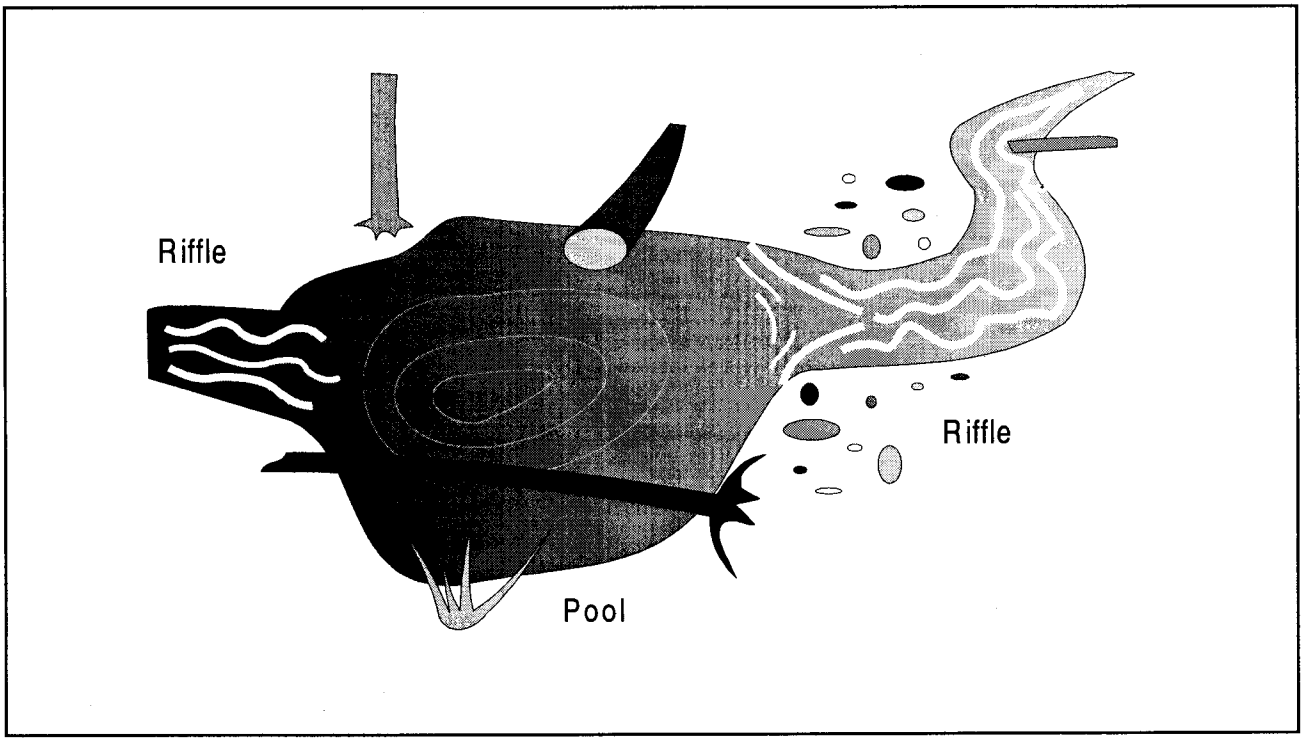
TFW Monitoring Program

METHOD MANUAL

for the

HABITAT UNIT SURVEY



by:
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NW Indian Fisheries Commission

Timber Fish & Wildlife

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Abstract

The TFW Monitoring Program method manual for the Habitat Unit Survey provides a standard method for assessing and monitoring the quantity and quality of habitat in wadable streams. The core Habitat Unit Survey collects information on the frequency and distribution of riffle and pool habitat units. Quantitative criteria are used to distinguish and identify habitat units to ensure consistency between observers. The unit's channel location is identified as either primary, secondary, side, or tributary channel. Wetland, sub-surface flow, and obscured unit types are also used to characterize portions of the stream that are either flowing through wetland systems, have gone subsurface, or cannot be identified because visibility is obscured. Additional information is collected on the maximum and outlet depths of pools, and on features associated with pool formation. Guidance is provided for optional collection of sub-unit habitat types. The TFW Monitoring Program database accepts data collected using the Habitat Unit Survey method, performs standard calculations, and generates data summary reports of habitat unit data at 100 meter and stream segment scales.

The remainder of the introduction section describes the purpose of the Habitat Unit Survey, reviews scientific background information, and describes the cooperator services provided by the TFW Monitoring Program. Following the introduction, sections are presented in order of survey application including: study design, pre-survey preparation, methods, post-survey documentation, data management, and references. An extensive appendix is also provided that includes: copy masters of field forms; examples of completed field forms; a field code sheet; a standard field and vehicle gear checklist; and data management examples.

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Manual cover, method illustrations, and layout by Allen Pleus unless otherwise noted.

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Copying of the Method Manual

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Habitat Unit Survey

1. Introduction

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1.1 Purpose

The Timber-Fish-Wildlife Monitoring Program (TFW-MP) provides standard methods for monitoring changes and trends in stream channel morphology and habitat characteristics. The Habitat Unit Survey method has been approved by TFW's Cooperative Monitoring, Evaluation and Research Committee (CMER) and is accepted as a standard method for monitoring on forest lands in Washington state by tribal governments, state natural resource agencies, timber companies, environmental organizations, and others. The purpose of the Habitat Unit Survey method is to:

1. Provide a means of accurately characterizing the current status of stream habitat at a level of precision and detail suitable for use as a foundation for monitoring.

2. Provide an accurate methodology that can be repeated over time to document changes and trends in habitat unit frequency and abundance.

3. Provide information on the percentage of pools suitable for use as a resource condition index in the Watershed Analysis cumulative effects assessment procedure.

1.2 Background

This section provides a review of the scientific literature used as the basis for the Habitat Unit Survey. Background information includes the relationship between channel morphology, land use, and salmonid habitat.

Hydraulic conditions such as water depth and velocity vary within stream channels. This variation often occurs in somewhat orderly patterns with distinct, alternating areas of deeper/slower water (pools) and shallower/faster water (riffles). These distinct areas are referred to as "habitat units."

Various species and life history stages of aquatic organisms have adapted to the rigors and opportunities presented by particular hydraulic and channel conditions. Consequently, they are more likely to be found in particular habitat units (Bisson et al., 1982). The type and amount of habitat units present in a stream reach can be used as an indicator of its suitability for a particular species or life history stage.

Intrinsic factors such as stream size, gradient and confinement influence the type and relative abundance of habitat units found in a particular reach (Beechie and Sibley, 1990). In addition, the relative abundance and characteristics of various habitat units responds to changes in local- and watershed-scale processes that determine sediment supply, runoff during storm events and recruitment of large woody debris. These processes and their inputs may be altered by human activities such as forest practices and by changing natural conditions.

Because the utilization of instream habitat varies by species, life history stage and physiographic region, no single habitat survey methodology can accurately characterize habitat conditions for all salmonids throughout the State of Washington. Instead, the habitat unit survey focuses on partitioning streams into basic morphological features. The intent of the survey is to characterize current morphological conditions, and to monitor changes in the size and frequency of these units in response to changing inputs of sediment, discharge and large woody debris associated with natural or management-induced disturbance and recovery.

1.3 Cooperator Services

The TFW Monitoring Program provides a comprehensive suite of services to support TFW cooperators collecting data consistent with program goals. Services include study design assistance, pre-season training through annual workshops and on-site visits, pre-season quality assurance reviews, data entry systems, summary reports of monitoring results, and database/data archiving services. These services are offered free of charge. TFW method manuals are available for the following surveys:

- Stream Segment Identification
- Reference Point Survey
- Habitat Unit Survey
- Large Woody Debris Survey
- Stream Temperature Survey
- Spawning Gravel Composition Survey
- Spawning Habitat Availability Survey
- Spawning Gravel Scour Survey
- Wadable Stream Discharge Meas. Method

To find out more about TFW Monitoring Program services and products, contact us or visit our link on the NWIFC homepage. The address is:

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2. Study Design

A well designed monitoring study identifies changes in channel characteristics over time due to land management or natural disturbances. Poorly designed studies detect changes that are the result of differences in crew method application or changes in sampling location. Effective monitoring study designs require rigorous planning, documentation, and consistency in methods, method application, and data analysis. This ensures that the monitoring data produced meets the objectives of the project and monitoring plan.

Developing a study design involves the identification of monitoring segments, timing of surveys, reviewing survey modification and additional parameter options, and planning for pre-season crew training and quality assurance reviews.

2.1 Identifying Monitoring Segments

The Habitat Unit Survey uses the TFW stream segment as the fundamental unit of analysis for characterizing habitat abundance and characteristics. A basic step in study design development is identifying a group of candidate segments from which to select suitable monitoring segments or sub-segments.

The TFW method identifies stream segments based on gradient, valley confinement, and flow. A USGS 7.5 minute topographic map (photocopy worksheet) with delineated segments is required for this part of the study design development. Many streams have already been segmented through past TFW monitoring projects, Watershed Analysis processes, and the Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP). If the stream has not been pre-segmented, or pre-segmented boundaries are not suitable for your monitoring plan, partition the river system into stream segments or sub-segments using the TFW Monitoring Stream Segment Identification method (Pleus and Schuett-Hames, 1998a) before continuing. Segment data documented on Form 1 and USGS topographic maps are required for data tracking and to provide important information for identifying segment boundary locations and access points.

Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP)

Contact:

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Northwest Indian Fisheries Commission
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Olympia, WA 98516
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e-mail: mcintos@nwifc.wa.gov

2.2 Channel Length and Width and the TFW Reference Point Survey

Information on mean segment bankfull width and survey reach length are required to calculate habitat parameters such as number and types of units per channel width and kilometer. This information is automatically provided were the TFW Reference Point Survey has been conducted (Pleus and Schuett-Hames, 1998b). Reference points are also used for associating pieces and jams with 100 meter reaches, and for analysis of their frequency and distribution within the segment in the data summary by reference point report. If no reference point survey is done, data analysis is limited to segment mean characteristics.

2.3 Timing of Surveys

The ideal time to sample is during the late summer/ early fall low flow period when discharge conditions are most stable in non-glacial streams. Sampling should be conducted during moderate to low flow conditions so repeat surveys can be conducted at similar discharges and the data can be used to compare stream reaches and determine trends over time. Surveys can be conducted at higher flows and linked to repeat surveys at similar discharge measurements. However, higher flows generally increase data variability because of decreased visibility and access due to turbidity, turbulence, and water depth. If you are unfamiliar with the hydrologic regime of the stream to be sampled, consult with people familiar with the system or refer to USGS streamflow

records to determine an appropriate sampling period. However, avoid working in the channel during the spawning season or when there are eggs in the gravel to prevent unnecessary disturbance and mortality to salmonid populations.

2.4 Survey Modification Options

Data collected using the Habitat Unit Survey methods are supported by the TFW-MP database and are used to produce standard data analysis summary reports. Data collected using these methods can be compared with other data collected using the same methods from around the state. Modifying the Habitat Unit Survey to collect data on additional parameters that meet individual cooperator needs is acceptable if it does not compromise the integrity of the core parameters. Survey modifications are defined as any change to the core criteria and methods as documented in the latest version of the TFW method manual. In other words, data collected using the modified method would not be comparable at some level with data collected using the methods and criteria as stated in the manual. Analysis of modified data is the responsibility of the cooperator. Contact the TFW Monitoring Program for assistance in modifying the methods to ensure data integrity and compatibility.

There are two levels at which modification documentation is important. The first is to qualify data collected on the field forms and the second is to qualify data entered into the TFW database. Documentation in the *Survey Criteria* and/or *Survey Notes* sections of Form 3.0 allows accurate interpretation of the field data from Form 3.1. It is feasible to have the field forms flagged as modified, but not the database where core data has been extracted by the cooperator before data entry. Documentation of modification in the database allows accurate interpretation of affected parameters and calculations on summary reports. However, in most situations modified data cannot be entered into the database due to validation checks.

Identification of sub-unit habitat types is one of the most common modifications that cooperators apply. The choice of system used to classify sub-unit types is at the discretion of the cooperator. However, experience and research confirm that there is a positive correlation between increasing the number of unit types and increasing crew variability. Therefore, it is recommended that cooperators select the minimum number of sub-unit types required for their study design and identify the system used on the field forms.

The field forms provided in the manuals have been designed for consistent and accurate recording of Habitat Unit Survey data. The forms have been refined based on research and monitoring experience to reduce data errors caused by factors such as legibility, required parameter field calculations, and data transfer during database entry. The field forms have been designed to accommodate the collection of additional parameter data, thus limiting the necessity of cooperators to modify or create new forms.

2.5 Pre-Season Crew Training and Quality Assurance Review

Cooperators are strongly encouraged call the TFW Monitoring Program to make appointments for pre-season training and quality assurance (QA) reviews. This ensures that field crews are applying survey methods correctly from the start and the highest quality data is being collected throughout the survey. Training should be repeated annually to learn new methods, techniques, or simply refresh skills. QA reviews should be repeated seasonally to maintain documentation and to refresh survey skills.

3. Pre-Survey Preparation

This section describes what and how to gather, prepare, and pack for transportation all necessary survey equipment and materials required for field crews to complete the field portion of the Habitat Unit Survey. These lists are not intended to cover all possible survey equipment and materials that could be of use.

3.1 Survey Equipment

Acquire, check, and calibrate survey equipment well before the date the survey is scheduled to begin. The following list of survey equipment contains items necessary for crews to conduct the Habitat Unit Survey, but does not cover all possible equipment that could be of use. The necessary equipment includes:

Survey Equipment

- Measurement tape (30 to 50 m; accuracy ± 0.10 m)
- Measuring rod (5 to 7 m: accuracy ± 0.01 m)
- Weighted flags (6-12)
- Standard field and vehicle gear (Appendix D)

All measurements must be in metric units for entry into the TFW-MP database. If using English units, measurements must be converted to metric units before database entry. Mixing measurement unit types (metric/English) within a survey is strongly discouraged due to potential for multiple conversion errors. The cost of purchasing metric equipment is often offset by savings in personnel time and effort required to convert from English to metric units. It also results in the highest quality data due to avoidance of errors during conversion of large data sets.

Check all measurement equipment for damage before using. Calibrate all measurement equipment to a standard of known accuracy before and after the survey to ensure that the instruments provided accurate data during collection.

Select wading gear to accommodate stream and survey conditions. On most streams, having one crew with chest waders is important for taking measurements in the deeper parts of the channels. Having only knee or hip boots for a larger stream limits access and prevents accurate measurement of unit surface areas and residual pool depths. However, it is important to note that use of chest waders in fast flowing streams can be dangerous. Also consider future repeatability of each option. For example, data collected wading wet or swimming may not be comparable to data collected using knee or hip boots due to access limitations the next time the survey is done.

3.2 Survey Materials

Survey materials are those items necessary for crews to locate and document the stream segment and access points, site conditions, and for recording field data. This list does not cover all possible materials. The basic materials include:

Survey Materials

- USGS 7.5 minute topographic map worksheet
- Road map
- Copy of segment's Form 1.0 and 2H
- Copy of Habitat Forms 3.0 and 3.1 (Appendix A)
- Copy of Habitat Criteria and Code Field Sheet (Appendix C)

Start by gathering and organizing site access information and working on logistical factors. Obtain directions and maps; contact landowners and secure permission to access property; acquire necessary permits and passes; and determine if the access roads are gated and get gate keys or make necessary arrangements with landowner to open access. Next, begin the survey documentation by preparing and completing header and preliminary information on the field data forms. Refer to Appendix B for examples of completed field forms.

3.2.1 Habitat "HEADER INFORMATION" Form 3.0

One Form 3.0 is completed for each stream segment. Use the Form 3.0 copy master to make a copy on regular paper (Figure 1). Most header information can be copied directly from the segment's completed Form 1. Instruction on completing the "Study Design Information," "Discharge Information," and "Survey Notes" boxes will be covered in the "Post-Survey Documentation" section. The Water Resource Inventory Area number (WRIA #), unlisted tributary number (Unlisted Trib), segment number (Segment #), Sub-Segment Code, and Begin Survey Date are key fields used to identify unique monitoring segments for the TFW-MP database.

