Field Survey Procedure - Large Woody Debris (LWD) & Logjams

Restoration Monitoring Guidance

3 April 2025

Document details	A LWD and logjam survey, including a 1-page field method (Appendix A) and a field data form (Appendix B), for the purpose of monitoring changes in reach LWD magnitude and configuration.
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Document history

Version	Revision	Author	Reviewed by	Date	Comments
Draft	0.1	Nicci Zargarpour	Oliver Franklin	3-April-2024	added comments
Draft	0.2	Nicci Zargarpour			Comments addressed in tracked changes. Added additional variables.
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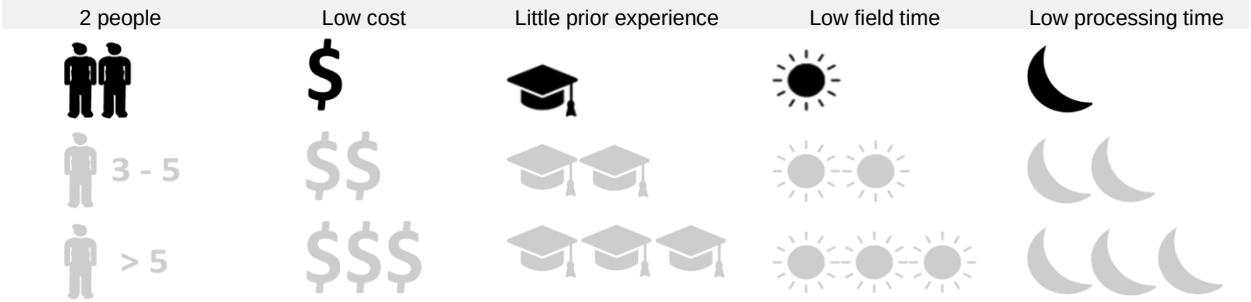
Draft	0.5	Nicci Zargarpour	Oliver Franklin	3 April 2025	Addressed comments. Changes tracked. Added content around survey timing and reach length.

Resource Commitments



CONTENTS

Acronyms and Abbreviations

GPS	Global Positioning System
LWD	Large Woody Debris

1. OVERVIEW

Please refer to 'APPENDIX A: Large Woody Debris (LWD) & Logjam Survey 1-Pager' for a concise step-by-step field method, intended for quick-reference in the field. The main body of this document provides further context and some relevant background.

Large Woody Debris (LWD) plays an important role in forested stream ecosystems and contributes to the creation and maintenance of fish habitat. From an ecological perspective, LWD serves a key role in biogeochemical cycling (Bilby 2003, Battin et al. 2008, Marttila 2018), and is an important structural component in aquatic habitats, providing cover and increasing habitat complexity (Dolloff and Warren 2003). From a geomorphological perspective, LWD influences pool formation (Beechie and Sibley 1997, Gurnell and Sweet 1998, Rosenfeld and Huato 2003), sediment storage (Montgomery et al. 1996, Thompson 1995), flow resistance (Shields and Gippel 1995, Curran and Wohl 2003), and longitudinal variation in channel depth and width (Montgomery et al. 2003). These processes have, in turn, been linked to the creation of fish and invertebrate habitat (Lemly and Hilderbrand 2000, Mossop and Bradford 2004). Consequently, maintaining or restoring the quality and quantity of LWD within stream systems is an important component of fish habitat restoration.

The objective of this protocol is to provide a repeatable methodology that can be used to monitor the abundance, characteristics and function of LWD in wadeable streams. This protocol collects information regarding the number, physical dimensions, orientations, and positions of LWD pieces and logjams over the entire length of the focal reach. Derived metrics provided in our data analysis guidance (.html and .rmd files) allow comparisons over time and between control/reference and restoration sites, to assess the impact of restoration actions in quantity, quality, and functional parameters associated with wood.

LWD and logjam surveys should be conducted during periods of low to moderate flow, when discharge conditions are most stable (ideally in late summer or early fall). Repeat surveys should be carried out under similar discharge conditions to allow for meaningful comparisons across stream reaches and detect trends over time,

A summary of the required equipment for LWD and logjam surveys is provided in Table 1.

