels use Form C2 to document specific information regarding these features. Other suggested notable features to note are:

Fish passage: jams, barriers, fish habitat improvement opportunities, etc.

Watershed concerns: landslides, erosion areas, streambank damage, watershed rehabilitation potential, etc.

Other: diversions, mining, dredging, filling, riprap, etc. Also include reaches that are within Wild and Scenic rivers and wilderness areas.

Tributaries: Note the habitat unit at the confluence, estimated tributary discharge, the channel gradient of the tributary immediately upstream of mouth, and the percent contribution to the flow of the mainstem stream.

End of Survey: Note the reasons for ending the inventory at a given point. The upstream endpoint for the inventory must be geographically defined so that the point can be reestablished in the future. If possible, mark beginning and end of each reach with metal tag to tree and define in "Comments" section.

This information will give the reviewer insight as to the reasoning for ending the survey, and will minimize the need to reexamine that point in the watershed. (FL:240 (e.g., riparian buffers intact, 10-yr old reveg on upland R.BANK slope))

STREAM HABITAT DATA FORM C3 Page: ____ of ____
R6-2500/2600-25

A. State __________ B. County __________ C. Forest __________ D. District __________

E. Stream Name ____

F. Watershed Code ___, ___, ___, ___ NFS ___,____;____.____,___.___,___.____,____.____

G. USGS Quad ____

H. Survey Date ____-______-____
DD-MMM-YY

Reach Number	Natural Sequence Order (NSO)	Habitat Type and Number	Comments

FISH AND AMPHIBIAN DISTRIBUTION - FORM D, R6-2500/2600-30

This form is to be used to document the range and distribution of aquatic-dependent species identified during the inventory. Although the focus is on those species that are dependent on water for all life stages (fish), amphibians are to be noted. Sampling methods will focus on those specific to collecting/observing fish species. The sampling intensity may vary between forests, but the minimum standard is to establish the range of species throughout the section of inventoried stream. Consider sampling at each 10th pool and 15th riffle. Snorkeling, electroshocking, or seine methods may be used to gather this information. Species must be directly observed to be identified. At a minimum, identify to the genus level; where possible, to the species level.

NOTE: INSTRUCTIONS FOR COMPLETING THE FORM D HEADER (ATTRIBUTES A - H) ARE LISTED ON THE FORM A INSTRUCTIONS)

I. REACH NUMBER: Enter the number of the reach where sampling occurred. (FL:3 (e.g., 999))

J. METHOD: Circle the method used for collection/identification. (FL:2 (e.g., SN))

1. NATURAL SEQUENCE ORDER (NSO): Enter the Natural Sequence Order as listed in Form C of the habitat in which the fish and/or amphibian identification occurred. (FL:4 (e.g., 9999)).

2. HABITAT TYPE AND NUMBER: Enter the habitat type and number assigned to the NSO described in #1 (above) as listed in the Form C. (FL:4 (e.g., P999))

3. SPECIES: If only identified to genus, enter the first 2 alpha characters of the genera, and denote species by XX. If identified to species, enter the first two letters of the genus, followed by the first two letters of the species. If additional identifiers are desired, the last 2 spaces will accomodate two more letters. For example, these additional letters would allow steelhead and rainbow trout which are the same species *(Oncorhynchus mykiss* = ONMY) to be uniquely identified as ONMYAN (ONMY anadromous) and ONMYRE (ONMY resident).

Amphibian species can be treated in an identical manner using a four-letter code designating genus and species that are encountered. The Seattle Audubon Society has produced a field guide appropriate for the Pacific Northwest Region titled, Amphibians of Washington and Oregon: The Trailside Series,authored by William P. Leonard, et al. This guide gives excellent color photos, a species description, a brief discussion of habit and habitat, and distribution maps for each species.(FL:6 (e.g., SACOFL))

4. COMMENTS: Enter comments regarding any of the evaluations and document photos. Additional comments might include geomorphic, hydrologic, or biological observations. (FL:240 (e.g., several stream restoration structures in this reach offering excellent cover for juvenile trout))

PARTIAL LIST OF FISH SPECIES

CODE	GENUS AND SPECIES	COMMON NAME
ONCL	*Oncorhynchus clarki*	Cutthroat Trout
ONGO	*Oncorhynchus gorbushcha*	Pink Salmon
ONKE	*Oncorhynchus keta*	Chum Salmon
ONKI	*Oncorhynchus kisutch*	Coho Salmon
ONMY	*Oncorhynchus mykiss*	Steelhead, Rainbow, Redband Trout
ONNE	*Oncorhynchus nerka*	Sockeye Salmon
ONTS	*Oncorhynchus tshawytscha*	Chinook Salmon
PRWI	*Prosopium williamsoni*	Mountain Whitefish
SACO	*Salvelinus confluentus*	Bull Trout
SAFO	*Salvelinus fontinalis*	Brook Trout
SATR	*Salmo trutta*	Brown Trout
ONXX	*Oncorhynchus* sp.	Unknown salmon/trout
JUVL	....	Unknown juvenile salmonid
RHXX	*Rhinichthys* sp.	Unknown dace
COXX	*Cottus* sp.	Unknown sculpin

STREAM HABITAT DATA FORM D
R6-2500/2600-30

Page: ____ of ____

A. State __________ B. County __________ C. Forest __________ D. District __________

E. Stream Name ______________________________

F. Watershed Code ___, ___, ___, ___ NFS ___,____;____.____,____.___,___.___,____.____

G. USGS Quad ______________________________

H. Survey Date ____-______-____
DD-MMM-YY

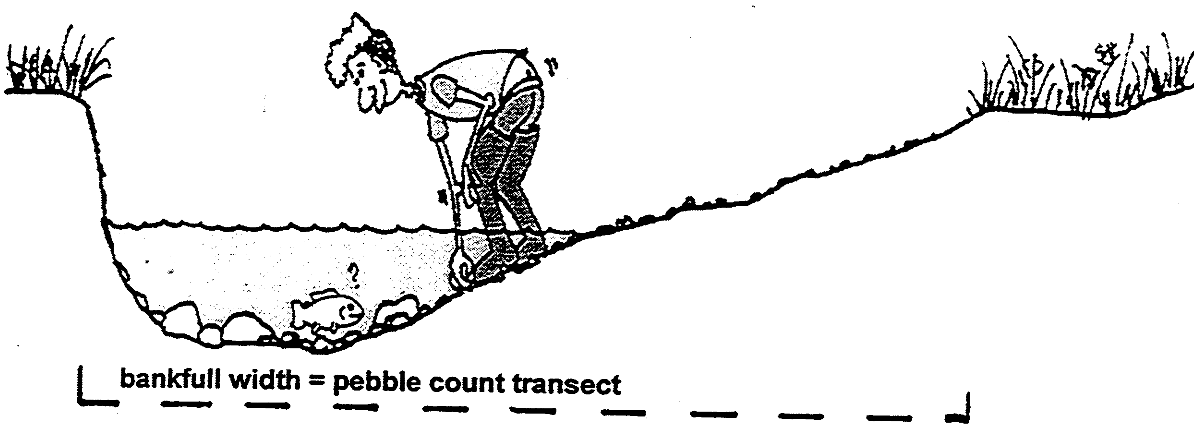
I. Reach Number ____________

J. Method (circle method used for collection/identification)

Seine (S) Snorkel (SN) Electroshock (E)