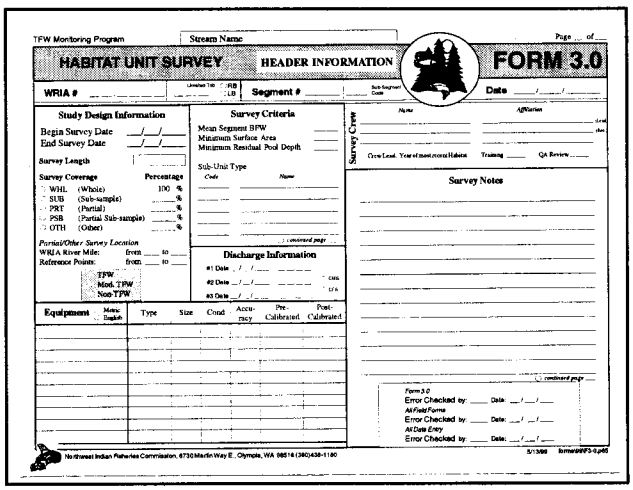
TFW Monitoring Program
Stream Name
HABITAT UNIT SURVEY
HEADER INFORMATION
FORM 3.0
WRIA #
Segment #
Date
Study Design Information
Begin Survey Date
End Survey Date
Survey Length
Survey Coverage
Percentage
WHL (Whole) 100 %
SUB (Sub-sample)
PRT (Partial)
PSB (Partial Sub-sample)
OTH (Other)
Survey Criteria
Mean Segment BFW
Minimum Surface Area
Minimum Residual Pool Depth
Sub-Unit Type
Code
Name
Survey Crew
Name
Affiliation
Crew Lead. Year of most recent Habitat
Training
QA Review
Survey Notes
Discharge Information
Equipment
Type
Size
Cond
Accuracy
Pre-Calibrated
Post-Calibrated
Error Checked by:
Date:
Northwest Indian Fisheries Commission, 6730 Martin Way E., Olympia, WA 98516 (360)438-1180

Figure 1. Habitat Survey "HEADER INFORMATION" Form 3.0.

Header Section

Stream Name: Record the WRIA-designated stream name. Use "Unnamed" where appropriate.

WRIA #: Record the six digit Water Resource Inventory Area (WRIA) number (00.0000).

Unlisted Trib: Only streams without assigned WRIA numbers require unlisted tributary numbers. For streams with WRIA numbers, fill this space with three zeros (000). For unlisted tributaries, record a three digit cooperator-designated unlisted tributary number (001 - 999) and mark the appropriate RB/LB circle.

Segment #: Record the one to three digit segment number (1 - 999).

Sub-Segment Code: If the survey reach is a sub-segment, record the number or letter character sub-segment code (1 - 99 or a - zz). Record a "0" if not a sub-segment.

Date: Enter the date the form is being filled-out.

Survey Crew Section

Record the names and affiliations of the lead, recorder, and other field crew involved in data collection for the survey. Affiliations correspond to employers such as a tribe, government agency, industry, environmental group, consulting company, etc. Record the most recent year that the lead crew person received official TFW Monitoring Program on-site and/or annual workshop Habitat Unit training, and/or a QA Review. Note any other relevant training or field experience in the "Survey Notes" section.

Survey Criteria Section

Record the average bankfull width of the segment from the Reference Point Survey Report or calculated from Form 2D. This parameter is used to identify the minimum unit surface area and residual pool depth criteria used during the survey (see Tables 2 and 3 in the "Core Habitat Unit Identification" section).

Record the criteria in the appropriate blanks. For example, if the segment has a mean bankfull width of 7.5 meters, the minimum unit surface area will be recorded as 2.0 square meters (m^2) and the minimum residual pool depth will be recorded as 0.25 meters.

Equipment Section

As equipment is selected for conducting the survey, document the equipment type, size, condition, measurement accuracy, and pre-survey calibration dates as indicated. Mark the appropriate circle corresponding to whether equipment is in metric or English units. Document the type of wading gear used (wet/knee/hip/chest/dry/swim/etc.). Document any other measurement equipment used during the survey.

3.2.2 Habitat "FIELD DATA" Form 3.1

Use the Form 3.1 copy master to make one copy on regular white paper for additional copying purposes (Figure 2).

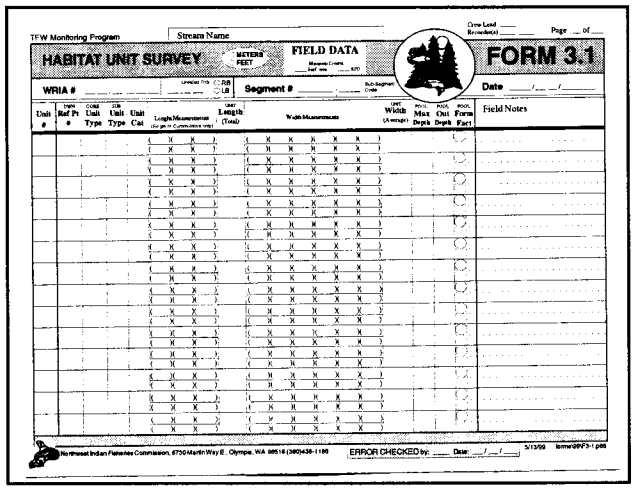

Figure 2. Habitat Survey "FIELD DATA" Form 3.1.

Record the *Stream Name/WRIA #/Unlisted Trib/Segment #/Sub-Segment Code* as documented on Form 3.0. Mark the circle in the header bar identifying the measurement unit used as either meters or feet. Record the minimum criteria in the header bar as defined in the "Survey Criteria" box on Form 3.0. Record the initials of the crew lead, recorder, and other crew in the spaces provided in the upper right-hand corner. Leave the *Page __ of __* and *Date* spaces blank as they are recorded in the field during the survey.

Use this copy to make multiple field copies onto waterproof paper. This process eliminates the need to fill out all header information on each form. Copies can be made single-sided or duplex.

3.2.3 Habitat Criteria and Code Field Sheet

Use the copy master to make one copy on waterproof paper. This sheet provides all pertinent survey criteria and documentation codes for quick and easy reference in the field.

4. Stream Discharge Measurement

For all Habitat Unit Surveys, a discharge measurement is required before the start of the survey because habitat unit surface area (and sometimes identification) are flow dependant. This information is used to determine appropriate flows for repeat surveys and to evaluate whether the discharge at the time of the survey is representative of summer low flows.

Discharge measurements are taken using the TFW Monitoring Program Wadable Stream Discharge Measurement Method (Pleus, 1999). Stream discharge measurements are recorded using Forms 7.0 and 7.1. The results are copied onto Habitat Unit Form 3.0. It is important that a survey be started and completed as soon after the discharge measurement as possible. In general, monitoring value decreases with increasing changes in discharge during a survey.

Habitat Unit Surveys should not be conducted during periods of high water associated with storms or during periods of rapidly fluctuating discharge. If crews note that the discharge has or is changing substantially (± 10%), the survey should be suspended until the flows return to original levels as documented with an additional discharge measurement. If the discharge does not return to the original level, then the data should be thrown out and the segment re-surveyed at a more stable discharge. The number of discharge measurements needed during a given survey depends upon stream and weather conditions, survey length, study design objectives, and quality assurance plan requirements. Future surveys of the same segment should be conducted at a discharge similar to that of the original survey (± 10%).

5. Habitat Unit Survey Method

This section provides the procedures for conducting the Habitat Unit Survey and describes how to document information on the field forms. It is organized in a sequential format to facilitate accurate and consistent application of the methods. This section can be copied for crews to take out into the field. Form 3.1 has been designed to record, organize, and track the information gathered using these methods.

Data is collected on qualifying individual habitat units during this survey. In situations where only one habitat type is identified along an entire segment, a Form 3.1 must still be filled-out. This includes sub-surface, wetland, and obscured unit types. The information is entered into the database. Mark the blank row after the last habitat unit record "END OF SURVEY" for documentation.

The methods section is divided into eight parts: 1) Habitat Unit Numbering; 2) Downstream Reference Point Association; 3) Core Habitat Unit Identification; 4) Optional Sub-Unit Identification; 5) Channel Location Category Identification; 6) Surface Area Measurement; 7) Residual Pool Depth Measurement; and 8) Pool Forming Factor Identification. The Habitat Unit Survey procedure will be explained as if a crew were conducting the survey for the first time on one stream segment within a watershed and structured to match the data entry format of Form 3.1. This procedure can be applied on a watershed level by systematically following the same methods segment by segment.

5.1 Habitat Unit Numbering

Record a unique unit number in the *Unit #* column starting with unit number "1" at the downstream segment boundary and sequentially number habitat units (1, 2, 3, 4, etc.) to the upstream boundary of the segment (Figure 3). The only time a unit number is repeated is where a unit's surface area is split at a reference point boundary. Begin the numbering sequence over again for each segment surveyed.

In general, the numbering system reflects the sequential placement of habitat units along the channel as crews progress upstream. That is, unit number one is assumed to be downstream of unit number 2. Where an adjacent unit (defined in the "Channel Location Category Identification" section) is located next to a primary unit, number and collect information on the primary unit before numbering and collecting information on the adjacent unit. In this situation, unit 3 is assumed to be adjacent to unit 2. Where a side channel is present, number and collect information on all habitat units in the main channel from the downstream outlet to the upstream inlet point of the side channel. Then return to the downstream outlet of the side channel and continue the sequential numbering system up the side channel until the main channel is reached.

5.2 Downstream Reference Point Association

Where a Reference Point Survey has been conducted prior to this survey, record the number of the nearest downstream reference point in the *Dwn Ref Pt #* column for each habitat unit. Reference point numbers are generally numbered sequentially starting with a zero at the downstream segment boundary (i.e., RP #0, 1, 2, 3, etc.).

In situations where the surface area of a habitat unit is split at a reference point, the unit number is repeated on two separate data rows, but associated with different downstream reference point numbers on Form 3.1. All habitat unit types can be split at reference points. Surface area measurements reflect the portions of the unit below and above the reference point boundary. For pool units, residual pool depth and pool forming factors (defined in related sections) are only recorded on the first row for that unit number.

5.3 Core Habitat Unit Identification

Identify the core habitat unit type and record a single letter unit type code in the *Core Unit Type* column as either: Riffle (*R*); Pool (*P*); Sub-surface flow (*S*); Wetland (*W*); or Obscured (*O*) (Table 1). A useful identification technique is to assume that everything is a riffle unless proven otherwise. All wetted portions of the main bankfull channel and side channels must be assigned one of the first four core unit type categories

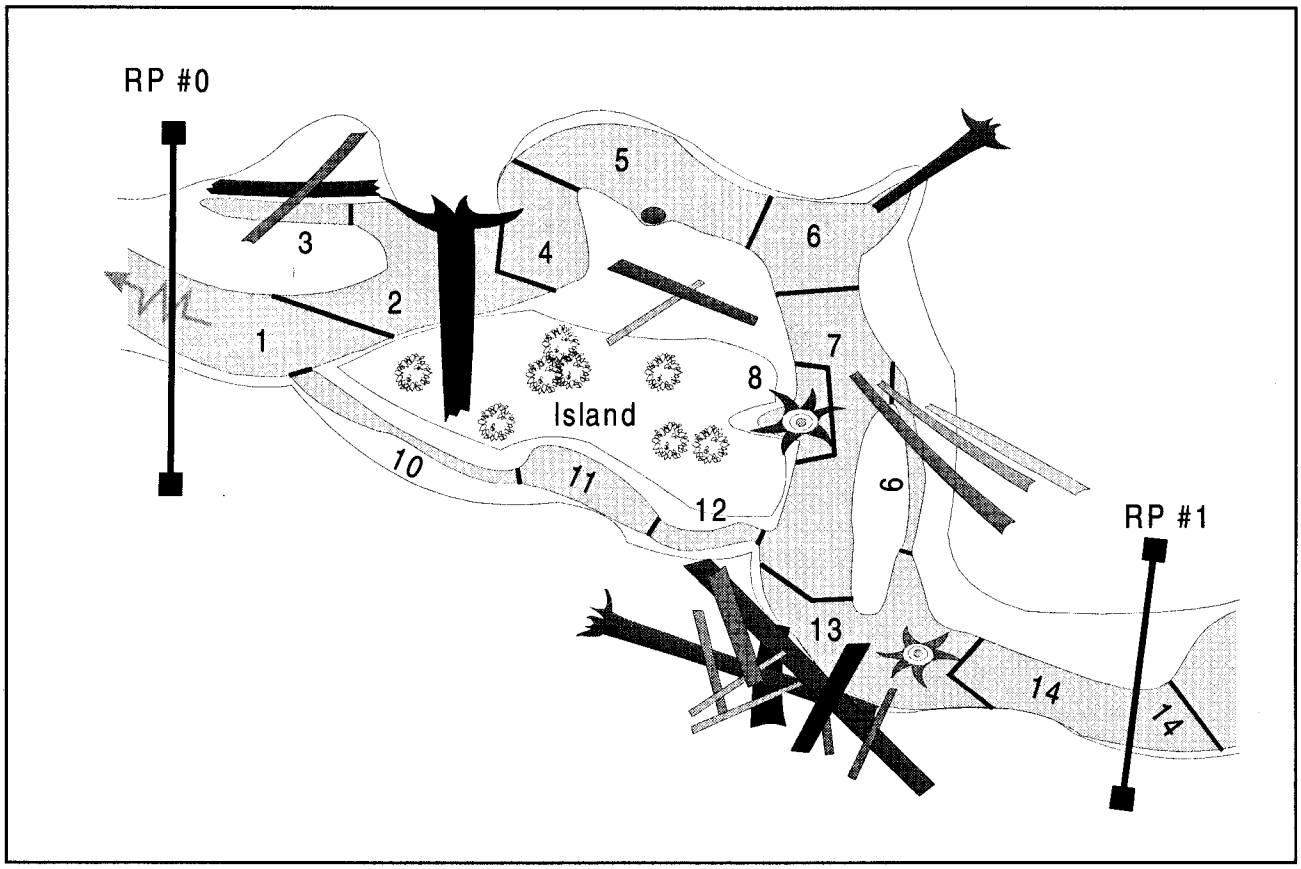

Figure 3. Habitat unit numbering system.

Table 1. Core habitat unit types and their field codes.

Core Habitat Unit Types	
Riffle	R
Pool	P
Sub-Surface Flow	S
Wetland	W
Obscured	O

(Figure 4). Sub-surface flow unit identification is only applied along dry sections of the main channel.

Individual core riffle and pool habitat units must meet the minimum surface area size criteria and core pool habitat units must also meet the residual pool depth (RPD) criteria based on the segment's mean bankfull width (Tables 2 and 3). The minimum criteria should already be recorded on the Form 3.1 header bar and is applied to all habitat types uniformly along the entire survey segment. Refer to the "Residual Pool Depth Measurement" section for RPD measurement procedure and techniques.

Wetted channel areas that do not meet the minimum surface area size criteria are lumped with the most similar adjacent unit. Isolated pockets of water within the bankfull channel that do not meet the minimum surface area criteria are ignored. Wetted channel areas that do not meet the minimum RPD criteria are lumped with the most similar adjacent unit. Isolated pockets of water within the bankfull channel that do not meet the minimum RPD criteria are identified as riffle units, unless they also do not meet the minimum surface criteria.

Habitat unit identification is a two step process. The first step is to positively identify the unit type. The second, and most difficult task, is identifying the boundary where one unit ends and the other begins.

Table 2. Minimum surface area and residual pool depth criteria by segment mean bankfull width - metric units.

Mean Segment Bankfull Width (m)	Minimum Unit Size (m^2)	Minimum Residual Pool Depth (m)
0 to < 2.5	0.5	0.10
≥ 2.5 to < 5.0	1.0	0.20
≥ 5.0 to < 10.0	2.0	0.25
≥ 10.0 to < 15.0	3.0	0.30
≥ 15.0 to < 20	4.0	0.35
≥ 20	5.0	0.40

Table 3. Minimum surface area and residual pool depth criteria by segment mean bankfull width - English units.