Table 1: Equipment Checklist - LWD and Logjam Surveys

Item	
Field forms (waterproof)/Tablet	☐
Camera	☐
GPS	☐
Measuring tape	☐
Range finder	☐
Depth rod/metre stick	☐
Chest waders	☐
Personal floatation device	☐
Throw bag	☐

Note: This list includes only equipment necessary for performing LWD surveys and does not include items required for remote work, wildlife safety, or equipment cleaning/decontamination.

1.1 Key Terminology

This section briefly covers important concepts and definitions relevant to this protocol.

Active Floodplain / Active Bench

Adjacent to the streambank, the active floodplain is a relatively flat depositional area which often features distinct vegetation communities (typically with a relative abundance of hydrophytic obligate to facultative vegetation), rafted debris, and/or recent alluvium. It is an area that we expect to be inundated by the 1 in 5 year return period flow. The active floodplain may be a section of a broader floodplain that includes areas historically but not presently subject to inundation.

Bankfull

Bankfull is the water level (stage) of the watercourse at which any further rise would cause the watercourse to flow over the banks and onto the floodplain. The bankfull mark (boundary) can be recognised by a transition in soil/substrate and rooted vegetation, whereby the regular action of flows in ordinary years distinguishes the areas below the bankfull mark from those above.

Bankfull height (also referred to as bankfull depth) indicates the difference in elevation from the bankfull mark to the thalweg at that particular cross-section.

Bankfull width indicates the horizontal distance, measured perpendicular to the stream flow, between bankfull mark on the left bank and bankfull mark on the right bank, including only those sections of the stream that are beneath the elevation of the bankfull stage (i.e., would be underwater at bankfull flows). As such, bars are included in the bankfull width, but the widths of vegetated islands are not.

Large Woody Debris (LWD)

In this protocol, LWD is defined as a piece of wood that is ≥ 10 cm in diameter and ≥1 m long. Wood of this size and larger can play a key role in shaping channel form and influencing function.

1.2 Determining Focal Reach Length

Typically, a representative section of the focal reach is surveyed. The length of the reach surveyed is based on the measured bankfull width at a ‘typical’ location of the focal reach of the impact

(restoration) site. It is recommended that three to five measurements of bankfull width are obtained and averaged while the reach is initially explored, to generate a reasonable estimate of bankfull width. The length of surveyed reach will then be:

a. 20 x bankfull width, if the bankfull width is 7.5 m or greater; or

b. 150 m, if the bankfull width is < 7.5 m; or

c. The full reach, if the reach is < 150 m in length.

This focal reach length, based on the impact (restoration) reach, will also be applied to the control/reference sites and kept consistent for any future surveys. In general, the assessed focal reach will be centred on the location of the restoration action, and the centre of an equivalent control/reference reach, and will not feature (or will note) any atypical features.

2. LWD SURVEY PROCEDURE

Working from the downstream end of the focal reach towards the upstream end, count and classify qualifying LWD pieces within the focal reach following the steps outlined below. Data collection forms are presented in Appendix B.

Step 1 - Identify qualifying LWD within the bankfull channel

- LWD size qualifications:
  - Each piece must be ≥ 1 m in length. The length of LWD with attached roots is measured from the lowest end of the root mass to the top of the trunk (Figure 1).
  - Each piece must have a diameter ≥ 10 cm measured at the midpoint of the piece. For LWD with attached roots, the diameter is measured at the midpoint between where the main stem joins the root mass (e.g., root collar) and the top of the piece (Figure 1). For pieces that are not evenly round, measure the widest axis.
- For pieces that are cracked or broken, include the entire length when the two pieces are touching at any point along the break. Treat them separately if they are not touching along the break (Figure 2).

Note: Count all qualifying LWD pieces within the entire bankfull channel of the focal reach.

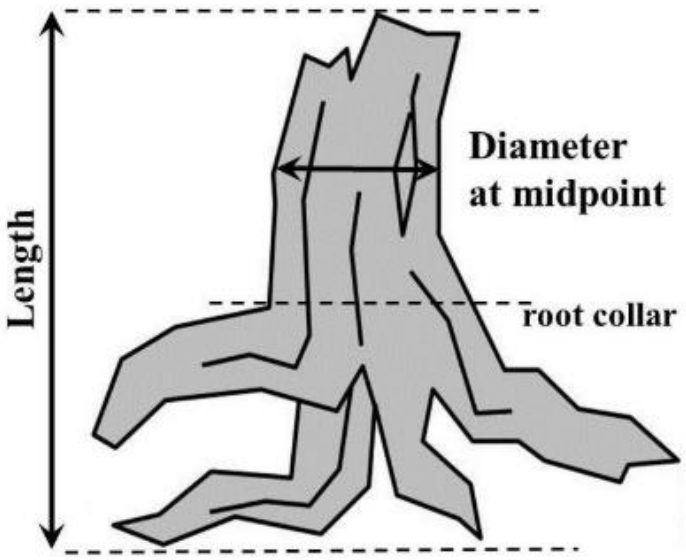


Figure 1: Diameter and length measurement locations for LWD with attached roots (Source: CHaMP 2016).