Natural Sequence Order (NSO)	Habitat Type and Number	Species	Comments

Figure 15: General guidelines for doing pebble counts



Pebble Count "Hints":

1) Always go from bankfull-to-bankfull, traverse the channel and perpendicular to the thalweg.
2) Measure at least 100 "pebbles" (but, don't stop measuring until you reach the end of the transect atop the bankfull indicator).
3) Measure the first "substrate element" you touch at each designated sample location.
4) Substrate is measured across the intermediate axis, (neither the longest nor shortest of the three mutually peroendicular sides).
5) Pebble counts are only done in riffles (twice per reach).
6) If you don't get 100 measurements on a transect, continue to do transects within the riffle until you meet or exceed 100 measurements.
7) Two pebble counts should be done for each reach, at riffle units. They should be located about 1/3 and 2/3 of the total length of each reach. Use your map (developed during filling out Form B1) to locate the section of stream in which the sample riffles will be located.

* for additional information, see Harrelson, et al. 1994.

CHAPTER 4

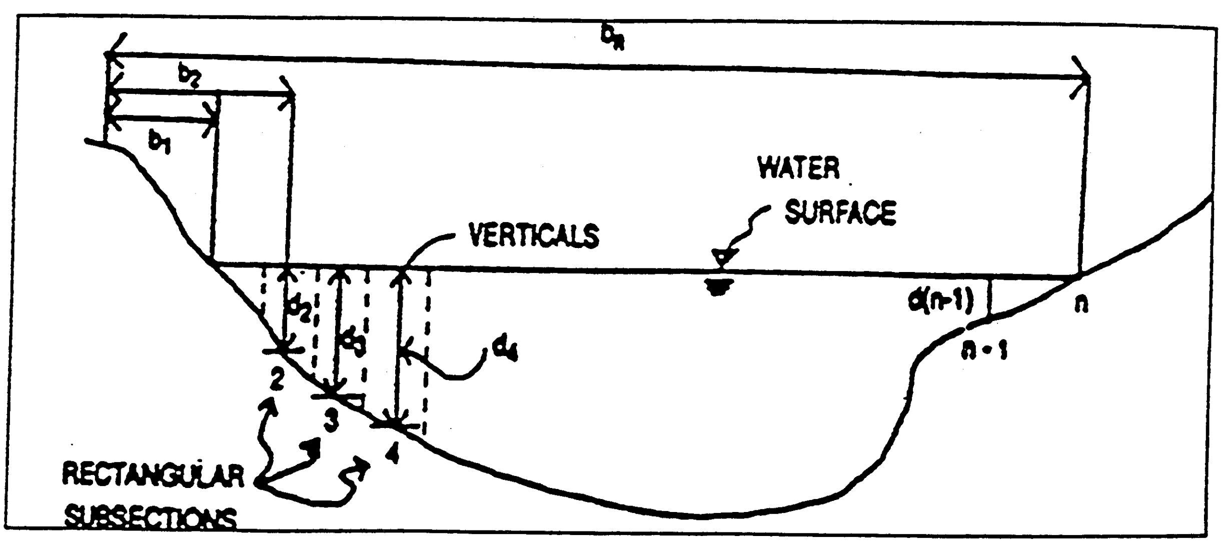
STREAM INVENTORY HANDBOOK

STREAM HABITAT DATA FORM E, R6-2500/2600-31

The level II stream inventory is designed to identify habitats during low streamflow conditions. On most stream in the Pacific Northwest low flow occurs in the summer. Habitats with only slight turbelence during low flow conditions are often quite turbelent as streamflow (discharge) increases. By measuring discharge at the beginning of the field inventory, mangers are able to compare inventories completed during different years on the same stream.

Stream discharge (Q) is the volume of water passing a cross-section per unit of time and is generally expressed as cubic feet per second (cfs). Discharge is simply the velocity multipled by the cross-sectional area of the stream (Q=VA). Cross-sectional area is the vertical plane of water filling the channel, and athis plane is always perpendicular to the thalweg. Area is approximated by dividing the wetted cross-section into subsentions. The depth and width of each subsention are determined. Velocity is measured in each subsection using a current meter. The discharge for each subsection is calculated, and the subsectional discharges are summed to derive a total stream discharge.

The figure below displays the mid-section method for dividing the stream cross-sectional area into subsections. The distance "b_n" is the width of the wetted channel. The distance, "b," represents the distance from the initial point ("O") to the location of the first depth and velocity measurements. The dotted lines indicate the vertical boundaries of each subsection, with the measured depth and velocity of each subsection occurring along the midline of the subsection.



The best place to measure discharge is where laminar flow dominates and the flow is perpendicular to the cross-section. These conditions exist in gravel dominated riffles or pool tail outs. Seek a cross section with where smaller subtrates dominate (cobble or finer) and turbulence is minimized.

Water in a channel flows at different rates depending on its location, so the area of the cross-section is divided into subsections, with one or more measurements taken for each. At least 25-30 subsections are needed for most channels, and no more than 5% of the total dicharge (Q) should pass throught any subsections in each. Use more subsections for broad or structurally complex cross-sections.

For computing area, the mid-section method (see figure above) uses the vertical line of each measurement as the centerline of a rectangular subsection; boundaries fall halfway between the centerlines. Discharge in the triangles at the water's edge, where the water is too shallow to allow a meter reading, are negligible in terms of total discharge.

Multiply the mean velocity for each subsection by the area of the subsection to compute the discharge (Q_n) for the subsection. Sum all subsection discharges to get the total discharge (Q) for the cross-section.

The field procedure is much like measuring elevations along the cross-section, except a current meter is used instead of a stadia rod. A two-person crew works best, one to operate the current meter and one to take notes. In high gradient or deep streams use appropriate safety precautions.

CURRENT METERS

Meters commonly used to measure current velocity include: Marsh-McBirney, Price AA, and Pygmy. Some brands have rotating cups, while others have a pair of electronic contacts on a small head. Older models read out revolutions of the cups by clicking or buzzing into a headset. Newer models have digital read-out.

Most current meters mount on a top-setting rod, which allows the current meter to be easily set to the correct depth. Top-setting rods are recommended for discharge measurement because they make the process simpler and quicker.