Mean Segment Bankfull Width (feet/tenths)	Minimum Unit Size (feet/tenths^2)	Minimum Residual Pool Depth (feet/tenths)
> 0 to 8.2	5.4	0.33
≥ 8.2 to 16.4	10.8	0.66
≥ 16.4 to 32.8	21.5	0.82
≥ 32.8 to 49.2	32.3	0.98
≥ 49.2 to 65.6	43.1	1.15
≥ 65.6	53.8	1.31

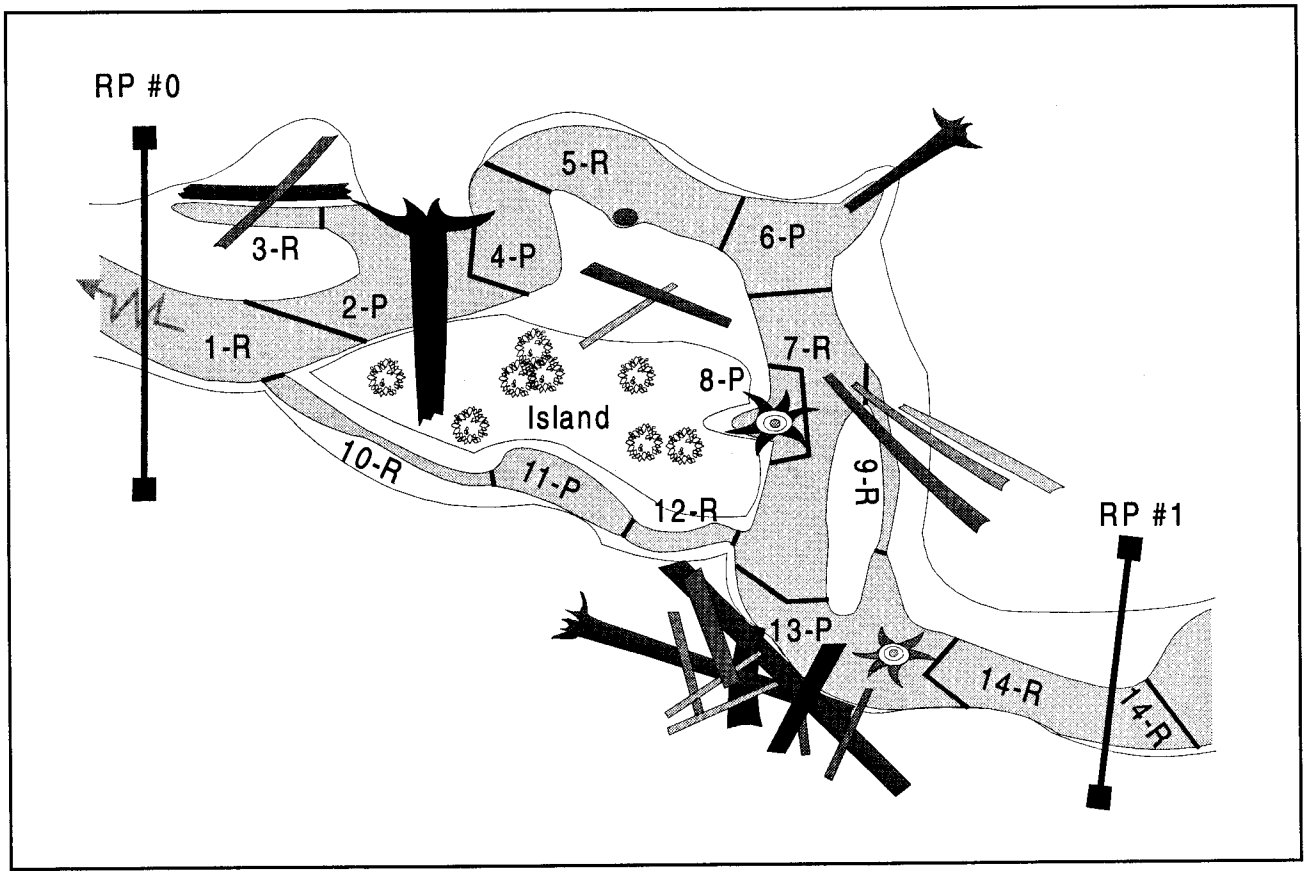

Figure 4. Habitat unit numbering and code type system.

5.3.1 *Riffle and Pool Units*

Riffle and pool units are the primary habitat types used in this survey (Figure 5). The term riffle applies to a broad range of wetted channel conditions for TFW-MP purposes. The classic riffle definition is a shallow and low gradient area with surface turbulence associated with increased flow velocity over gravel or cobble beds. However, riffle classification also includes deeper areas without surface turbulence such as "glides" and "pocket water" conditions, and higher gradient/turbulence areas such as "cascades" and "rapids."

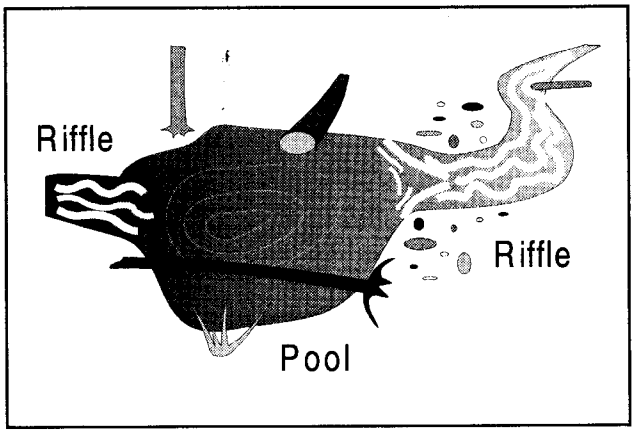

Figure 5. Riffles and pools are the primary habitat unit types used in this survey.

The term pool also applies to a range of wetted channel conditions for TFW-MP purposes. The classic definition of a pool is a section of stream channel where water is impounded within a closed topographical depression (Abbe and Montgomery, 1996). These pools are created by fluvial processes such as scour associated with channel obstructions that form depressions in the channel bed. The depression creates a cup or basin that would hold residual water even if there was no flow (Lisle, 1987; MacDonald et al., 1991). A good identification technique is to think of a pool as a slightly tilted cup with water being slowly poured into one end and the excess water spilling over the lowest part of the rim.

Pools can also be formed by the impoundment of water behind channel blockages such as large woody debris, beaver dams, boulders, or bedrock outcrops. Pools formed by blockages are generally less efficient at retaining water if the flow were to stop.

Identification Technique Using Hydraulic and Geomorphic Indicators

Initial assessment of habitat unit type is based on hydraulic and geomorphic indicators. Where pool units are indicated, they must also meet the minimum residual pool depth criteria. Accurate and consistent unit type identification requires recognition of many geomorphic and hydraulic indicators (Table 4). These indicators include, but are not limited to: water velocity; water surface turbulence; water depth; wetted perimeter irregularity; wetted width; substrate size; bed roughness; bed and water surface gradient; channel bed uniformity; significant scour depressions; and impoundment and obstruction factors. Indicators show channel energy patterns resulting from current flow and past bankfull flow events.

Table 4. Relative ratings of common hydraulic and geomorphic riffle and pool habitat indicators.

Indicators	Riffle	Pool
Hydraulic		
Water Velocity	+	-
Water Surface Turbulence	+	-
Water Depth	-	+
Wetted Perimeter Irregularity	-	+
Wetted Width	-	+
Geomorphic		
Substrate Size	+	-
Bed Roughness	+	-
Bed and Water Surface Gradient	+	-
Channel Bed Uniformity	+	-
Significant Scour Depressions	-	+
Impoundment/Obstruction Factors	-	+

Think of indicators as fingers pointing towards (+/positive) or away from (-/negative) unit identification at the time of the survey. For example, pool hydraulic indicators correspond to decreased flow energy. These include relatively deeper water with slower velocities resulting in less surface turbulence. Complex pool surface area shapes result from flow energy deflecting off the hydraulic impoundment and causing the wetted width to expand along and fill-out its topographical boundaries. The dissipation of flow energy within the pool causes smaller particles to drop-out at the downstream end of the pool. This build-up of material creates an increase in bed elevation between the pool's deepest point and the downstream outlet. In other words, a person walking upstream from the pool's outlet would be going downhill until they reached the pool's maximum depth. A cross section of the pool would show a curved or cupped shape defining the contours of the scour depression whereas a riffle would be a relatively flat shape.

It is important to observe all available indicators before weighting the evidence in complex situations. The more indicators identified, the more accurate the identification. Indicators are never absolute and must be assessed under local conditions. This is because most indicators are flow dependant and/or require clear water to see factors such as channel bed form and substrate size. Where field identification indicates a pool units, measure the residual pool depth to verify that it meets the minimum criteria.

Riffle and Pool Boundary Identification

Once positive riffle and pool unit identification is made, the next step is to establish their boundaries. Unit boundaries are lines drawn across or within the wetted channel that define the physical limits of the unit's wetted surface area. The classic habitat unit boundary encircles the unit with the sides bounded by the dry channel bed and the downstream and upstream boundaries extending laterally across the channel from one wetted edge to the other. In more complex situations, smaller units may lay adjacent to or are embedded within another and share a common boundary within the wetted channel.

When identifying habitat unit boundaries, there are three basic techniques to follow. The first technique is to work from simple (easy) to complex (hard) boundary areas. Knowing the location of part of the boundary often provides the information required to identify the rest of the boundary. The second technique is to use weighted or wire stake flags to visually define the boundary. This provides a visual indicator of the boundary line. The third rule is to use the confidence/default technique where the boundary is not *clearly* defined. This technique is described below and provides a systematic method for consistent and repeatable identification of unit boundary location. The two most common unit boundaries are at the downstream and upstream boundaries of pool units.

Downstream Pool Boundary: The high point in channel bed elevation below a pool is know as the riffle crest (Figure 6). The riffle crest is the critical boundary indicator regardless of whether the downstream unit is a riffle or another pool. One technique is to think of the riffle crest as a mountain range. At any point along the range, a crew walking upstream from the lower unit toward the center of the pool unit will gain elevation until reaching the top of the riffle crest. Moving upstream from the riffle crest, the crew will start losing elevation as they drop into the pool. Similarly, walking downstream within a pool unit, the channel bed will gain elevation until it reaches the riffle crest where it will start losing elevation. Elevation is viewed at a 90 degree angle to the suspected boundary line. The lower pool boundary is always the upper boundary of the downstream riffle or pool unit.

Upstream Pool Boundary: The upstream pool boundary is often complex and difficult to clearly identify. In general, look for indicators of change in channel bed morphology. Another technique is to use the extension of the pool's channel edge to form the boundary line across the channel. The identification of the upper pool boundary automatically identifies the lower boundary of the next riffle unit.

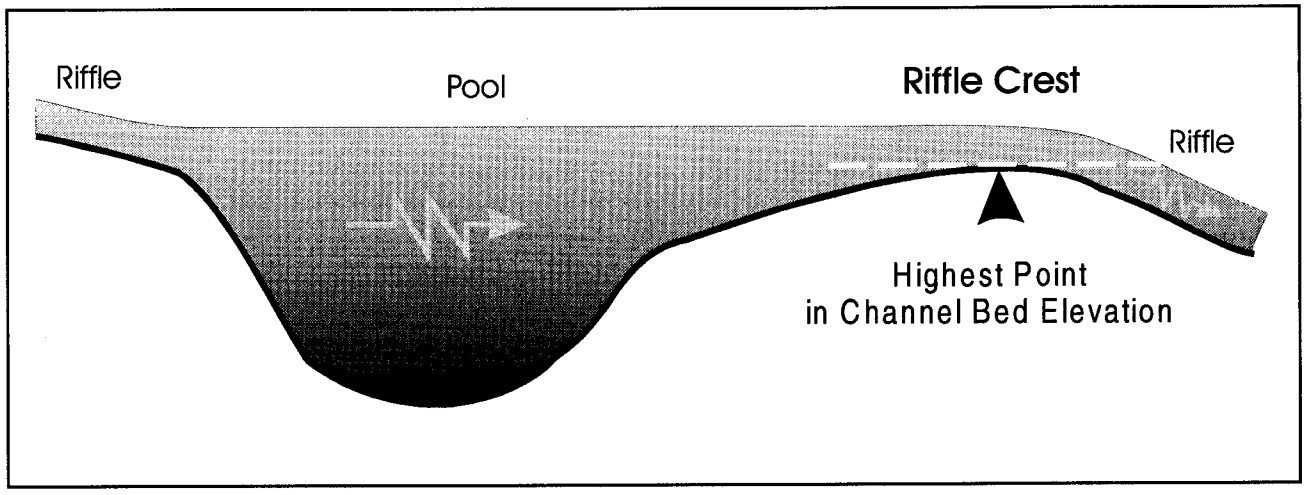

Figure 6. The downstream boundary of a pool unit is found along the riffle crest.

Confidence/Default Technique: The confidence/default technique is used to provide a systematic and scientifically-based procedure for consistent identification in situations where unit boundaries are not clearly defined (Figure 7). The downstream confidence point marks where a crew walking upstream is no longer 100 percent confident they are in the identified lower unit type. The upstream confidence point marks where a crew walking downstream is not longer 100 percent confidence they are in the identified upper unit type. Check and adjust if necessary one or both markers after reassessing. The default boundary point is identified and marked half-way between the confidence markers. The confidence markers can now be removed. This technique can be used along the entire boundary length if required.

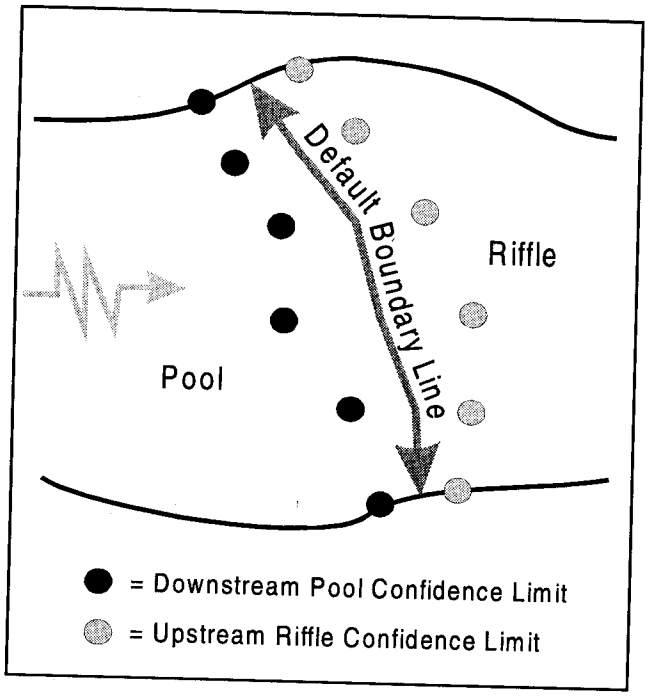

Figure 7. Using the confidence/default technique to identify a pool/riffle boundary.

Multiple Pool Situations

Complex pool systems may have more than one scour depression across or along the channel length, but they appear to be connected under a common surface area (Figure 7). Multiple scour depressions are called one pool where they share a common outlet. That is, if the water were to stop flowing, all scour depressions would be connected by surface water at some point behind the common outlet. Conversely, individual scour depressions would be called separate units if they would be separated from the other scour depressions by resulting dry channel bed. Independent scour depressions are tested for minimum surface area and residual pool depth criteria for unit identification.

5.3.2 *Sub-Surface Flow, Wetland, and Obscured Units*

Sub-Surface Flow - A unit is identified as a sub-surface flow type where the main channel becomes dry across its entire width (Figure 8). Dry conditions along secondary or side-channels are not recorded (see unit category section) unless the side channel is being surveyed as a sub-segment. Conditions along the stream segments may alternate between wet and dry areas, or be completely dry. If the stream is dry because of extreme low flow associated with drought, it may not be an appropriate time to conduct a habitat unit survey because the information generated might not be useful for trend analysis. On the other hand, if intermittent flow is a typical low flow condition, or if it appears to be resulting from changing conditions such as coarse sediment aggregation, then documenting its occurrence is useful.

Wetland Units - A unit is identified as a wetland type where it flows through wetland, marsh, bog, fen, or swamp conditions (Figure 9). Where a stream enters or exits a wetland, the extension of the wetland edge forms the boundary line across the channel. In situations where the boundaries are not clear, use the confidence/default technique. Wetland units can be identified along primary, secondary, and side channels. Wetlands greater than 100 meters in length should be identified as sub-segments (Pleus and Schuett-Hames, 1998). Wetlands are transitional areas between terrestrial and aquatic systems (Cowardin et al., 1979). In these situations, channel formation and maintenance are not dominated by normal fluvial processes. Therefore, application of the Habitat Unit Survey in wetland conditions is not recommended, or if applied, data should be interpreted independently of fluvial channel surveys. Wetland unit boundaries can be flagged to aid in relocation if the project manager determines that the wetland is to be made into a separate segment at a later time.

Obscured Units - When positive unit identification and/or minimum surface area measurement is not possible due to portions of the channel not being visible or

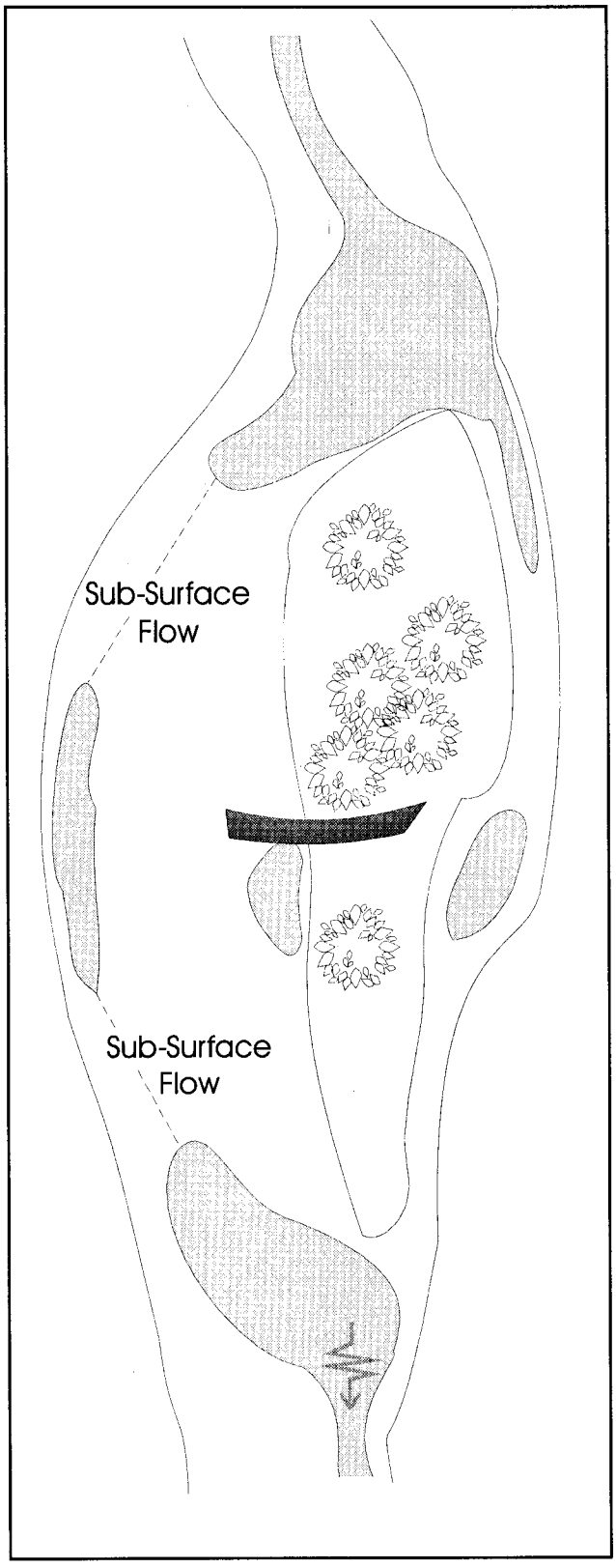

Figure 8. Sub-surface flow units are identified only along the main channel.