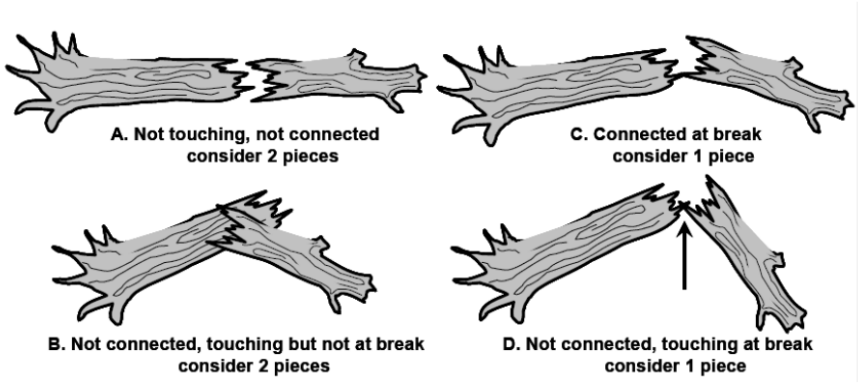


Figure 2: Variations that may be seen in how pieces may be touching vs. not touching along a break (Source: Crawford 2011).

Step 2 – Classify qualifying LWD as 'wet' or 'dry'

- Classify piece as 'wet' if a portion of the main stem or root that touches the water is ≥ 10 cm in diameter (Figure 3).
- Classify piece as 'dry' if a portion of the main stem or root ≥ 10 cm in diameter intersects the bankfull channel but is outside of the wetted channel (i.e., would get wet at bankfull flows; Figure 3).
- LWD outside of the bankfull channel are NOT counted.

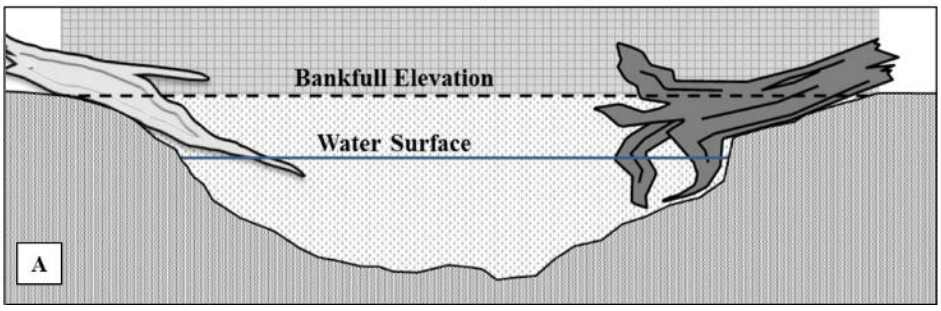


Figure 3: Channel cross-section showing LWD wet/dry classification (Source: CHaMP 2016). LWD piece on the left side is classified as "dry" because the portion of the piece touching the water is <10 cm in diameter. LWD piece on the right is "wet" because a root ≥ 10 cm diameter touches the water.

Step 3 – Record the length, diameter, and orientation of qualifying LWD pieces

- Measure and record the length and diameter of the first 10 qualifying LWD pieces encountered within the focal reach. Record length to the nearest 0.1 m and diameter to the nearest 0.01 m
- Visually estimate and record the length and diameter of the next 9 LWD pieces and measure the 10th. Repeat this process of measuring every 10th piece until all qualifying pieces have been recorded. The same person will make all estimates for a given reach. Record the name of the estimator on the data sheet.
- For each piece of LWD, record whether the rootwad is present or absent.
- In instances where a piece cannot be measured accurately, estimate the length and diameter and measure a different qualifying piece.