Examine the meter before going into the field, read the instuctions, do a spin test before each measurement, perhaps even test it in running water--using a nearby stream, irrigation ditch, or a garden hose aimed at the cups. Check the batteries and take spares. If you have more than one meter, compare results from the same point and calibrate as necessary. Calibrate your meters prior to the field season. Meter calibration services are available from the U.S. Geological Survey and universities.

PROCEDURE FOR CURRENT VELOCITY MEASUREMENT

1. Stretch a tape between the endpoints of your wetted channel cross-section and perpendicular to the flow. Divide the distance between the water's edges by 25 (at least) to set the interval for metering (e.g., the water surface is 22 feet across, $22 \div 25 =$ an interval of 0.88 feet, which can be rounded to 0.8 to ensure a minimum of 25 subsections). Use closer intervals for the deeper parts of the channel.

2. Start at the water's edge and call out the distance first, then the depth, then the velocity. Stand downstream from the current meter in a position that least affects the velocity of the water passing the meter. Hold the rod in a vertical position with the meter directly into the flow. Stand approximately 1 to 3 inches downstream from the tape and at least 18 inches from the meter.

3. To take a reading, the meter must be completely under water, facing into the current, and free of interference. The meter may be adjusted slightly up or downstream to avoid boulders, snags and other obstructions. The observer is also permitted to move cobble, boulders, or other obstructions to improve laminar flow at the meter. The recorder will call out the calculated distance for each velocity reading, however, the observer is free to change that distance (e.g., take velocity and depth readings at closer intervals through the thalweg).

- Take one or two velocity measurements at each subsection.
- If depth (d) is less than 2.5 feet, measure velocity (v) once for each subsection at 0.6 times the total depth (d) measured from the water surface (e.g., if d is 2 feet, measure at 1.2 feet from the water surface, or 0.8 feet above the bottom).
- If depth (d) is greater than 2.5 feet, measure velocity (v) twice, at 0.2 and 0.8 times the total depth (e.g., if d is 3 feet, measure at 0.6 ft. and 2.4 ft. from the water surface). The average of these two readings (+) is the velocity for the subsection.
- Allow enough time for each reading--a minimum of 40 seconds for most meters. The observer calls out the distance, then the depth, and then the velocity. The note taker repeats it back as it is recorded, as a check. Readings from some meters are simply a count of revolutions by the meter and must be converted by the note taker, while others read out digitally in feet-per-second.

4. The recorder will calculate the partial stream discharge for each subsection, and finally sum all of the subsectional discharges to determine the total discharge of the stream. If any of the subsections has a discharge greater than 5% of the stream's total discharge, the "problem" subsections will be further divided into smaller subsections such that noe of these smaller partitions will exceed the 5% limit.

5. The observer will measure new depths and velocities at the midline of each of these smaller subsections. The recorder wil calculate the partial stream discharge in each of the samll subsections and sum these values. This new sum will replace the sum of discharges for all original subsections carrying more than 5% of the total stram discharge, and a new stream discharge will then be calculated.

COMPUTING DISCHARGE

When the velocity measurment is complete, calculate the total discharge (Q). Determining total discharge accurately is a complex issue, and a varity of methods and equations exist. The mid-section method is currently recommended by the U.S. Geological Survey.

The following formula defines the basic method for calculating discharge:

$$Q = \sum (a\ v)$$

Where Q is the total discharge, a is the area of a rectangular subsection, the product of width (w) and depth (d) for that subsection, and v is the mean velocity of the current in a subsection.

1. Using the mid-section method, compute the area (a_n) of each subsection:

$$a_n = d_n \frac{b(n+1) - b(n-1)}{2}$$

Where b is distance along the tape from the initial point. "Lost" discharge in the triangular areas at the edges is assumed to be negligible.

2. Next, multiply the subsectional area (a_n) by the mean velocity (v_n) for the subsection to get the subsection discharge (Q_n). If only one velocity measurement was taken at 0.6 depth, it is the mean velocity (v_n). If two measurements (v_1 and v_2) were taken at 0.2 and 0.8 depth, compute the mean value as:

$$v_n = \frac{v_1 + v_2}{2}$$

3. To compute the discharge for each subsection, use the equation:

$$Q_n = a_n v_n$$

Where:

Q_n= discharge for subsection n,
a_n= area of subsection n, and
v_n= mean velocity for subsection n.

The calculation is repeated for each subsection, as shown below:

$$Q_1=a_1 v_1, Q_2=a_2 v_2, Q_3=a_3 v_3, \text{ and so on...}$$

4. The subsection products are then added to get total discharge (Q):

$$Q = Q_1 + Q_2 + Q_3 + Q_4 + Q_5 \text{ and so on...}$$

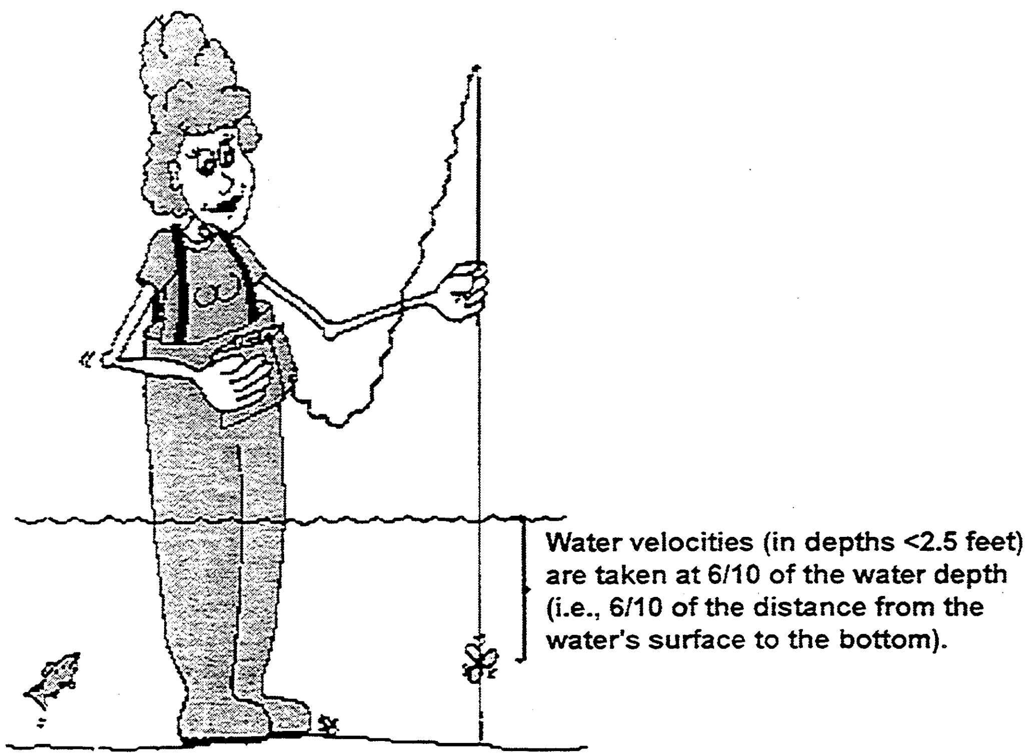
Thus, total discharge (Q) equals the sum of all subsectional discharges ($\sum (a\ v)$), as stated earlier in the basic equation:

$$Q = \sum (a\ v).$$

If you have any questions about this computation, draw a hypothetical cross-section, assign current velocities (from 0 to 5 feet per second) to each vertical, midline, and work out a sample discharge before going to the field. Field crew members should understand this procedure and be able to compute sample discharges before field work begins.