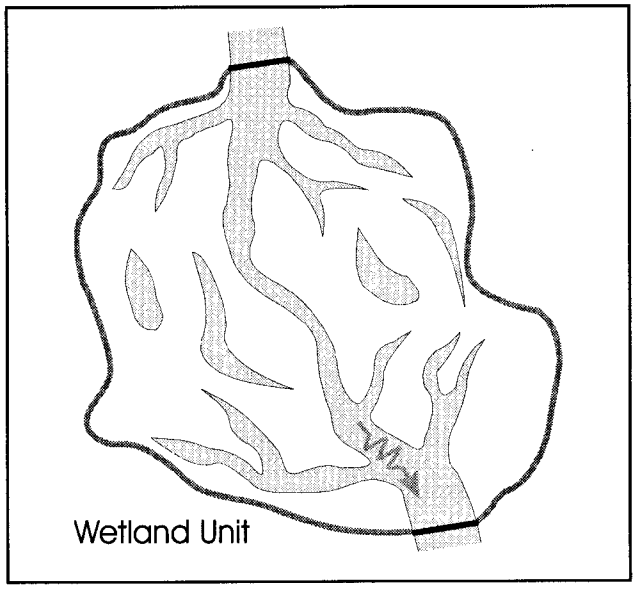

Figure 9. Wetland unit boundaries are identified as an extension of the wetland edge.

accessible, it is designated as an obscure type unit (Figure 10). Obscured units are identified in situations where a channel passes under a dense debris jam, beneath an undercut bank, or through a culvert (regardless of culvert size). The downstream boundary of the obscure unit is where positive identification of the lower unit is no longer possible due to measurement obstructions or indicator changes suggest a different unit type. The upstream boundary is where positive unit identification becomes possible through measurable criteria. Obscured units can be identified along the wetted portions of primary, secondary, and side channels.

5.4 Optional Sub-Unit Type Identification

Record up to a three-letter sub-unit type code in the *Sub-Unit Type* column. The TFW Monitoring Program does not provide training or quality assurance for sub-unit identification. It is offered to provide flexibility to those cooperators who wish to collect more detailed information on habitat unit types. The choice of sub-classification system is solely the cooperator's responsibility. However, any sub-unit type system used is required to fit hierarchically and consistently with the TFW Monitoring riffle, pool, sub-surface flow, wetland, and obscured core unit classification system.

Core riffle units can be split into multiple sub-units based on sub-unit type and/or to improve total surface

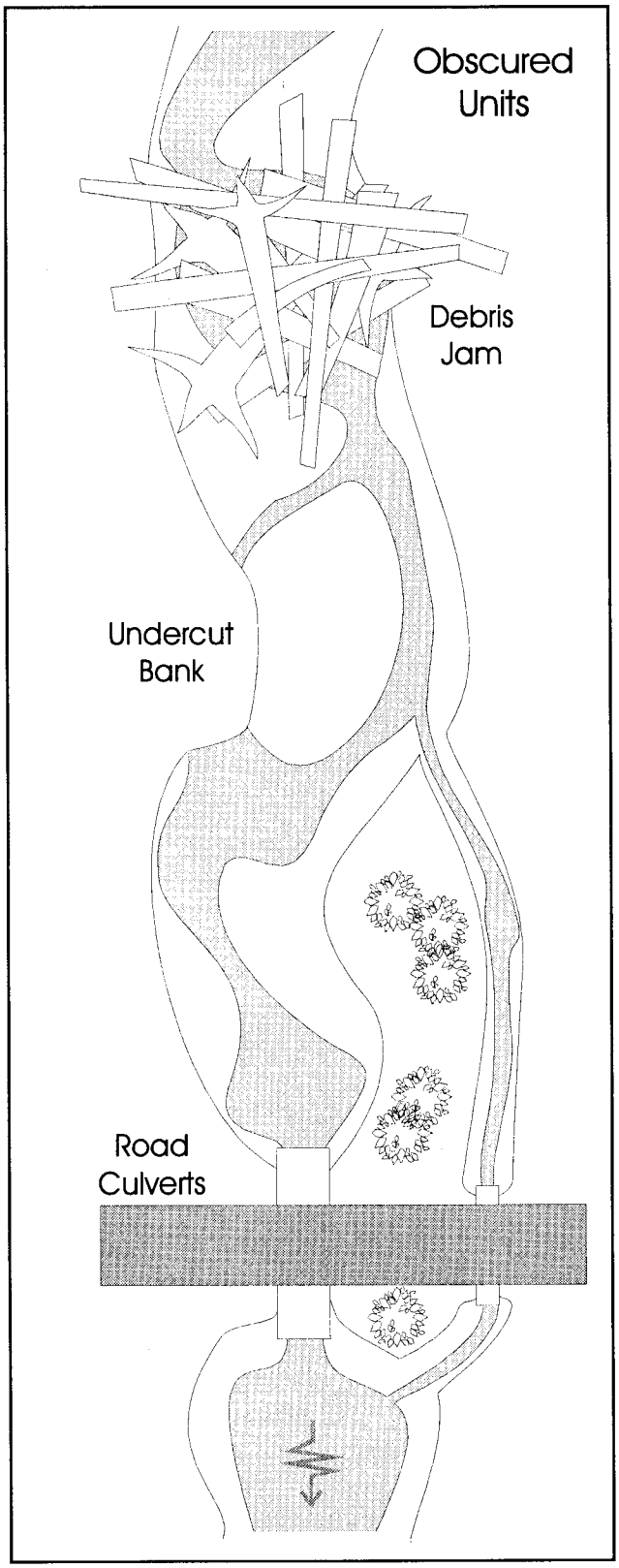

Figure 10. Obscured units are identified where positive unit identification and/or measuring minimum surface area is not possible.

area accuracy. This means that the total of multiple sub-unit surface area measurements equals the total core riffle unit surface area. Use the hydraulic and geomorphic indicators and boundary identification strategies described above for sub-unit identification and boundary delineation.

Core pool units can be identified by a single sub-unit type. Individual core pool units can *not* be split into multiple sub-units. Splitting pool units causes database calculation errors for the residual pool depth and pool forming factor parameters. This means that a pool unit cannot be split to identify sub-unit sections such as "tailout," "eddy," and "backwater" areas that do not individually meet the minimum residual pool depth criteria. It is recommended that those pool characteristics be identified in the field notes column with estimates of percent surface area coverage.

5.5 Channel Location Category Identification

Record the unit's channel location category in the *Unit Cat* column as either Primary (1), Secondary (2), Side channel (3), or Tributary channel (4). Habitat units are classified depending on their location and relative significance within the stream channel (Figure 11). Information on habitat unit location allows determination of the relative abundance of these type channel habitats during summer low flow conditions. The four categories are:

Category 1- *Primary units*. These are the dominant units in the main channel. Use the following rules to test for category 1 classification: 1) the unit width spans the entire wetted channel at some point along its length; or 2) the unit width spans at least 50% of the wetted channel width along at least half its channel length.

Category 2- *Secondary units*. These are sub-dominant units in the main channel that span less than 50% of the wetted channel width along less than half their channel length. They may be either physically adjacent to a primary unit, lie embedded within a primary unit, or are separated from the primary unit by a dry gravel bar or obstruction. This category is never applied to sub-surface flow unit types.

Category 3- *Side channel units*. These units are found in smaller, clearly defined channels that are divided from the main low flow channel by an island (see

definition below). These channels currently contain, or would contain flowing water fed by the main channel during a bankfull flow event. The side channel's bankfull edges must be definable. Side channel units begin and end at the island boundaries and along a line formed by the general continuation of the main channel bankfull edge. Pool units having surface area spanning both the main and side channel bankfull widths are assigned the channel category associated with the majority of its surface area (Figure 12a). Where side channels are being surveyed as independent sub-segments, all habitat types would be classified as category 3 units (Figure 12b). In this situation, sub-surface flow units and their lengths can be recorded.

An island is defined as an area of terrestrial land that is isolated from the floodplain or valley flat by the bankfull channel of a divided stream and meets both of the following criteria: 1) the length of the island above the bankfull channel is at least two times the segment's mean bankfull channel width; and 2) the terrestrial area is vegetated by two or more perennial plants that are greater than 2 meters in height. Units separated only by dry gravel bars, regardless of their length above the bankfull channel, are treated as adjacent units. This category is never applied to sub-surface flow unit types.

Category 4- *Tributary channel units*. These units are found in smaller channels (< 100 meters long) within the bankfull channel of one stream, but with its flow originating from a tributary stream draining an adjacent sub-basin (Figure 13a). Category 4 units are unique low flow channel features that can vary in length and habitat from year to year and disappear during winter high flow events. In situations where a secondary channel contributes more than an estimated 50% of a tributary channel's flow, units along that section of the channel downstream to the main channel are classified as category 2 units (Figure 13b).

Category 4 units can be included in the surveys of both stream systems affected. When surveying a tributary in this situation, assign the category 4 units to the segment's lower boundary reference point (Figure 13c). Tributary channels longer than 100 meters within the bankfull channel it drains into should be identified as a separate segments and all habitat types are classified as category 4 units.

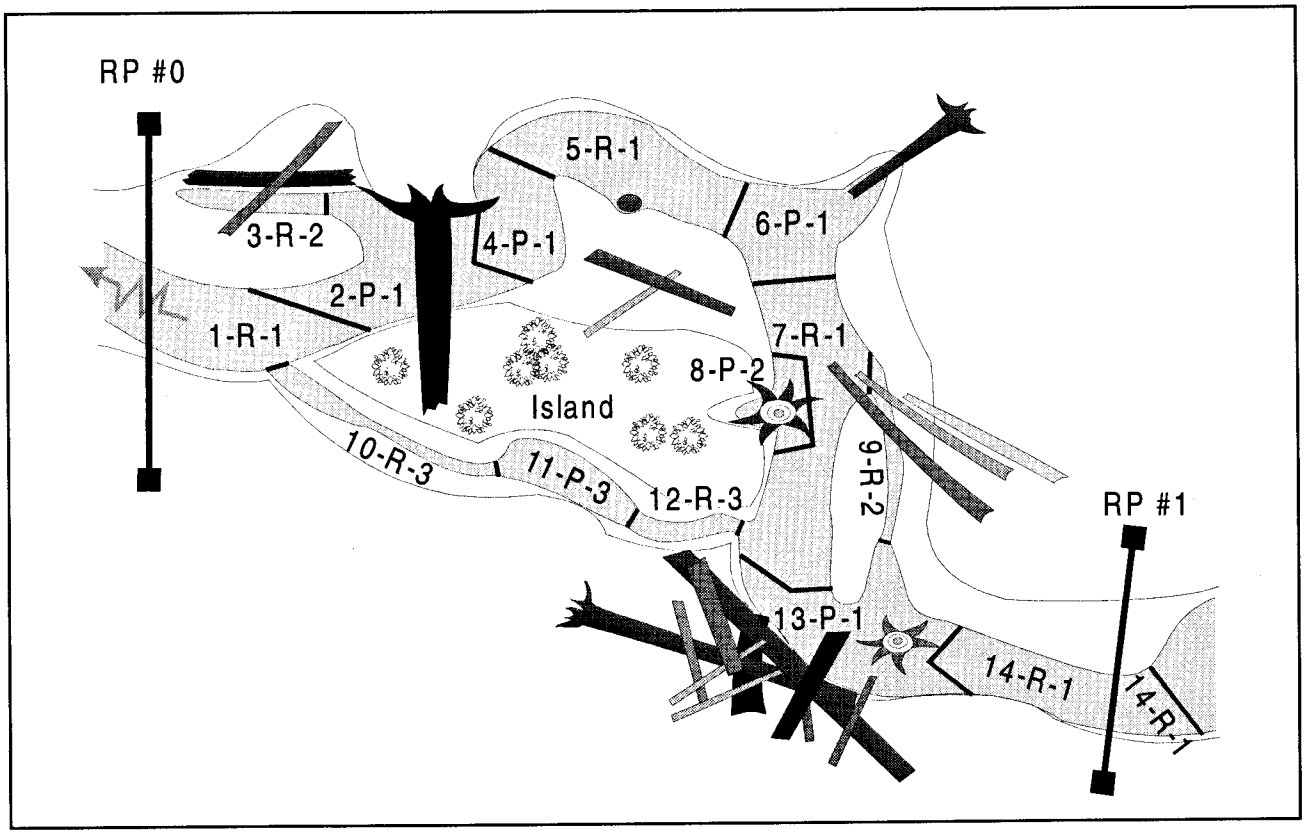

Figure 11. Habitat unit numbering, code type, and channel location system.

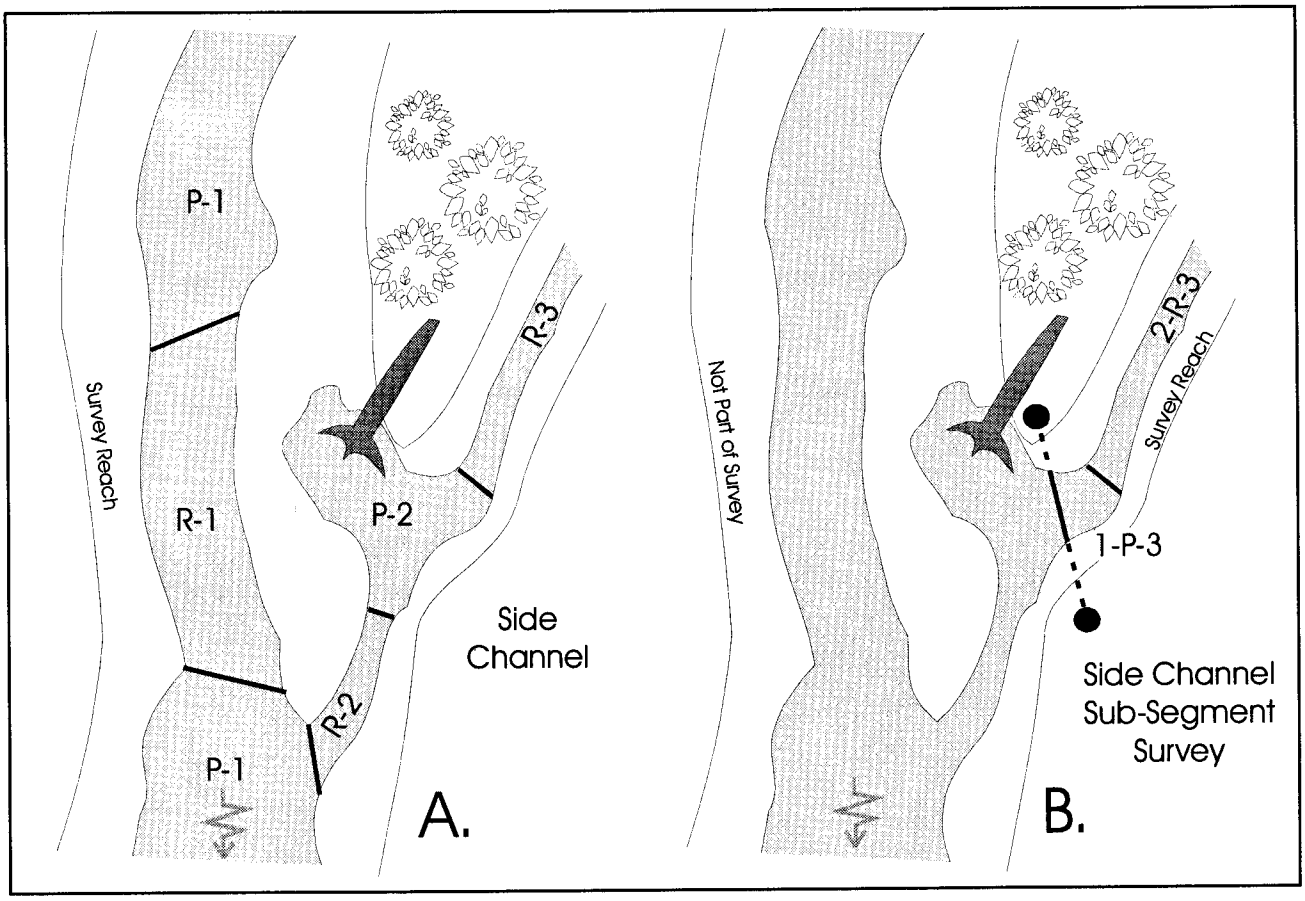

Figure 12. Procedure for channel location identification of a side channel as part of the main channel survey (A) and as a separate sub-segment survey (B).