- Observe and record the orientation of LWD relative to the direction of flow. This provides a readily obtained, quantitative metric for assessing stability and transport processes (Wohl et al. 2010). Orientation categories are as follows (Adapted from Magilligan et al. 2008; Figure 4):
  - Zone A: parallel to flow irrespective of rootwad orientation
  - Zone B: perpendicular to flow
  - Zone C: oblique to flow with the larger-diameter end oriented upstream
  - Zone D: oblique to flow with the larger-diameter end oriented downstream
  - Zone E: oblique to flow, larger-diameter end is unclear

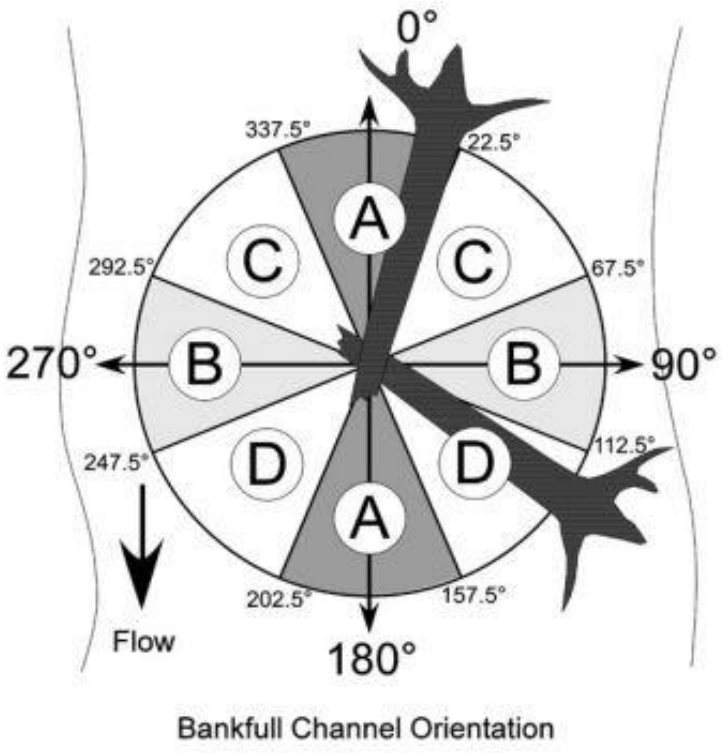


Figure 4: Orientation of LWD by zone (Source: Magilligan et al. 2008). Note, Zone E (i.e., oblique to flow, larger-diameter end unclear) is not pictured.

Step 4 – Categorize qualifying LWD by stability

Classify each piece of LWD based on the stability classes presented in Table 2. Characterizing the relative stability/mobility of the wood based on its position, degree of burial, and association with other wood may provide information about the geomorphic function of the wood (e.g., promotion of scour or retention of sediment) as well as the method of recruitment (Wohl et al. 2010).

Table 2: LWD Stability Classifications (Adapted from: Wohl et al. 2010)

Stability Classes

Category	Description
Unattached	Entire piece is contained within bankfull channel and no portion is buried or pinned
Ramp	One end in channel, the other end above bankfull channel
Pinned	All or a portion is lodged beneath other pieces of wood in the stream
Buried	All or a portion is buried in the streambed or in the streambank, below and/or forming bankfull
Cabled	LWD piece is anchored in place with cable

3. LOGJAM SURVEY PROCEDURE

In this protocol, logjams are defined as collections of three or more pieces of LWD (i.e., ≥ 10 cm in diameter and ≥ 1 m long) that physically contact each other. Logjams within the focal reach will be evaluated as follows:

Step 1 – Record the location of the logjam

- Mark the location of each logjam with a handheld GPS unit and record the coordinates.

Step 2 – Count the number of LWD pieces that contribute to the structure

- Tally the total number of LWD pieces in the jam.

Step 3 – Measure the dimensions of the logjam

- Measure and record the dimensions (length, width, height) of the logjam.

Step 4 – Classify the jam type

- Classify the logjam type based on the following categories (Adapted from: Wallerstein and Thorne 2004):
  - **Underflow Jam:** logjam spans the channel at the bank top level. At bankfull flow, water moves primarily under the jam.
  - **Dam Jam:** logjam spans the channel width and blocks flow. At bankfull flow, water primarily moves through the logjam.
  - **Deflector Jam:** logjam is shorter than the channel width so that flow is deflected toward one or both banks.
  - **Flow Parallel:** logjam is predominantly aligned parallel to the flow.