Reference: Harrelson, C.C, C.L. Rawlins and J.P. Potgondy, Stream Channel Reference Sites: An Illustrated Guide to Field Techinique, General Technical Report RM-245, USDA Forest Service, Rocky Mountain Forest and Range Experiemnt Station, Fort Collins, Co. 1994.

Figure 16: Water velocities are measured at 6/10 of the water column depth



STREAM HABITAT DATA FORM E
R6-2500/2600-31

Page: ____ of ____

A. State __________ B. County __________ C. Forest __________ D. District __________

E. Stream Name ____

F. Watershed Code ___, ___, ___, ___ NFS ___,___,___,_____.______,______.____,____.____

G. USGS Quad ____

H. Survey Date ____-_____-____ I. Observer/Recorder __________________________

DD-MM-YY

J. Meter Type _______________

K. Remarks ____

____

Distance from initial point (ft)	Width (ft)	Depth (ft)	Observation Depth (ft)	Revolutions	Time in Seconds	Velocity at point (ft/sec)	Velocity Mean in Vertical (ft/sec)	Area (ft^2)	Discharge (cfs)

WOLMAN PEBBLE COUNT METHODOLOGY

PROCEDURE: The Wolman pebble count will be performed two times in each stream reach identified during the level I (office phase) inventory and delineated on a map. The pebble count will be completed at 1/3 and 2/3's of the total reach length, and in a measured (nth) riffle. The transects are usually places at or near where the bankfull width and floodprone width were measured. Avoid areas influenced by backwater at bankfull or less stage.

Several different schemes can be adapted to meet the 100 point sampling value. One transect of 100 points can be selected, or 2 transects of 50 points, or any combination that is linear and equates to 100 samples or greater. It is OK to have an excess of 100 samples, but avoid having less than 100. The transects must run from bankfull to bankfull perpendicular to the flow; do not limit the sampling to the wetted channel!

The pebble count technique (Wolman 1954) has long been used by geomorphologists, hydrologists, and river engineers to characterize rivers which flow on coarse material and are wadable during low flows. The procedure has recently been recognized by fishery biologists as a better alternative to characterize substrate than the visual estimation techniques commonly used in fisheries and instream flow studies. In addition, pebble counts are used on many National Forests as monitoring tools to evaluate entry of fine sediment into streams.

THE PEBBLE COUNT TECHNIQUE

A pebble count consists of a random selection of at least 100 particles from the streambed. Individual pebbles can be selected from a grid system, but more commonly pebbles are selected from the toe of the boot along a toe-to-heel transect which traverses the stream from bankfull to bankfull stage. The intermediate axis of each pebble, defined as neither the longest nor the shortest of three mutually perpendicular axes of a particle, is measured. The intermediate axis can be visualized as that dimension of the pebble which controls whether or not it would pass through a soil sieve.

The greatest source of bias in pebble counting is associated with the manner in which observers pick up particles. The natural tendency is to select larger rocks. To avoid this, observers will need to consistently use a fixed reference point, such as a mark on the tip of a boot, and a fixed point on the tip of the finger that descends into the water to select the particle for measurement. The first particle touched by the tip of the finger will be measured. Because the technique requires physically picking up particles, it is commonly limited to wadable streams.

Pebbles down to 2mm in size (very coarse sand) will be directly measured and tallied in the appropriate size class. Sand, silt, and clay particles will be tallied as "less than 2 mm".

The number of pebbles in each size class will be tabulated and converted into percentages. Data will be plotted as a cumulative size distribution curve. "Cumulative percent finer" will be plotted on the y-axis, and "particle size" expressed as the upper limit of each size range will be plotted on the x-axis. "Particle size" classes and cumulative percent finer vs. size are shown on Form F.

The frequency distribution represents the percent of the stream bed covered by particles of a certain size since each pebble represents a portion of the bed surface. Results are theoretically equivalent to size distributions obtained from bulk samples.

For monitoring purposes, a selected site is often measured for several years. Generally, individuals are interested in measuring changes to surface fines due to management activities such as timber harvest, fire, or road construction. It is widely accepted that an increase in fines in stream channels is detrimental to fisheries.

The entire width of the bankfull channel is investigated, and the rocky particles of the streambed are grouped by their size. A frequency distribution by size class is graphed, and the resultant curve is used to make inferences about channel dynamics. During bankfull flows, it is expected that all particles smaller than the median value (D_{50}) displayed on the curve wil be mobile, and this same value further refines the Rosgen channel type for that reach. In a similar sense, particles larger than the 84th percentile (D_{84}) will comprise the immobile portion of the streambed during bankfull discharge.

References:

King, R, Potyandj, J. Statistically Testing Wolman Pebble Counts: Changes in Percent Fines! Stream Notes, USDA Forest Service 1993.

Rosgen, D.L. A Classification of Natural Rivers - Catena. ***Month? Pages?***

Wolman, M.G. 1954. A method of sampling coarse river-bed material. Transactiions of the American Geophysical Union 35(6): 951-956.

STREAM HABITAT DATA FORM F
R6-2500/2600-

Page: ____ of ____

A. State _________ B. County _________ C. Forest __________ D. District _______

E. Stream Name ____.

Watershed Code ___, ___, ___, ___ NFS ___,____.____,____.____,____.____,____.____