5.6 Surface Area Measurement

General Procedure

Record each unit or sub-unit's single or cumulative length(s) and multiple width measurements using the techniques described below in their corresponding *Length Measurements* and *Width Measurements* column brackets to the nearest 0.1 meter. Width measurements are not required for sub-surface flow, wetland, or obscured units.

Calculate the unit's total length and average width and record the results in their corresponding *Unit Length (Total)* and *Unit Width (Average)* columns to the nearest 0.1 meter. Average width is calculated by adding the individual measurements and dividing the sum by the number of measurements taken. If the number of individual length or width measurements is greater than the number of brackets available on one row, continue into the next row. The length and average width of a habitat unit is used in the database to calculate surface area.

Natural obstacles, such as log jams and dense vegetation, combined with field equipment limitations and safety concerns, may prevent access to some unit boundaries. In these situations, measurements are taken as accurately as possible. Record the estimated accuracy in the field notes as either a "within" range accuracy (e.g., ± 0.5 m) or as an "at least" measured distance plus an unknown (e.g., 4.5 m +). Sometimes using multiple measurement equipment such as a fiberglass tape up to the obstruction and a stadia rod that can reach to the boundary is a helpful technique.

Unit Length Measurement Techniques

The position of the length measurement line (baseline) along the shape of a unit is the key to accurate surface area measurement. Three basic length baseline techniques are used for unit shapes along straight, meander, and complex channel situations. The baseline

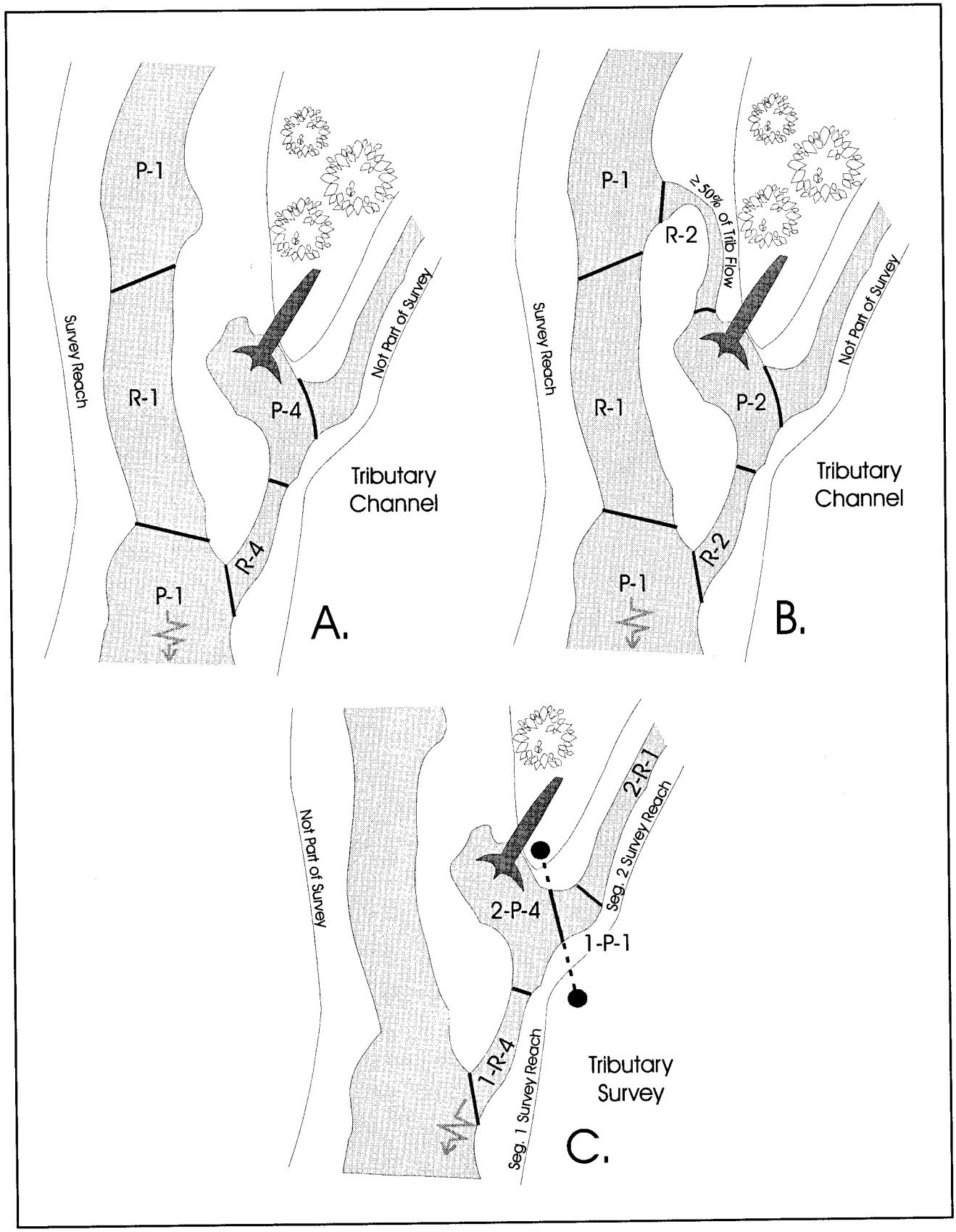

Figure 13. Procedure for channel location identification of a tributary channel as part of the main channel survey (A), where an adjacent channel contributes ≥50% of the flow (B), and as a separate survey (C).

positions are related to proper representation of a unit's longest dimension, and for setting up a good line for taking subsequent width measurements.

On straight units with generally rectangular shapes, the length baseline is along a single line that connects the downstream to the upstream wetted boundary midpoints (Figure 14). In situations where a unit flows around a meander, the length measurement follows the general curvature of the unit along the middle of its wetted channel length. Cumulative length measurements are used where unit lengths are greater than the equipment measurement range, but can also be made at smaller intervals when convenient. On habitat units with complex shapes, or where the downstream and/or upstream boundaries are irregular, the length measurement is along a straight line placed so the area of the shape is entirely encompassed within 90^0 of the endpoints.

Average Width Measurement Techniques

Width measurements are taken perpendicular to the length baseline at systematic intervals. This requires remembering the baseline position and using a pacing technique to identify systematic width measurement intervals (Figure 15). The number of paces per width measurement varies with the size of the unit (Table 5).

For example, if a habitat unit has a length of 15 meters, width measurements are taken every third pace. Start by returning to the downstream length measurement

Table 5. Guideline for minimum number of paces per width measurement for various unit lengths.

Unit Length (m)	Minimum number paces per width measurement
< 2.5 to 5	1
≥ 5 to 10	2
≥ 10 to 20	3
≥ 20	4+

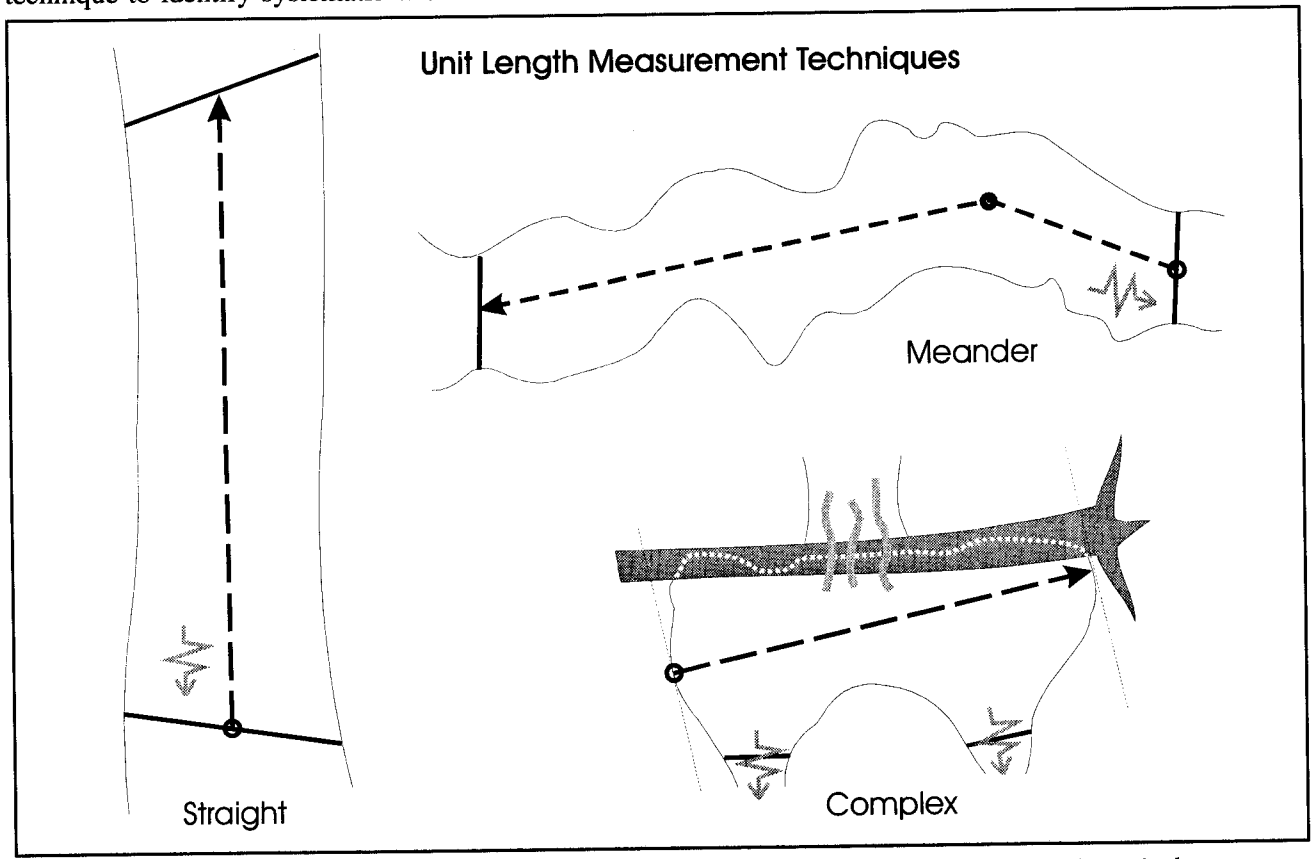

Figure 14. Basic surface area length measurement techniques for straight, meander, and complex unit shapes.

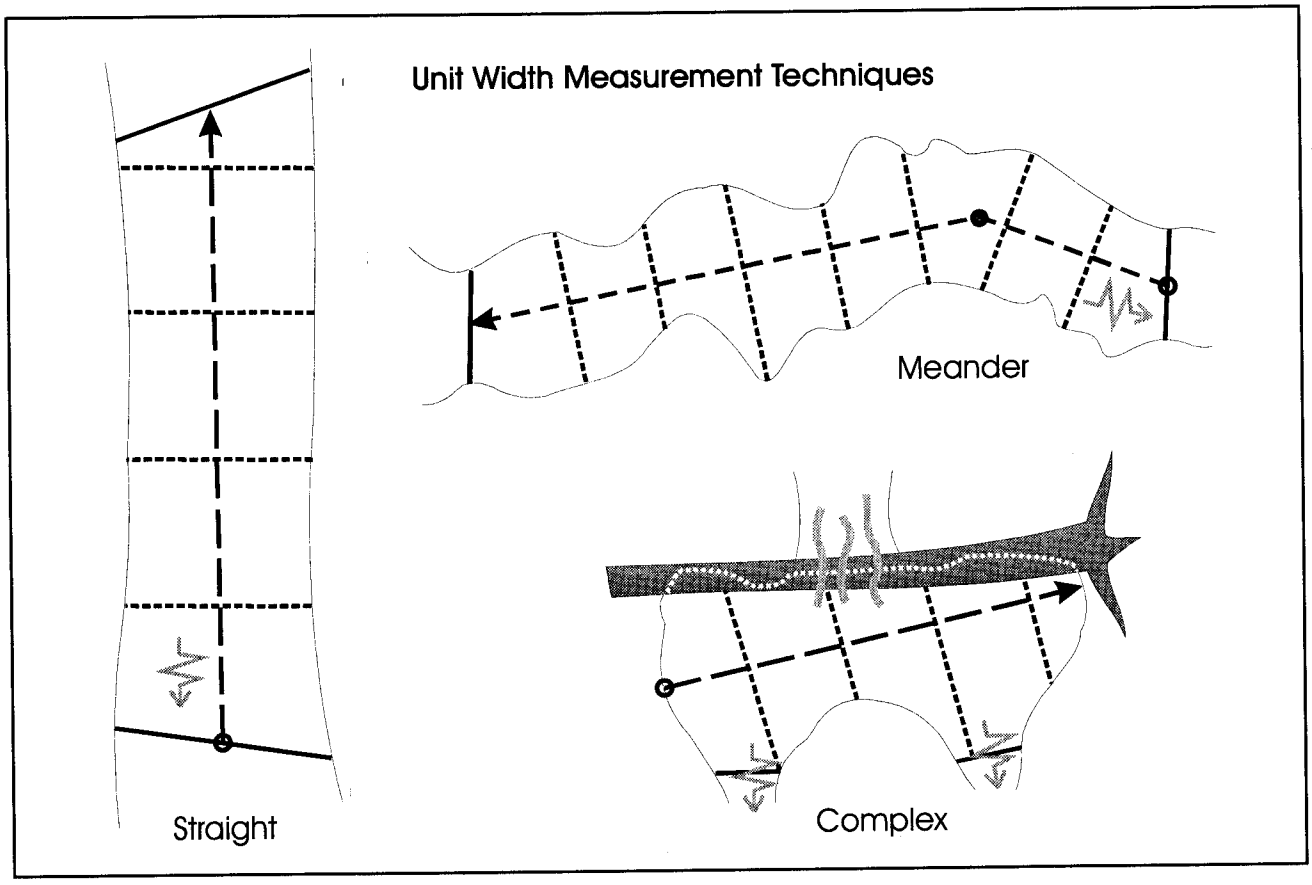

Figure 15. Basic surface area width measurement techniques for straight, meander, and complex unit shapes.

point. Face upstream and take three paces (steps) along the remembered length baseline *before* taking the first width measurement. Stop and adjust the measuring rod so that it is held perpendicular to the baseline, then sight along the rod and identify the width measurement endpoints on both sides of the channel. Measure the distance between the points using the rod or a measuring tape. Return to the length baseline and take three more paces along it and repeat the process until the upstream length measurement point is reached. In situations where the baseline follows the continuous curve of a long unit, smooth out the hard angle of the measurement points. Width measurements are taken up to one pace distance from the baseline endpoint. That is, never take a width measurement within one pace of any baseline endpoint. Changing the frequency of width measurements is related to unit length and complexity, and the length a given crew's pace. Larger/complex units may require more width measurements for an accurate average width. Crew with longer or shorter legs may need to take fewer or more paces per width measurement. However, a balance must be struck between accuracy and the time required to make the measurements.

The most common width measurements are taken from the verified wetted edge on one side of the stream channel to the verified wetted edge on the other side along the surface of the water (Figure 16). Verified means that crews must be able to visually confirm the

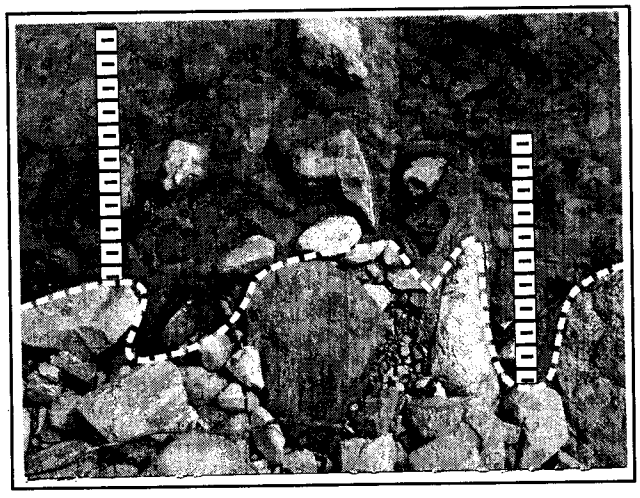

Figure 16. Measure unit widths to the wetted edge of the channel.

boundary of the wetted channel at that measurement point. In channels with sand or other fine substrate particles, the wetted edge is identified as the point where the water surface ends and the dry channel bed begins. In channels with larger substrate particles, the wetted edge is defined as the point where the protruding particles are no longer surrounded by water (Platts et al., 1983). Isolated water pockets are not included unless their surface area meets the minimum criteria for a separate unit. Protruding objects such as dry bars, embedded logs, and boulders that protrude through the surface are not subtracted from the width measurement unless they are big enough to meet the minimum habitat surface area criteria. In situations where undercut banks or other obstructions obscure the true wetted unit boundary, width measurements are taken at the point where the wetted edge can be verified for consistency.