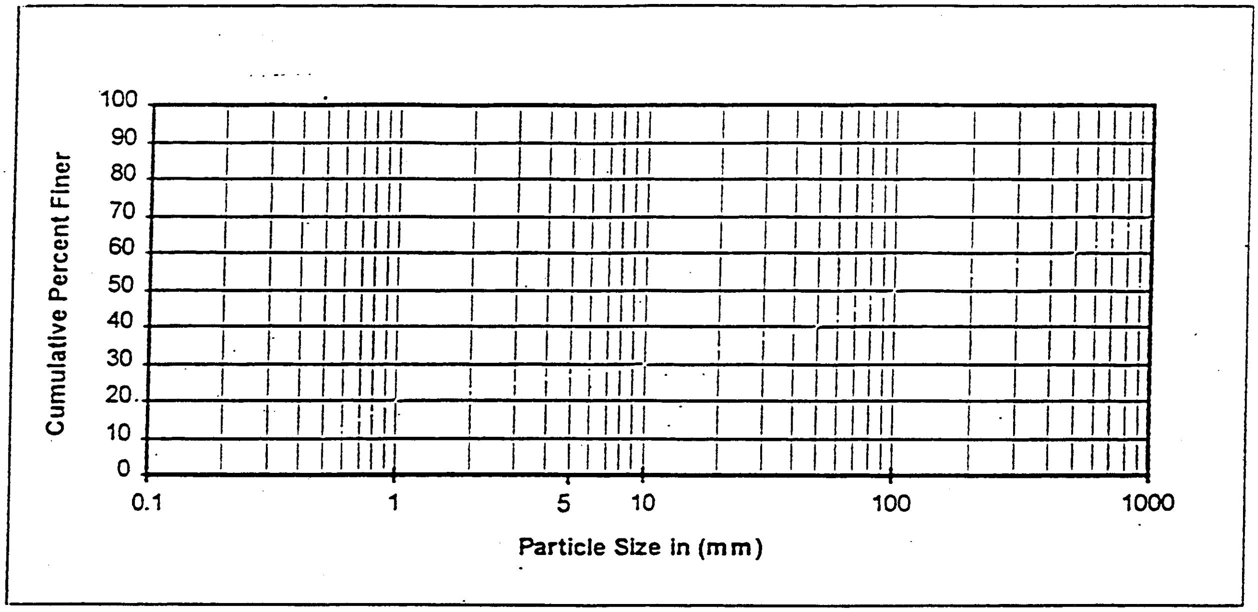
G. USGS Quad ____

H. Survey Date ____-______-____ I. Name ______________________________

DD-MMM-YY

PEBBLE COUNT	
Stream Name:	Survey Date:
NSO #:	# of Transects:
Party:	Reach:

Inches	PARTICLE	Millimeters		Particle Count	TOT AL #	ITEM %	% CUM
<.08	≤ Sand	< 2	S/C/S				
.08 -.16	Very Fine	2 -4					
.16 - .24	Fine	4 -6	G				
.24 - .31	Fine	6 - 8	R				
.31 - .47	Medium	8 -12	A				
.47 - .63	Medium	12 - 16	V				
.63 - .94	Coarse	16 -24	E				
.94 - 1.26	Coarse	24 - 32	L				
1.26 - 1.9	Vry Coarse	32 - 48	S				
1.9 -2.5	Vry Coarse	48 - 64					
2.5 - 3.8	Small	64 - 96	C				
3.8 - 5.0	Small	96 - 128	O				
5.0 - 7.6	Large	128 - 192	B				
7.6 - 10	Large	192 - 256	L				
10 - 15	Small	256 - 384	B				
15 - 20	Small	384 - 512	L				
20 - 40	Medium	512 - 1024	D				
40 - 80	Large	1024 -2048	R				
80 - 160	Vry Large	2048 -4096	S				
	Bedrock						
				Totals:			
Total Tally:							


Cumulative Percent Finer
100
90
80
70
60
50
40
30
20
10
0
0.1
1
5
10
100
1000
Particle Size in (mm)

APPENDIX A

Watershed Codes

Nationally, the US Geological Survey and the Water Resources Council have established a coordinated watershed delineation and coding system which is referred to as the Hydrologic Unit Codes (HUC). This system is hierarchical and is comprised of Region, Subregion, Accounting Unit, and Cataloging Unit. The Accounting Unit is generally referred to as a river basin and the Cataloging Unit is usually known as a subbasin. An example of this type of coding is:

Region	Pacific Northwest	17
Subregion	Upper Columbia River	1707
Accounting Unit	Deschutes River Basin	170703
Cataloging Unit	Upper Deschutes River Subbasin	17070301

The Forest Service has added an additional 2 levels of finer resolution to the HUC coding system to define specific watersheds within a Forest. The structure for these two fields (watershed and subwatershed) is displayed below.

Watershed	Tumalo Creek	17070301 02
Subwatershed	Bridge Creek	17070301 02A

Watersheds can be divided into a maximum of 25 subwatersheds denoted by a letter of the alphabet. The letter "O" cannot be used to designate a subwatershed because of the potential to mistake it for zero. All districts should have a good quality watershed map showing the location of all watersheds and subwatersheds.

The Region 7 Standardized Stream Survey Methodology has adopted additional criteria to specifically identify every stream and tributary within a subwatershed.

Under NFS code on Form A there are up to four entries for stream mile measurements to identify the specific stream within the NFS watershed (2 digit code) and subwatershed (1 letter code). These four entries (each 4 characters long) are used to record measured stream miles upstream of the confluence with the next highest (hierarchical order) stream. **ALL MILEAGES UNDER THE NFS CODE SHOULD START AT THE MOUTH OF THE MAINSTEM WHICH FORMS THE NFS SUBWATERSHEDS AND PROCEED UPSTREAM UNTIL THE SPECIFIC SURVEYED TRIBUTARY IS REACHED.**