Where primary and secondary units share a common wetted boundary, measure from the wetted edge of the stream to the boundary between the adjacent units. A helpful technique is to have a second crew walk along the common boundary and use their leg as a measurement point. The use of weighted flags during the unit boundary identification process provides an accurate and consistent marker to prevent width measurement overlap or gaps when collecting surface area data on the adjacent unit.

Measuring Lengths of Sub-surface Flow, Wetland, and Obscured U nits

Only length measurements are required for sub-surface flow, wetland, and obscured units. Measure unit lengths to the upper segment boundary where conditions exist. Use the following guidelines to make these measurements.

Sub-Surface Flow Units: In areas where the main channel goes dry, the length of the sub-surface flow unit is the distance between the middle of the upper boundary on the last downstream wetted unit and the middle of the lower boundary of the next upstream wetted unit. Use a point-to-point measurement unless the area is very long and the general curvature of the channel can be determined (Figure 17).

Wetland Units: In areas where the stream flows into and out of a wetland, the length of the wetland unit is the distance between the extension of the lower and upper wetland edge where it crosses the channel

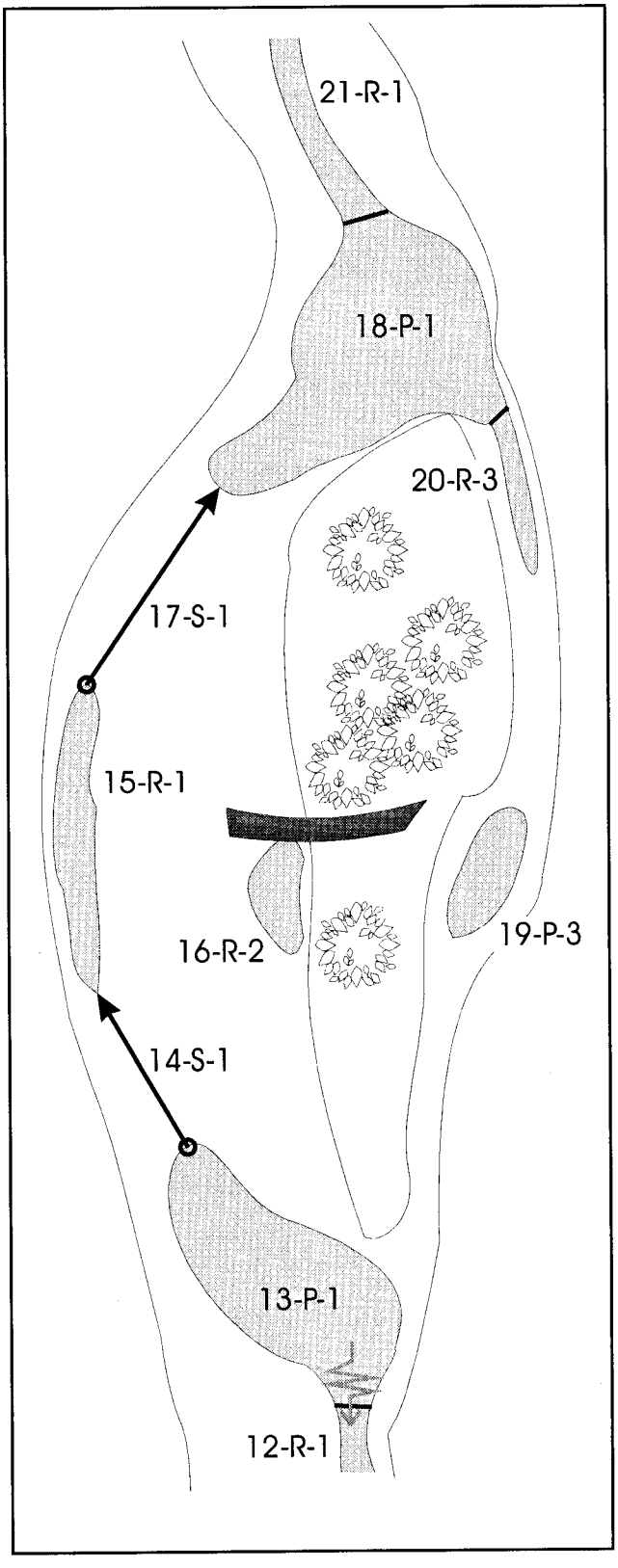

Figure 17. Measure sub-surface flow units lengths from the middle of the upper boundary on the last downstream wetted unit to the middle of the lower boundary of the next upstream wetted unit.

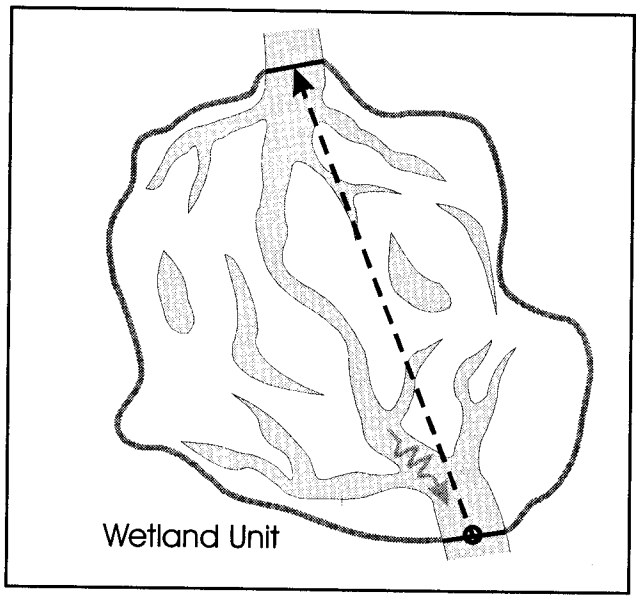

Figure 18. Measure the length of the wetland unit between the extension of the lower and upper wetland edge where it crosses the channel midpoints.

midpoints. In situations where the boundaries are not clear, use the confidence/default technique. Use a point-to-point measurement (Figure 18).

Obscured Units: In areas where the wetted portion of the channel is not visible and habitat unit identity or dimensions are not possible to quantify, the length of the obscured unit is the distance from the middle of the upper boundary on the last downstream unit to the middle of the lower boundary of the next upstream unit. Use a point-to-point measurement unless the area is very long and the general curvature of the channel can be determined (Figure 19).

5.7 Residual Pool Depth Measurement

Measure the maximum water depth of each pool and record the result in the *Pool Max Depth* column to the nearest 0.01 meter (Figure 20). Measure the pool outlet depth of each pool unit using the techniques describe below and record the result in the *Pool Out Depth* column to the nearest 0.01 meter. Residual pool depth (RPD) is calculated in the database as the difference in measurements between the pool's maximum and outlet depths.

RPD measurements are used both to verify that a candidate pool meets the minimum criteria, and to document the actual outlet and maximum depths. For unit

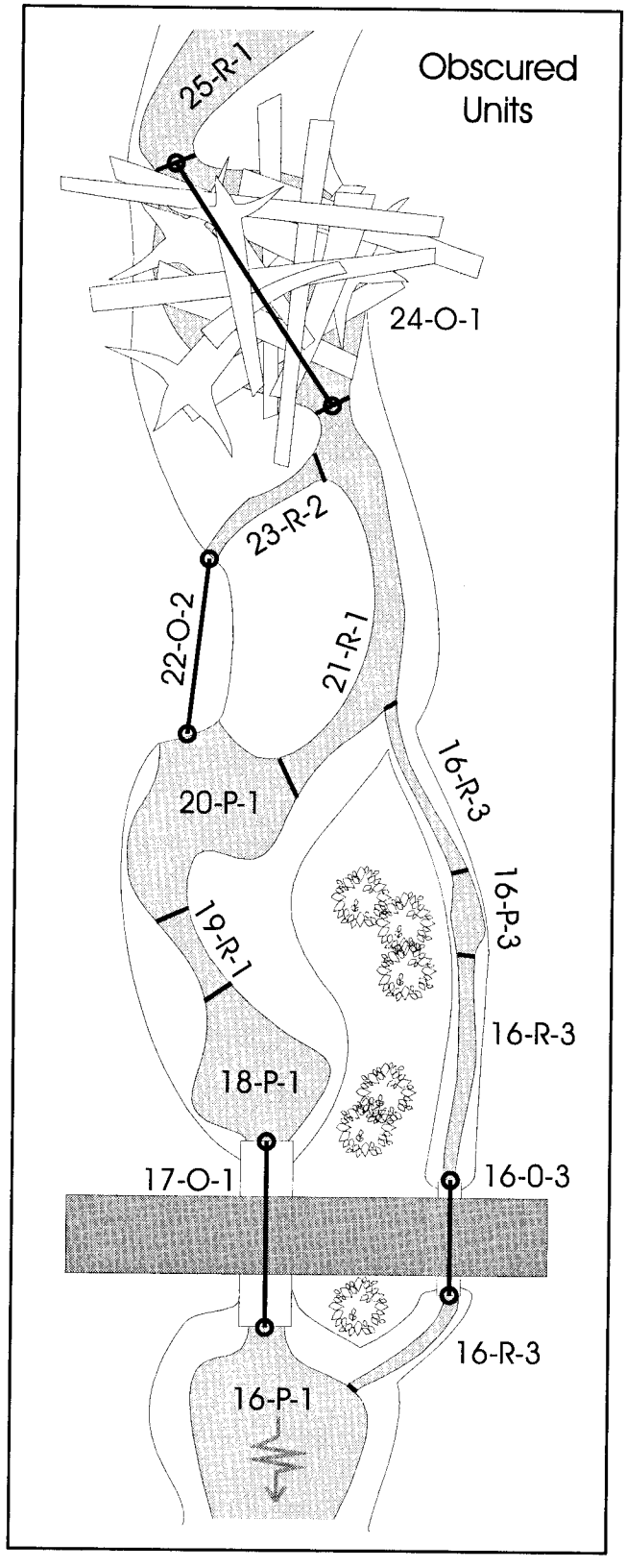

Figure 19. Measure lengths of obscured units from the middle of the upper boundary on the last downstream unit to the middle of the lower boundary of the next upstream unit.

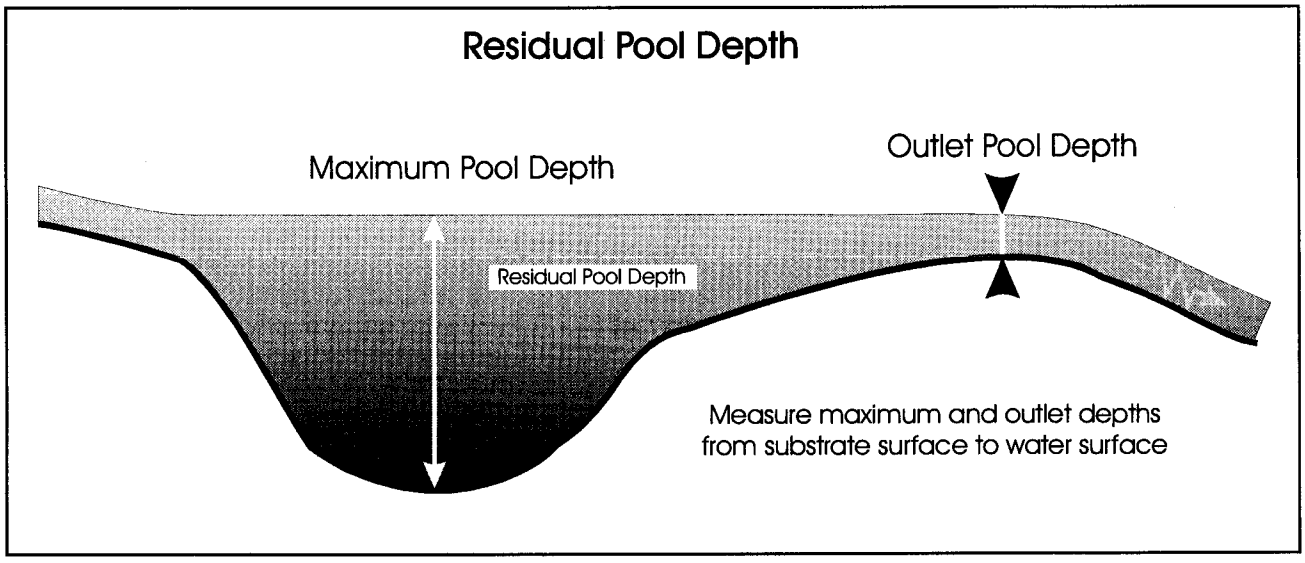

Figure 20. Measure the outlet and maximum pool depths for pool unit identification and calculation of residual pool depth.

identification, first measure the outlet depth and use this to determine the required maximum depth for pool qualification. For example, a candidate pool has an outlet depth of 0.17 meters and the minimum RPD criteria for the survey is 0.35 meters. The outlet depth plus the RPD criteria (0.17 + 0.35 = 0.52) equals the maximum depth required to qualify as a pool unit. If the maximum depth is less than 0.52 meters, it remains a riffle unit. Once the pool minimum criteria is met, continue probing to locate the deepest point and record that number as the maximum depth.

Natural obstacles, such as log jams and dense vegetation, combined with field equipment limitations and safety concerns, may prevent access to some RPD measurement points. In these situations, measurements are taken as accurately as possible. Record the estimated accuracy in the field notes as either a "plus-or-minus" or "within" range accuracy (e.g., ± 0.05 m) or as an "at least" measured distance plus an unknown (e.g., 0.65 m +).

Pool Outlet Depth Measurement Technique

The pool outlet depth is measured from the channel bed to the surface of the water with the measuring rod held vertically plumb. Pool outlets are located at the lowest point in bed elevation along the lower pool boundary. This point is the same as where water would last spill out from the impounded pool if the water flow were turned off. Often, this corresponds to where the thalweg or deepest part of the channel crosses the top of the unit's lower boundary line. Complex pools with multiple outlets require subjective evaluation of which one is the true outlet depth. In situations where the outlet is covered in debris such as leaves, try to work the measuring rod down to the top of the channel bed without disturbing the accumulation.

For dam pools caused by logs or beavers, the deepest point in the water flowing over the obstruction is the pool outlet depth. If the water is not flowing over the downstream hydraulic control, then the pool outlet depth would be zero even where water can be seen or heard flowing under or through debris. For large cobble or boulder pool outlets (higher gradient areas), the water surface may actually start lowering before it reaches the outlet point. In these situations, do not try to compensate. Follow the standard procedure listed above and measure the depth to the water surface at that point. Note data accuracy factors in the field notes.

Pool Maximum Depth Measurement Technique

The pool maximum depth is measured from the channel bed to the surface of the water with the measuring rod held vertically plumb. Use the measuring rod to determine the pool's maximum depth. Finding the deepest point in the pool requires taking multiple measurements at suspected locations. The measuring rod should rest lightly on the bed surface, especially in situations where the bed is covered with fine silts.

5.8 Pool Forming Factor Identification

Estimate the primary pool forming factor and record primary code number and up to 3 additional factors in the *Pool Form Fact* column (Table 6). Pools typically form as a result of scour adjacent to channel obstructions and bank resistance during bankfull flows, or due to impoundment of water behind blockages. In most situations, a "primary" factor is estimated to contribute more to the formation of the pool than the others. There are eleven pool forming factors to choose from including LWD logs (1), LWD rootwads (2), LWD jams (3), roots of standing trees or stumps (4), boulders (5), bedrock (6), channel bedform (7), scour-resistant bank (8), artificial bank (9), beaver dam (10), and other factors not listed (11).

Table 6. List of pool forming factors, field codes, and descriptions.

Code	Pool Forming Factor	Description
1	LWD Log(s)	one to nine dead trees or pieces; 10 cm diameter and 2 meter length; and roots no longer support weight of bole[1]
2	LWD Rootwad(s)	one to nine dead tree root systems; 20 cm diameter and 2 meter length; and roots no longer attached in original location[1]
3	LWD Jam	10 grouped qualifying LWD logs and rootwads[1]
4	Roots of standing tree(s) or stump(s)	live or dead standing trees and stumps
5	Boulder(s)	one or more particles of bed substrate larger than 26 cm (basketball size)
6	Bedrock	geologic protrusion of bedrock material
7	Channel bedform	wetted channel situations (not along the bank) where the channel bed shape itself creates pools, such as where two channels join or where pools form next to bars in the absence of other contributing factors
8	Resistant bank	erosion resist banks due to consolidated substrate materials (not bedrock) and/or general root mass from grasses and/or shrubs
9	Artificial bank	banks protected by human modification (rip-rap, concrete, bridge, culvert, etc.)
10	Beaver dam	the impoundment of flow caused by debris placed in the stream by beavers
11	Other/Unknown	factors contributing to pool formation that are not on the list or where the cause cannot be determined. Describe the factor in the field notes section

[1]Refer to the TFW Large Woody Debris Survey manual (Schuett-Hames et al., 1999) for detailed description.

6. Post-Survey Documentation

After completion of the field portion of the Habitat Unit Survey, field forms need to be organized, supplemental information and calculations completed, and all forms and information error checked before the data is ready to be entered into the database. The objective of this section is to ensure that this survey can be repeated the same way in the future by different crews.

6.1 Finalizing Forms 3.0 and 3.1

Organize the forms and check for missing sheets. Systematically check each Habitat Unit Survey form for completeness. All parameter blanks and boxes should contain information or a "/" to designate that no information is available or needed.

6.1.1 All Forms

The following list provides guidance on some common tasks:

- Page numbering is related to form type. Count the number of total pages separately for Forms 3.0 and 3.1.
- The page number should be filled in as used during the survey (e.g., Page 1 of __, Page 2 of __, Page 3 of __, etc.). Forms that have been copied on both side of one sheet of paper will count as two separate pages.
- The total number of pages for each type of form is filled in at the end of the survey (e.g., Page 1 of 6, Page 2 of 6, Page 3 of 6, etc.).
- Organize the field forms by type and then by page number for easy reference. It is common to have different totals for each type.

6.1.2 Form 3.0

Study Design Information

Begin/End Survey Dates: Record the dates based on Form 3.1 that Habitat Unit Survey field data collection began and ended for that segment. The *Begin Survey Date* is a key database field used to track and identify this specific survey.

Survey Length: Where the entire segment was surveyed, record the segment length as documented in the "Study Design Information" section on the Reference Point Survey Form 2H or the database report. Where only portions of the segment were surveyed, record the total length of reach actually surveyed within the segment.

Survey Coverage: Fill-in the survey's coverage circle and percentage of the survey length that best applies to the survey. Mark *WHL* if the whole or entire segment or sub-segment was inventoried for sample collection (100%). Mark *PRT* if the survey was applied on a consecutive length of a partial segment/sub-segment. For example, where only the first 500 meters of a 2,000-meter-length segment will be inventoried for sample collection (25%). Mark *SUB* if the survey was applied using a random or systematic placement sub-sampling strategy. For example, where every other 100 meter interval reach will be inventoried for sample collection (50%). Mark *PSB* if a combination of PRT and SUB was applied. Mark *OTH* if your study design differs from the above.

Partial/Other Survey Location: These locations are associated with survey length lower and upper boundaries - that is, the boundaries encompassing the section of stream actually surveyed. Record the WRIA river/stream mile locations to the nearest tenth of a mile (0.0 - 9999.9) and reference point numbers (0 - 9999).

Methods: (Non-database information) Mark the appropriate circle identifying whether the study design uses *TFW* Habitat Unit Survey methods as described in this manual, *Mod. TFW* if a modified version of the TFW methods is used and core data can be extracted, or *Non-TFW* if data collected does not meet the minimum TFW core criteria or the core criteria cannot be extracted from the data set.

Discharge Information Section

Record all date and discharge measurements from Form 7.1 that apply to this survey.

Survey Notes Section

This section is provided to make brief notes related to segment identification, unique survey conditions, and problems encountered that affect data quality. Note any modifications to the TFW-MP Habitat Unit Survey criteria used to meet individual cooperator needs. This includes minimum surface area, residual pool depth, or other identification criteria. Additional information can be included on the back of the form or on separate sheets of paper. If separate sheets are used, they need to be included in the Page __ of __ information and have the key header information listed at the top of each page - even when using the back of a Form 3.0.

6.1.3 Form 3.1

Calculate any cumulative length and mean width measurements that were not completed in the field.

6.2 Error Checking

Error checking of field forms is a very important task and sufficient time should be taken to complete it. It is best done during or immediately after data collection. It is best done during or immediately after data collection because it becomes more difficult to reconcile discrepancies and track down correct information as time passes. Contact the TFW-MP for assistance in determining how to handle missing data fields.

Review Forms 3.0 and 3.1 plus all other documents compiled during the Habitat Unit Survey. Have a second person look them over for completeness, legibility and errors. Every page of every form requires error checking for legibility, complete and consistent header information, obvious measurement and transcription errors, and calculation errors. Work systematically through each section and when completed, put your initials and date in the "Error Checked by" box at the bottom of each page. If the person error checking the data is not a crew member, their full name and task should be recorded in the "Survey Notes" section of Form 3.0. When all field forms relating to the habitat survey have been error checked, record the initials of the responsible crew and date completed.

7. Data Management

The TFW Monitoring Program offers data management services to help cooperators quickly analyze data collected with the program methods and to produce standard monitoring reports. The heart of the service is a database system housed at the Northwest Indian Fisheries Commission. This database produces reports and archives electronic versions of the data. The database is also an important archive of monitoring data that can be used for developing study designs and identifying control or reference sites. This section describes the process for data preparation, data processing and archiving, and data analysis.

7.1 Data Preparation

Before data entry can occur for the Habitat Unit Survey, some preparation must be done. The following materials are needed:

- completed and error-checked Forms 3.0, and 3.1 as needed for each segment;
- a data entry system and set of instructions;
- an "Ambsys" data dictionary;
- a copy of completed Stream Segment Identification Form 1.0; and
- a copy of completed Reference Point Survey Form 2.H.

Before the data entry process can begin, an entry system must be selected. Choose a data entry system from the list below and request a free copy and user's manual from the TFW Monitoring Program. The database has three entry system options for survey data. These are:

- Microsoft Excel 4.0 pre-formatted spreadsheets;
- Lotus 1-2-3 (vers. 3) pre-formatted spreadsheets;
- and Microsoft Access 7.0 pre-formatted entry forms.

Select a spreadsheet format if your data requires conversion from English to metric units. Use the spreadsheet calculation functions to replace all English unit measurements with metric equivalents. Read the instructions for the data entry system and the Ambsys data dictionary, noting the field types and data constraints (what type of data can be entered into each field). Refer to Appendix E for examples of each Excel pre-formatted spreadsheet.

7.2 Data Processing, Products and Archiving

Open the section of the entry system pertaining to the Habitat Unit Survey on your computer. Following the entry system instructions, enter the data from Forms 3.0 and 3.1 as directed. After the data has been entered and the session saved, error check the entered data. The most efficient technique for this time-consuming task is to have one person read the data off the screen and another check it with the original field form. Save the file a final time once the data has been error checked. When completed, record the initials of the responsible crew and the date on Form 3.0.

Data can be sent to the TFW Monitoring Program using several different methods. Copies of all survey field forms and other documentation are required for archiving and can be hand delivered, mailed, or faxed to the program. An original or copy of a USGS topographic map is also required and can be hand delivered, mailed, or faxed. Maps must have upstream and downstream segment boundaries marked along the stream. If a photocopy of the map is used, make sure the township, range, section, contour intervals, map name, and publishing date are identified. The electronic versions of the data can be sent via e-mail, CD, or on a floppy disk. After the program receives the electronic files, the data is imported into the database by a TFW-MP staff person.

Safe and efficient archiving is also provided by the TFW Monitoring Program to save data and survey reach locations for future use. The data generated by individual cooperators is archived electronically in the database system. Hard copies of the field forms, topographic maps and supplemental information are archived at the TFW-MP facility. Access to data can be limited at the request of the cooperator contributing the data to the database. Call for information on the data access policy.

7.3 Data Analysis

The results of the data analysis are available in two reports: the Habitat Unit Survey Report and the Data Summary by Reference Point Report. Refer to Appendix E for examples.

7.3.1 Habitat Unit Survey Report

Each Habitat Unit Survey Report covers one stream segment and is divided into header information, habitat unit summary, other unit information, habitat unit location, factors contributing to pool formation, and residual pool depth sections. The following is a brief description of the information provided and data analysis by section.

Header Information: The header section of the Habitat Unit Survey Report includes stream name, WRIA number, beginning and ending survey date, segment/sub-segment number, beginning and ending reference point numbers, beginning and ending river miles, discharge dates and measurements, survey length and coverage, and survey leader name and affiliation.

Habitat Unit Summary: This table presents data on riffle and pool core habitat units. Data is summarized by three categories including pool units, riffle units, and total pool/riffle units. Four parameters are calculated including total number of units, percentage of total, total surface area, and percentage of surface area. Four additional parameters are calculated separately including habitat units per kilometer, habitat units per bankfull width, pools per kilometer, and bankfull widths per pool.

Other Unit Information: This table presents data summarized by sub-surface flow, wetland, and obscured core habitat units. Two parameters are calculated including the number of units, and total length by unit.

Habitat Unit Location: This table presents data on core habitat unit channel location. Data is summarized by four channel location categories including primary, secondary, side-channel, and tributary channel unit types. Two parameters are calculated including number of units per category, and total length of units by category.

Factors Contributing to Pool Formation (PFF): This table presents data on factors contributing to pool formation for core pool units. Data is summarized by eleven PFF factors including LWD log, LWD rootwad, LWD jam, roots of standing trees or stumps, boulders, bedrock, artificial bank, beaver dam, and other/unknown. Six parameters are calculated including total number of pools units, percent of pools units, number of times each factor was identified as the primary PFF, surface area associated with each factor as the primary PFF, and percent pool surface area.

Residual Pool Depth (RPD): This table presents data on residual pool depths for core pool units. Data is summarized by RPD categories (in meters) including 0.24, 0.25 - 0.49, 0.50 - 0.74, 0.75 - 0.99, 1.00 - 1.24, 1.25 - 1.49, 1.50 - 1.74, and 1.75 - 1.99. Four parameters are calculated including the number of pools, percent of total, surface area, and percent surface area in each category. Two additional parameters are calculated separately including mean residual pool depth and maximum residual pool depth for the survey.

7.3.2 Data Summary by Reference Point Report

The Data Summary by Reference Point Report provides analysis of habitat unit data by individual 100 meter reaches defined by their downstream and upstream reference point numbers. This report requires that a Reference Point Survey has been completed and entered into the database. The report is divided into header information, reference point, habitat unit summary, other unit information, and habitat unit location sections. The report will also include analysis of large wood debris data if the LWD survey has been completed. The following is a brief description of the data analysis by sections not covered in the LWD Survey Report.

Reference Point: The Data Summary by Reference Point Report includes the following information by reference point reach - downstream/upstream reference point numbers, distance between the reference points, bankfull width and depth, canopy closure individual and percent measurements.

Habitat Unit Summary: This table presents data on riffle and pool core habitat units. Data is summarized by three categories including pool units, riffle units, and total pool/riffle units. Four parameters are calculated including total number of units, percentage of total, total surface area, and percentage of surface area. Four additional parameters are calculated separately including

habitat units per kilometer, habitat units per bankfull width, pools per kilometer, and bankfull widths per pool.

Other Unit Information: This table presents data summarized by sub-surface flow, wetland, and obscured core habitat units. Two parameters are calculated including the number of units, and total length by unit.

Habitat Unit Location: This table presents data on core habitat unit channel location. Data is summarized by four channel location categories including primary, secondary, side-channel, and tributary channel unit types. Two parameters are calculated including number of units per category, and total length of units by category.

8. References

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9. Appendixes

Appendix A
Form 3.0 and 3.1 Copy Masters

Appendix B
Completed Examples of Forms 3.0 and 3.1

Appendix C
Habitat Criteria and Code Field Sheet Copy Master

Appendix D
Standard Field and Vehicle Gear Checklist Copy Master

Appendix E
Data Management Examples

Appendix A

Form 3.0 and 3.1 Copy Masters

(Keep original copy master with manual)

TFW Monitoring Program

Stream Name

Page ___ of ___

HABITAT UNIT SURVEY

HEADER INFORMATION

FORM 3.0

WRIA # ___.___ Unlisted Trib ○RB ○LB ___ **Segment #** ___ ___ Sub-Segment Code **Date** ___/___/___

Study Design Information

Begin Survey Date ___/___/___

End Survey Date ___/___/___

Survey Length

Survey Coverage **Percentage**

- ○ WHL (Whole) 100 %
- ○ SUB (Sub-sample) ___%
- ○ PRT (Partial) ___%
- ○ PSB (Partial Sub-sample) ___%
- ○ OTH (Other) ___%

Partial/Other Survey Location

WRIA River Mile: from ___ to ___

Reference Points: from ___ to ___

- ○ TFW
- ○ Mod. TFW
- ○ Non-TFW

Survey Criteria

Mean Segment BFW ___

Minimum Surface Area ___

Minimum Residual Pool Depth ___

Sub-Unit Type

Code	*Name*

○ *continued page* ___

Discharge Information

#1 Date __/__/___ __.__

#2 Date __/__/___ __.__ ○ CMS ○ CFS

#3 Date __/__/___ __.__

Survey Crew

Name	*Affiliation*	
		(Lead)
		(Rec.)

Crew Lead: Year of most recent Habitat Training ___ QA Review ___

Survey Notes

○ *continued page* ___

Equipment ○ Metric ○ English	Type	Size	Cond	Accu-racy	Pre-Calibrated	Post-Calibrated

Form 3.0
Error Checked by: ___ Date: ___/___/___

All Field Forms
Error Checked by: ___ Date: ___/___/___

All Data Entry
Error Checked by: ___ Date: ___/___/___

TFW Monitoring Program

Stream Name

Crew Lead ____
Recorder(s) ____ ____

HABITAT UNIT SURVEY

○ METERS
○ FEET

FIELD DATA

Minimum Criteria
____ Surf. area ____ RPD

FORM 3.1

WRIA # __ __ . __ __ __ __

Unlisted Trib ______ ○ RB ○ LB

Segment # ______

______ Sub-Segment Code

Date ____/____/______

Unit #	DWN Ref Pt #	CORE Unit Type	SUB Unit Type	Unit Cat	Length Measurements (Single or Cummulative only)	UNIT Length (Total)	Width Measurements	UNIT Width (Average)	POOL Max Depth	POOL Out Depth	POOL Form Fact	Field Notes
					( )( )( ) ( )( )( )		( )( )( )( )( )( ) ( )( )( )( )( )( )				○	
					( )( )( ) ( )( )( )		( )( )( )( )( )( ) ( )( )( )( )( )( )				○	
					( )( )( ) ( )( )( )		( )( )( )( )( )( ) ( )( )( )( )( )( )				○	
					( )( )( ) ( )( )( )		( )( )( )( )( )( ) ( )( )( )( )( )( )				○	
					( )( )( ) ( )( )( )		( )( )( )( )( )( ) ( )( )( )( )( )( )				○	
					( )( )( ) ( )( )( )		( )( )( )( )( )( ) ( )( )( )( )( )( )				○	
					( )( )( ) ( )( )( )		( )( )( )( )( )( ) ( )( )( )( )( )( )				○	
					( )( )( ) ( )( )( )		( )( )( )( )( )( ) ( )( )( )( )( )( )				○	
					( )( )( ) ( )( )( )		( )( )( )( )( )( ) ( )( )( )( )( )( )				○	
					( )( )( ) ( )( )( )		( )( )( )( )( )( ) ( )( )( )( )( )( )				○	
					( )( )( ) ( )( )( )		( )( )( )( )( )( ) ( )( )( )( )( )( )				○	
					( )( )( ) ( )( )( )		( )( )( )( )( )( ) ( )( )( )( )( )( )				○	
					( )( )( ) ( )( )( )		( )( )( )( )( )( ) ( )( )( )( )( )( )				○	
					( )( )( ) ( )( )( )		( )( )( )( )( )( ) ( )( )( )( )( )( )				○	

ERROR CHECKED by: ____ Date: ___/___/___

Appendix B

Completed Examples of Forms 3.0 and 3.1

TFW Monitoring Program

Stream Name DESCHUTES RIVER

HABITAT UNIT SURVEY — HEADER INFORMATION — FORM 3.0

WRIA # 13.0028 | Unlisted Trib ○RB ○LB | Segment # 12 | 6 Sub-Segment Code | Date 6/28/98

Study Design Information

Begin Survey Date 6/29/98
End Survey Date 7/2/98

Survey Length 1750 m

Survey Coverage		Percentage
● WHL	(Whole)	100 %
○ SUB	(Sub-sample)	____ %
○ PRT	(Partial)	____ %
○ PSB	(Partial Sub-sample)	____ %
○ OTH	(Other)	____ %

Partial/Other Survey Location
WRIA River Mile: from ____ to ____
Reference Points: from ____ to ____

● TFW
○ Mod. TFW
○ Non-TFW

Survey Criteria

Mean Segment BFW	19.5 m
Minimum Surface Area	3.0 m²
Minimum Residual Pool Depth	0.35 m

Sub-Unit Type

Code	Name
LGR	LOW GRADIENT RIFFLE < 4%
PLG	PLUNGE POOL > 0.5 m
GLD	GLIDE
DAM	DAM POOL
CAS	CASCADE ≥ 4%
SCR	SCOUR POOL ○ *continued page* ___

Discharge Information

#1 Date 6/28/98 0.50
#2 Date 7/2/98 0.51 ● CMS ○ CFS
#3 Date ___/___/___ ___

Survey Crew

Name	Affiliation
DEVIN SMITH	TFW MONITORING PROGRAM (Lead)
AMY MORGAN	" (Rec.)