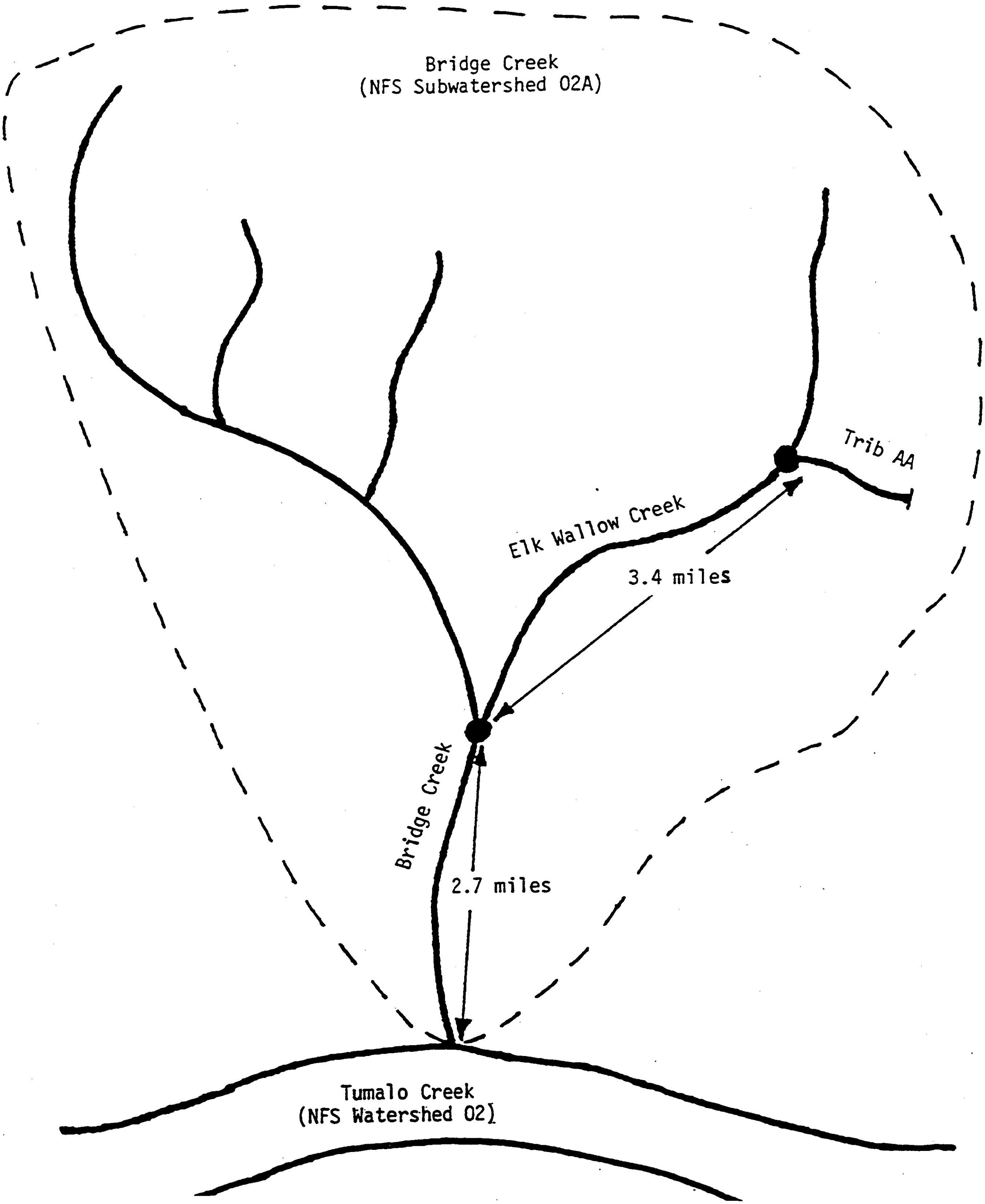
As an example, Tributary AA is a stream to be surveyed. This unnamed tributary flows into Elk Wallow Creek at river mile 3.4, which then flows into Bridge Creek at river mile 2.7 (refer to diagram). The four fields must have 4 digits (2 before and two after the decimal) in order for the program to accept them during data entry. Using the above river mileages, stream delineation coding would look something like this:

17070301,	02,	A,	02.70,	03.40,	____,	____
HUC code	Water-shed code	Sub-basin code	River miles			

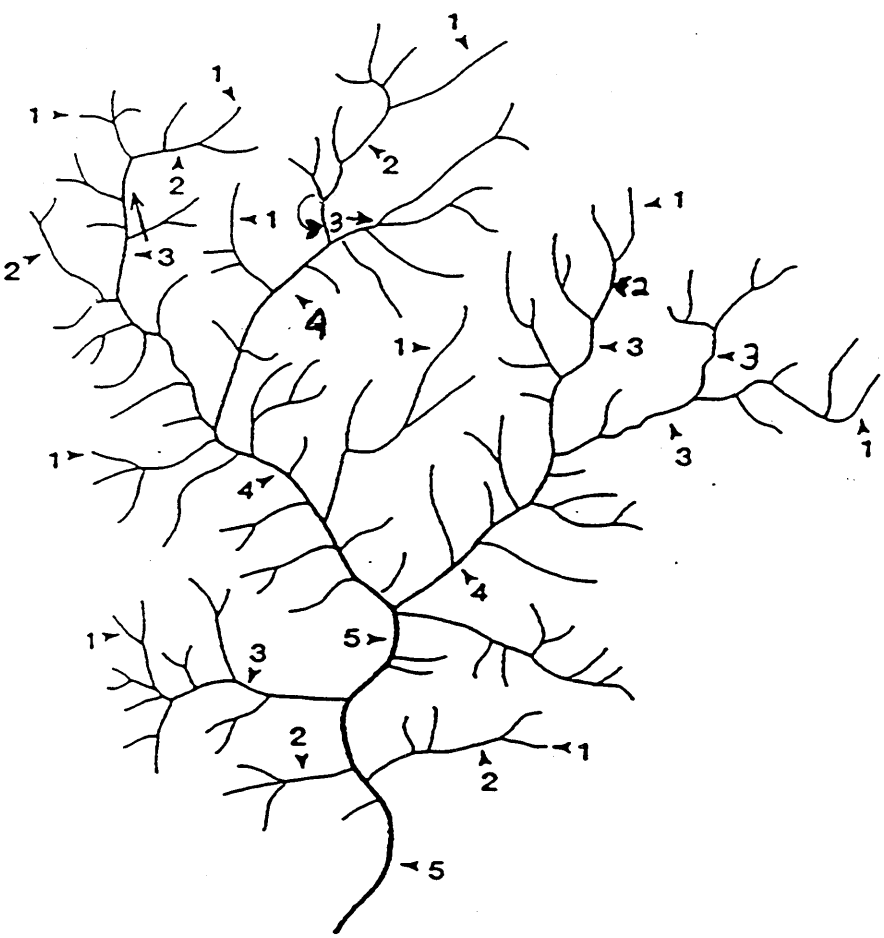
This procedure can be taken an additional two steps to further delineate other tributaries. These mileage measurements designate nodal points at confluences of streams.

To ease clarification, the tributary that has the greatest length from the mainstem confluence to the headwaters will be considered as the mainstem.

In cases where the mouth of the mainstem is an estuary or lake, estimate the stream mileages for tributary junctions along your best guess of what would be the main channel (based on topographical features).


Bridge Creek
(NFS Subwatershed 02A)
Trib AA
Elk Wallow Creek
3.4 miles
Bridge Creek
2.7 miles
Tumalo Creek
(NFS Watershed 02)

APPENDIX B



STREAM ORDERS

USE 1:24,000 SCALE TOPO MAP – COUNT BLUE LINES ONLY

Stream order: The designations (1, 2, 3, etc.) of the relative position of stream segments in a drainage basin network: the smallest, unbranched, intermittent tributaries, terminating at an outer point, are designated order 1; the junction of two first-order streams produces a stream segment of order 2; the junction of two second-order streams produces a stream segment of order 3, etc. Use of small-scale maps (<2"/mile) may cause smaller streams to be overlooked, leading to gross errors in designation. Ideally designation should be determined on the ground or from large-scale air photos.

APPENDIX C

ABBREVIATIONS FOR FISHES IN OREGON AND WASHINGTON

Use the following 4 digit code for describing the fish identified on the Forest. Note the first 2 alpha characters are the first 2 letters of the genus, and the second 2 alpha characters are the first 2 letters of the species. For the Forest index, please note the common name for the species. Below is a partial list of game species; be sure to identify non-game species on your Forest.