Crew Lead: Year of most recent Habitat Training '98 QA Review '98

Survey Notes

- SUB UNIT TYPE CRITERIA: NICKELSON ET AL. 1992
- DS TOOK PHOTOS
- SIDE CHANNEL (LB) RP 6-8
- 6 GRAB SAMPLE WATER TEMPS IN MIXED AREA OF POOLS AND RIFFLES #1, 15, 21, 39, 57, & 86. RANGE 16-19°C

* EXAMPLE DATA ONLY *

① ERROR CHECKING BY ALLEN PLEUS, TFW-MP

○ *continued page* ___

Equipment ● Metric ○ English

Equipment	Type	Size	Cond	Accuracy	Pre-Calibrated	Post-Calibrated
FIBERGLASS TAPE #035	KESON	30.0	6000	± 0.01	5/4/98	7/20/98
STADIA ROD #007	MOUND CITY	5.0	"	"	"	"
ABNEY LEVEL #042	LIETZ 5047-15	0 to ±90°	"	± 1°	"	"
CHEST WADERS						
CAMERA	MINOLTA WEATHERMATIC	35mm	W/30mm lens			
FILM	SLIDE	36 exp	400 EI	ROLL # 009		

① Form 3.0 Error Checked by: AP Date: 7/23/98
All Field Forms Error Checked by: AP Date: 7/23/98
All Data Entry Error Checked by: AP Date: 7/28/98

TFW Monitoring Program | Stream Name DESCHUTES RIVER | Crew Lead DS / Recorder(s) AM — | Page 2 of 22

HABITAT UNIT SURVEY

(●) METERS ( ) FEET

FIELD DATA 3.0 Minimum Criteria Surf. area 0.35 RPD

FORM 3.1

WRIA # 13.0028 | Unlisted Trib ( ) RB ( ) LB ___ | Segment # 12 | b Sub-Segment Code | Date 6/29/98

Unit #	DWN Ref Pt #	CORE Unit Type	SUB Unit Type	Unit Cat	Lenght Measurements (Single or Cummulative only)	UNIT Length (Total)	Width Measurements	UNIT Width (Average)	POOL Max Depth	POOL Out Depth	POOL Form Fact	Field Notes (RB = RIGHT BANK, LB = LEFT BANK)
15	Ø	R	CAS	2	(3.0)	3.0	(5.2)(4.1)	4.7				5%
16		R	LGR	2	(2.3)	2.3	(2.1)(2.5)	2.3				4.5%
17		R	CAS	1	(22.0)(8.3)	30.3	(2.2)(2.1)(2.8)(4.0)(3.2)(3.8)(3.8)(4.2)(4.1)	3.4				
18	↓	P	SCR	1	(11.2)	11.2	(4.1)(4.6)(3.0)(2.8)(2.3)	3.4	1.19	0.20	8 1 4	UNDERCUT RB - 2 WIDTH MEAS TO VISUAL EDGE
18	1	P	SCR	1	(21.8)	21.8	(6.3)(5.2)(9.6)(9.8)(8.3)(5.0)(5.6)(6.5)	7.0	—			EXAMPLE
19		P	SCR	2	(5.7)	5.7	(2.2)(2.5)	2.4			1 8	* DATA *
20		R	LGR	1	~~(23.2)~~(22.0)	22.0	(5.6)(5.8)(5.6)(6.3)(5.5)(5.9)	5.8				ONLY
21		P	PLG	1	(19.0)	19.0	(3.6)(3.7)(9.9)(10.3)(15.2)(14.3)(6.3)	9.0	1.00	0.21	1 2	SMALL TRIB/SPRING LB
22		R	GLD	1	(12.2)	12.2	(4.6)(4.3)(4.3)(4.2)(3.2)	4.1				
23		P	SCR	2	(5.2)	5.2	(1.7)(1.9)(2.0)(2.1)	1.9	0.42	0.05	1	
24		P	SCR	1	(17.9)	17.9	(7.3)(6.3)(6.8)(5.8)~~(5.0)~~(5.8)(4.8)	6.1	1.64 ①	0.34	3 1 4	LWD JAM - COMPLEX M2 MEAS ① DEEPER AREAS - NO ACCESS
25		R	~~GLD~~ CAS	1	(5.2)	5.2	(3.5)(4.9)(6.9)	5.1				6%
26		P	~~SCR~~ DAM	1 ①	(18.6)(2.2)	20.8	(5.1)(6.3)(7.6)(14.7)(18.0)(13.0)(8.3)(6.1)	9.9	1.16	0.29	3 4	SAME LWD JAM AS # 24 CREATING UPSTREAM DAM POOL
27	↓	R	LGR	2	(9.6)	9.6	(2.7)(4.8)(3.9)(1.7)	3.3				

MORE 2

ERROR CHECKED by: DS Date: 6/30/98 | 5/13/99 | forms\99\F3-1.p65

Appendix C

Habitat Criteria and Code Field Sheet Copy Master

(Keep original copy master with manual)

APPENDIX C

Habitat Unit Survey Criteria & Code Field Sheet

Code	Core Unit Types		
R	Riffle	Everything is a Riffle unless proven otherwise	
P	Pool	Meets minimum m2 and RPD criteria	
S	Sub-Surface	No water across main bankfull channel	
O	Obscured	Cannot identify unit type or meas. Min surf. Area	
W	Wetland	Not dominated by fluvial process	

General three step process

1. Identify unit type (test criteria)
2. Identify the boundaries of the unit
   (use confinement/default method & mark)
3. Measure the surface area
   (length baseline & systematic widths)

Code	Pool Forming Factors (Pool Form Fact)
1	Log*
2	Rootwad*
3	Debris Jam* *(meets LWD criteria)
4	Roots of standing tree/stump
5	Rock or Boulder
6	Bedrock
7	Channel Bedform
8	Scour-resistant bank
9	Artificial bank
10	Beaver dam
11	Other

> Identify primary (circle)
> Identify up to 3 more

Code	Unit Category (Cat)		
1	Primary unit	> 50% wetted width	
2	Adjacent unit	< 50% wetted width	
3	Side channel unit	Separated by Island*	
4	Tributary channel unit		

*Island criteria:
1) the length of the island above the BFC = 2 X the estimated BFW;
2) it is vegetated by two or more perennial plants that are greater than 2 m in height.

Residual Pool Depth (RPD)

(measured from channel bed to water surface)

Max Depth of pool at deepest point

Out Depth of pool at downstream end where water would last flow in a drought

RPD Max - Out = RPD (NOT RECORDED OR FIELD CALCULATED)

Lumpers & Splitters

> Core unit boundaries are identified before splitting out sub-units
> There is only one qualifying outlet for a given pool
> QA Review Note: Unit boundary ID is largest variability factor between crews
1. In difficult boundary ID situations - do easy part first
2. Use confidence/default technique to identify difficult boundaries
3. Mark boundaries with weighted or wire flags

Minimum Unit Criteria (Meters)		
Mean Seg BFW (m)	**Min m^2**	**Min RPD**
< 2.5	0.5	0.10
2.5 - 5.0	1.0	0.20
5.0 - 10	2.0	0.25
10 - 15	3.0	0.30
15 - 20	4.0	0.35
>/= **20**	5.0	0.40

Minimum Unit Criteria (Feet)		
Mean Seg BFW (feet)	**Min $ft.^2$**	**Min RPD** (feet/tenths)
< 8.2	5.4	0.33
8.2 - 16.4	10.8	0.66
16.4 - 32.8	21.5	0.82
32.8 - 49.2	32.3	0.98
49.2 - 65.6	43.1	1.15
=/> **65.6**	53.8	1.31

Appendix D

Standard Field and Vehicle Gear Checklist Copy Master

(Keep original copy master with manual)

APPENDIX D

✔ STANDARD FIELD GEAR

☐ Field clip board/form holder
☐ Survey Forms (on waterproof paper)
☐ Copy of survey methods
☐ Maps- topographic and road
☐ Pencils & erasers
☐ Permanent ink marker
☐ Calculator
☐ 150 mm ruler
☐ Pocket field notebook

☐ Survey Vest
☐ Compass
☐ Safety whistle
☐ Spring clips (2)
☐ Vinyl flagging
☐ Pocket knife/multi-purpose tool

☐ Backpack or canvas tote bag
☐ First aid kit
☐ Water bottle and/or filtration system
☐ Food/energy bars
☐ Rain gear
☐ Leather gloves
☐ Safety glasses
☐ Bug repellant
☐ Sun screen
☐ Small flashlight or headlamp
☐ Matches/fire starter
☐ Emergency blanket
☐ Snake bite kit (eastern Washington)

✔ STANDARD VEHICLE GEAR

☐ Waterproof plastic tote box
☐ Backup fiberglass tape
☐ Comprehensive first aid kit
☐ Rain tarp
☐ Rope (100 ft.)
☐ Extra water
☐ Extra food
☐ Extra dry clothes
☐ Extra batteries

☐ Spare tire/jack/tire iron
☐ Tire sealant/inflator
☐ Tow strap
☐ Come-along winch
☐ Fire shovel
☐ Fire extinguisher
☐ CB radio (to monitor logging activity)
☐ Cell phone/VHF radio
☐ Brush cutter
☐ Ax/bow saw/chain saw
☐ Tire chains

✔ For remote work, extra survival & safety gear is recommended.

This gear list is provided as a guideline for outfitting field crews and is not intended to cover all situations. Local conditions may require additional or different gear.

Appendix E

Data Management Examples

EXAMPLE: Excel Data Entry Spreadsheet Fields

TFW Monitoring
Habitat Survey Header

wria basin	wria stream	trib	segm	sub segm	begin survey date	end survey date	leader first name	leader last name	leader affiliation	recorder first name
> > > >										

recorder last name	recorder affiliation	begin ref pt	end ref pt	beginning river mile (mi)	ending river mile (mi)	discharge 1 date	discharge 1 flow (cms)	discharge 1 down ref pt	discharge 1 dist above ref pt (m)	discharge 2 date
> > > >										

discharge 2 flow (cms)	discharge 2 down ref pt	discharge 2 dist above ref pt (m)	discharge 3 date	discharge 3 flow (cms)	discharge 3 down ref pt	discharge 3 dist above ref pt (m)	survey length (m)	survey coverage	survey percentage (%)	field notes

EXAMPLE: Excel Data Entry Spreadsheet Fields

TFW Monitoring
Habitat Survey Data

wria basin	wria stream	trib	segm	sub segm	beginning survey date	habitat unit date	unit dwnstr ref pt	unit num	unit type	unit sub-type	unit cat (1-3)
>>>>	unit length (m)	unit width (m)	max pool depth (m)	pool outlet depth (m)	pool obst 1 (1-11)	pool obst 2 (1-11)	pool obst 3 (1-11)	pool obstr 4 (1-11)	field notes	entry date	

TFW Monitoring

Habitat Unit Survey Report

Stream Name: MCLANE CREEK WRIA: 13.0138 .000

Survey Date: 8/22/94 to 8/24/94 Segment: 6 sub: 0

Reference Points: 0 to 13
River Miles: 2.5 to 3.4

Discharge	Date	Flow (cms)
1	08/23/199	0.013
2		
3		

Svy Length (m)/Coverage: 1323 /
Survey Leader: WILL HENDERSON
Affiliation: SQUAXIN ISLAND TRIBE

Habitat Unit Summary

Unit Type	Total Number	Percentage of Total	Total Surface Area (sq. meters)	Percentage of Surface Area
Cascades	68	23.10%	310.06	6.60%
Pools	94	32.00%	2358.45	50.50%
Riffles	132	44.90%	2004.61	42.90%
Tailouts	0	0.00%	0.00	0.00%
Total	294		4673.12	

Habitat Units per Kilometer: 222.22
Habitat Units per Bankfull Width: 1.16
Pools per Kilometer: 71.05
Bankfull Widths per Pool: 2.70

Other Unit Information

Unit Type	Number	Total Length
Obscured Units	3	17.1
Subsurface Flow U	0	0
Wetland Units	0	0

Habitat Unit Location

Unit Category	Number of Units	Total Length
Primary Units	228	1467.22
Secondary Units	67	289.70
Side-channel Units	2	9.30

TFW Monitoring

Habitat Unit Survey Report

Factors Contributing to Pool Formation (PFF)

Description	Total Number	% of Units	Number Identified as Primary PFF	% of Primary PFF	Surface Area Associated w/ Primary PFF	% Pool Surface Area
Log	67	71.28%	63	67.02%	1415.07	60.00%
Beaver Dam	4	4.26%	4	4.26%	387.01	16.41%
Other/Unknown	0	0.00%	0	0.00%	0.00	0.00%
Rootwad	1	1.06%	0	0.00%	0.00	0.00%
Debris Jam	7	7.45%	3	3.19%	72.28	3.06%
Roots or Stump	25	26.60%	15	15.96%	295.03	12.51%
Rock or Boulder	0	0.00%	0	0.00%	0.00	0.00%
Bedrock Outcrop	0	0.00%	0	0.00%	0.00	0.00%
Channel Bedform	1	1.06%	1	1.06%	7.26	0.31%
Resistant Bank	13	13.83%	8	8.51%	181.81	7.71%
Artificial Bank	0	0.00%	0	0.00%	0.00	0.00%
Total	118		94		2358.46	

Residual Pool Depth

RPD Category (m)	Number of Pools	Percent of Total	Surface Area	% Surface Area
<= 0.249	2	2.13%	9.68	0.20%
0.250 - 0.4	69	73.40%	1231.94	26.04%
0.500 - 0.7	22	23.40%	719.56	15.21%
0.750 - 0.9	0		0.00	
1.000 - 1.2	1	1.06%	313.80	6.63%
Total	94		2274.98	

Mean Residual Pool Depth (m): 0.39

Max Residual Pool Depth (m): 1.15

TFW Monitoring

Data Summary by Reference Point Report

Stream Name: KENNEDY CREEK
WRIA: 14 .0012 .000
RFP Survey Date: 10/03/1994 to 10/03/1994
Segment: 8 sub: 0
HAB Survey Date: 10/03/1994
LWD Survey Date: 10/03/1994
Survey Length: 300
River Miles: 4 to 4.2
Survey Coverage:
Survey Leader: MICHELLE STEVIE
Affiliation: SQUAXIN ISLAND TRIBE

Reference Point	Dist between	Bank		Canopy Closure					
	Ref Pts	Width	Depth	Upstr	Rt Bnk	Dnstr	Lft Bnk	% Closure	Multi-Chan
0 - 1	100 mtrs	7.20	0.250					51	

Habitat Unit Summary

Unit Type	Total Number	Percentage of Total	Total Surface Area (sq. meters)	Percentage of Surface Area
Cascades	4	21.10%	31.89	3.90%
Pools	6	31.60%	620.95	75.10%
Riffles	9	47.40%	174.51	21.10%
Tailouts	0	0.00%	0	0.00%

Habitat Units per Kilometer: 190.0
Habitat Units per Bankfull Width: 1.5

Other Unit Information

Unit Type	Number	Total Length
Obscured Units	0	0
Subsurface Flow U	0	0
Wetland Units	0	0

Habitat Unit Location

Unit Category	Number of Units	Total Length
Primary Units	11	109.10
Secondary Units	5	32.10
Side-channel Units	3	11.20

TFW Monitoring

Data Summary by Reference Point Report

Total Piece Summary (Individual and Debris Jam Pieces)

	Number of Pieces	Percent of Total Pcs	LWD per Chan Width	LWD per Kilometer	# of Key Pieces	Prcnt LWD / Key Pieces	Key Pcs per Chan Width	Key Pieces per Kilometer
Rootwads	2	100.0%	0.16	20.0	0	0.00	0	0
Logs >=10 <20cm	12	42.9%	0.98	120.0	0	0.00	0	0
Logs >=20 <50cm	25	47.2%	2.03	250.0	0	0.00	0	0
Logs >= 50cm	13	81.3%	1.06	130.0	1	0.06	0.0813	10
Total	52		4.22	520.0	1	0.06	0.0813	10

	Number of Pieces	Mean Diam (cm)	Mean Len (m)	Total Vol (m3)	Mean Vol (m3)	Total In-Chan Vol (m3)	Mean In-Chan Vol (m3)	In-Chan Vol/CW (m3)	In-Chan Vol/Km
Rootwads	2	0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.0
Logs >= 10 <20 cm	12	14.8	3.6	0.734	0.061	0.424	0.035	0.034	4.2
Logs >= 20 <50 cm	25	30.9	5.4	10.175	0.407	8.925	0.357	0.725	89.2
Logs >= 50 cm	13	64.5	5.9	29.358	2.258	7.489	0.576	0.609	74.9
Total	52			40.267	2.726	16.837	0.968	1.368	168.4

Debris Jam Summary

Number of Debris Jams	Debris Jams per Kilometer	Logs >=10 <20 cm	Logs >=20 <50 cm	Logs >=50 cm	Rootwads	Number Total Pieces	Number Key Pieces	Percent Key Pieces
2	20	8	17	11	2	38	0	0