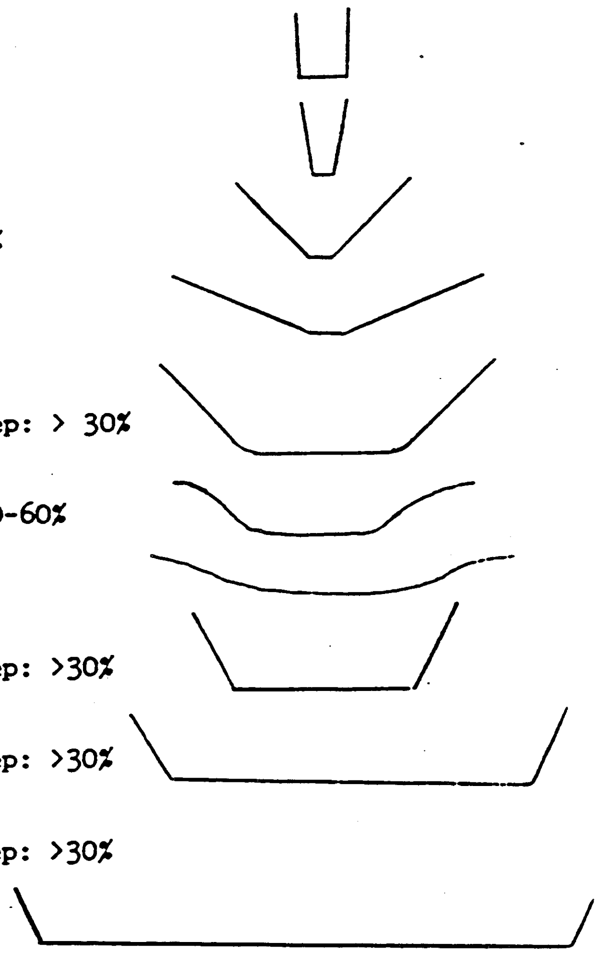
CODE	GENUS AND SPECIES	COMMON NAME
Onne	Oncorhynchus nerka	sockeye salmon
Onts	Oncorhynchus tshawytscha	chinook salmon
Onke	Oncorhynchus keta	chum salmon
Ongo	Oncorhynchus gorbushcha	pink salmon
Onki	Oncorhynchus kisutch	coho salmon
Onmy	Oncorhynchus mykiss	steelhead, rainbow, redbank
Oncl	Oncorhynchus clarki	cutthroat trout
Satr	Salmo trutta	brown trout
Saco	Salvelinus confluentus	bull trout
Safo	Salvelinus fontinalis	brook trout
Prwi	Prosopium williamsoni	mountain whitefish

APPENDIX D
(Forest Option)

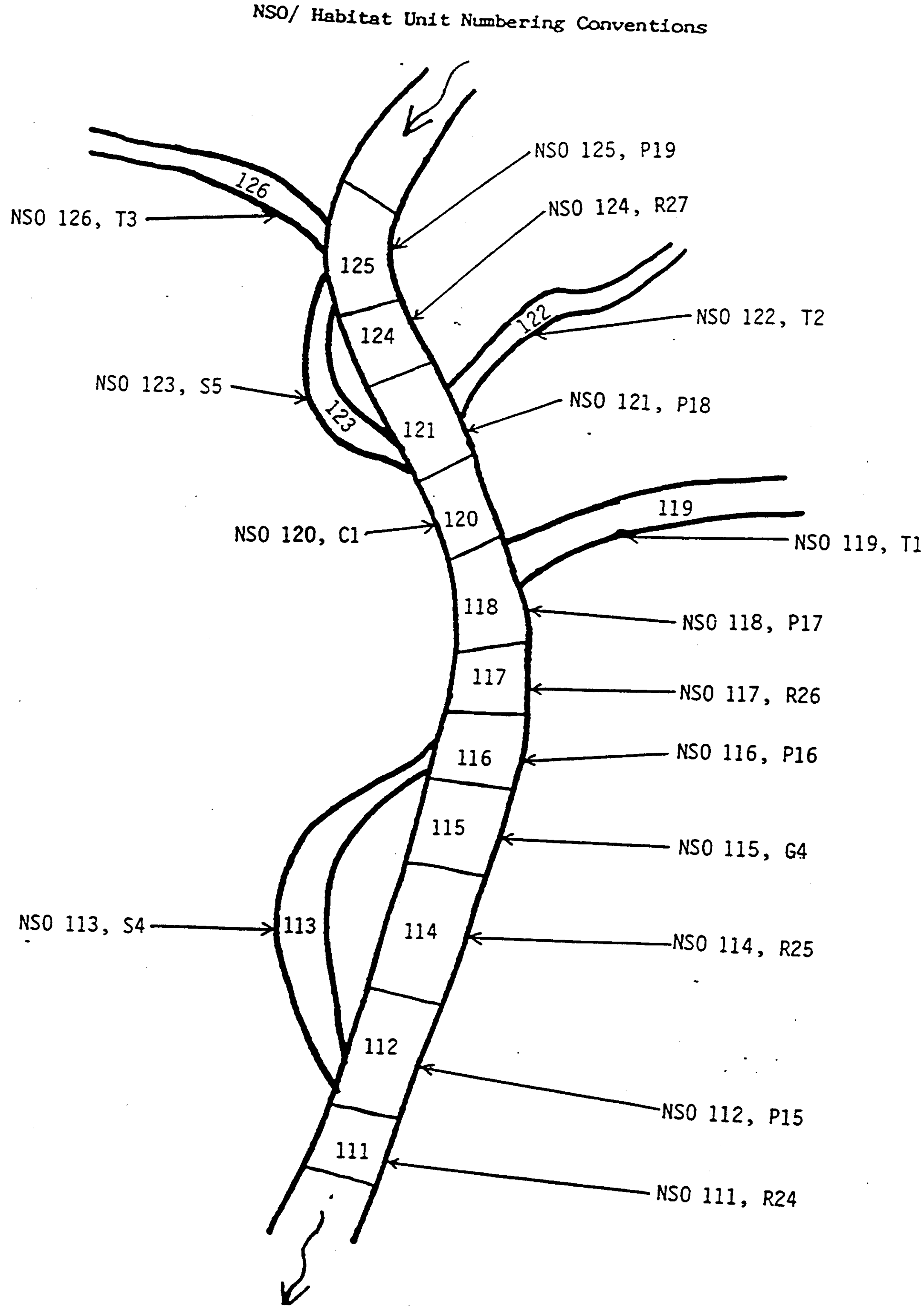
VALLEY FORM CODES

Code	Type	Side Slope
1 =	Box-like canyon	Steep: > 60%
2 =	Narrow V-shaped floor width < 100 ft.	Steep: > 60%
3 =	Moderate V-shaped floor width < 100 ft.	Moderate: 30-60%
4 =	Low V-shaped floor width < 100 ft.	Low: < 30%
5 =	U-shaped floor width > 100 ft.	Moderate to steep: > 30%
6 =	Through-like open short slope lengths	> 30%, mostly 30-60%
7 =	Broad, trough-like	Low: < 30%
8 =	Narrow flat-floored floor width 100-300 ft.	Moderate to steep: >30%
9 =	Moderate flat-floored floor width 300-600 ft.	Moderate to steep: >30%
10=	Wide flat-floored floor width > 600 ft.	Moderate to steep: >30%

ILLUSTRATION

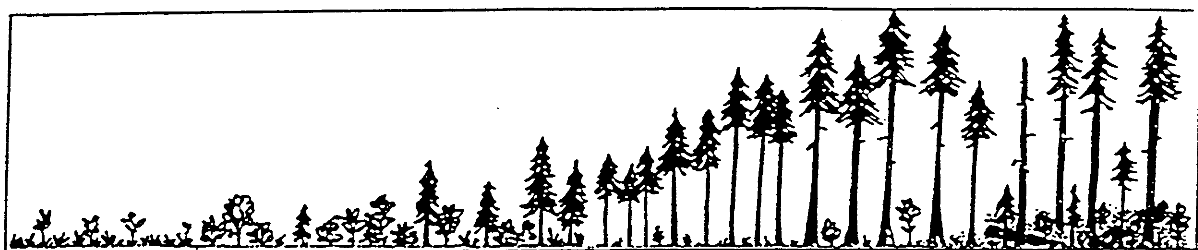


APPENDIX E


NSO/ Habitat Unit Numbering Conventions
NSO 125, P19
NSO 124, R27
NSO 126, T3
126
125
124
NSO 122, T2
122
NSO 123, S5
123
121
NSO 121, P18
119
120
NSO 120, C1
NSO 119, T1
118
NSO 118, P17
117
NSO 117, R26
116
NSO 116, P16
115
NSO 115, G4
NSO 113, S4
113
114
NSO 114, R25
112
NSO 112, P15
111
NSO 111, R24

APPENDIX F

SUCCESSIONAL CLASS CODES FOR RIPARIAN VEGETATION



Grass/Forb	Shrub/ Seedlings	Pole/Sapling	Small Trees	Large Sawtimber, Large Trees	Old-growth
Approximate stand age (years)					
0	5	15	30	80	200 – 700
	Height Class 1: < 2' 2: 2'-5' 3: 5'-10' 4: > 10'	Size: < 8"	Size: 8"-20.9"	Size: 21"-32"	Size > 32"
GF	SS	SP	ST	LT	MT

Code:

NV = NO VEGETATION.

GF = Grass/Forb Condition:
The grass-forb stand condition lasts 2-5 years and occasionally as long as 10 years. Shrubs and some trees that sprout are not yet dominant.

SS = Shrub/Seedling Condition:
The shrub stand condition often lasts 3-10 years but may remain for 20-30 years if tree generation is delayed. Tree regeneration may be common, but trees are generally less than 10 feet tall and provide less than 30 percent of crown cover.

SP = Sapling, Pole Condition:
The open sapling-pole condition occurs when trees exceed 10 feet in height and are less than 8 inches in dbh.

ST = Small Tree Condition:
The pole condition has very little ground vegetation because of closed crown canopy. Average stand d.b.h. is 8 inches to 20.9 inches.

LT = Mature Stand Condition:
The mature condition is characterized by trees with and average d.b.h. of 21 inches to 32 inches d.b.h.

MT = Old-growth Condition:
Old-growth stand conditions are characterized by decadence of live trees, snags, down woody material, and replacement of some of the long-lived pioneer species such as Douglas-fir by climax species such as western hemlock. Stands often have two or more layers with large diameter overstory trees commonly older than 200 years. Size is generally greater than 32 inches in d.b.h.

APPENDIX G

Aquatic Habitat Inventory Glossary

Cover: Anything that provides protection from predators or ameliorates adverse conditions of streamflow and/or seasonal changes in metabolic costs. May be instream cover, turbulence, and/or overhead cover, and may be for the purposes of escape, feeding, hiding, or resting. For use in Stream Inventory, count turbulence cover as only that area of turbulence; overhead cover must be within 10 inches of the surface.

Embeddedness: The degree that larger particles (boulders, rubble, or gravel) are surrounded or covered by fine sediment.

Glide: A portion of stream flowing smoothly and gently, with moderately low velocities (10-20cm/sec), and little or no surface turbulence. The longitudinal profile of the feature will be level, or slightly sloped downstream. No hydraulic control present.

Hydraulic Control: The top of an obstruction to which stream flow must rise before passing over, or a point in the stream where the flow is constricted. Examples are bedrock outcrops, gravel bars, log weirs, or dams.

Pool: A portion of the stream which has reduced current velocity and is generally deeper than the surrounding areas. May at times contain surface turbulence, but always has a hydraulic control present across the full width of the channel on the downstream end.

Reach: A relatively homogenous section of stream having a repetitious sequence of habitat types and relatively uniform physical characteristics such as slope, depth, substrate, and bank cover.

Riffle: A portion of the stream with increased current velocity where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation. For purposes of the level II survey, riffles are an inclusive term for riffles, rapids, and cascades.

Riparian Area: The area between a stream or other body of water and the adjacent upland identified by soil characteristics and distinctive vegetation. It includes wetlands and those portions of flood plains and valley bottoms that support riparian vegetation.

<u>Riparian Vegetation:</u> Vegetation growing on or near banks of a stream or body of water on soils that exhibit some wetness characteristics during some portion of the growing season.

<u>Side Channel:</u> Lateral channel with an axis of flow roughly parallel to the mainstem and which is fed by water from mainstem; a braid of river with flow appreciably lower than the main channel, or in poorly defined watercourses flowing through partially submerged gravel bars and islands along the margins of the mainstem.

<u>Sinuosity:</u> (a) The ratio of channel length between two points on a channel to the straight distance between the same two points. (b) The ratio of channel length to valley length. Channels with sinuosities of 1.5 or more are called meandering.

<u>Stream Order:</u> See accompanying Appendix B for illustration.

<u>Stream Bank:</u> The portion of the channel cross section that restricts lateral movement of water at normal water levels. The bank often has a gradient steeper than 45 degrees and exhibits a distinct break in slope from the stream bottom. An obvious change in substrate may be a reliable delineation of the bank.

> Lower Bank: The periodically submerged portion of the channel cross section from the water's edge during the summer low flow period to the normal high water line.
>
> Upper Bank: That portion of the topographic cross section from the normal high water line to the break in the general slope of the surrounding land.

<u>Turbulence:</u> The motion of water where local velocities fluctuate and the direction of flow changes abruptly and frequently at any particular location, resulting in disruption of laminar flow. It causes surface disturbance and uneven surface level, and often masks subsurface areas because air bubbles are entrained in the water.