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APPENDIX A: LARGE WOODY DEBRIS (LWD) & LOGJAM SURVEY 1-PAGER

Criteria for qualifying LWD:

- LWD must be ≥ 10 cm in diameter and ≥ 1 m long.
    - Length:
        - Measured from the lowest end of the root mass to the top of the trunk (Figure 1, following page).
    - Diameter:
        - **For LWD with no attached roots** diameter is measured at the midpoint of the piece.
        - **For LWD with attached roots**, diameter is measured at the midpoint between where the mainstem joins the root mass (e.g., root collar) and the top of the piece (Figure 1).
- For pieces that are cracked or broken, include the entire length when the two pieces are touching at any point along the break. Treat them separately if they are not touching along the break (Figure 2).

Record the following for each piece of qualifying LWD in the focal reach:

1. **Length** to the nearest 0.1 m. Measure for the first 10 pieces, visually estimate for the next 9 pieces and measure the 10th, repeat.
2. **Diameter** to the nearest 0.01 m. Measure for the first 10 pieces, visually estimate for the next 9 pieces and measure the 10th, repeat.
3. **Classify each piece as 'wet' or 'dry'**
    a. **'wet'** if any portion of the LWD that touches the water is ≥ 10 cm in diameter.
    b. **'dry'** if any portion of the LWD ≥ 10 cm in diameter intersects the bankfull channel but is outside of the wetted channel (i.e., would get wet at bankfull flows).
4. **Record rootwad presence/absence**
5. **Orientation** relative to the direction of flow (Figure 3):
    a. Zone A: parallel to flow irrespective of rootwad orientation
    b. Zone B: perpendicular to flow
    c. Zone C: oblique to flow with the larger-diameter end oriented upstream
    d. Zone D: oblique to flow with the larger-diameter end oriented downstream
    e. Zone E: oblique to flow, larger-diameter end is unclear
6. **Stability** Classification:
    a. Unattached: Entire piece is contained within bankfull channel and no portion is buried or pinned
    b. Ramp: One end in channel, the other end above bankfull channel
    c. Pinned: All or a portion is lodged beneath other pieces of wood in the stream
    d. Buried: All or a portion is buried in the streambed or in the streambank, below and/or forming bankfull
    e. Cabled: LWD piece is anchored in place with cable

Criteria for qualifying Logjam:

- Collections of three or more pieces of LWD (i.e., ≥ 10 cm in diameter and ≥ 1 m long) that physically contact each other.

1. **Mark the location** of each logjam with a handheld GPS unit and record the coordinates.
2. **Tally the total number of LWD pieces in the jam.**
3. **Measure and record the dimensions (length, width, height) of the logjam.**
4. **Classify the logjam type based on the following categories:**
    a. Underflow Jam: logjam spans the channel at the bank top level. At bankfull flow, water moves primarily under the jam.
    b. Dam Jam: logjam spans the channel width and blocks flow. At bankfull flow, water primarily moves through the logjam.
    c. Deflector Jam: logjam is shorter than the channel width so that flow is deflected toward one or both banks.
    d. Flow Parallel: logjam is predominantly aligned parallel to the flow.

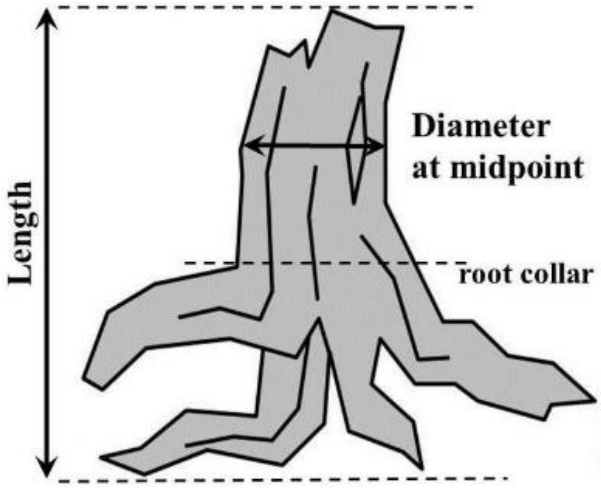

Figure 1: Diameter and length measurement locations for LWD with attached roots (Source: CHaMP 2016).

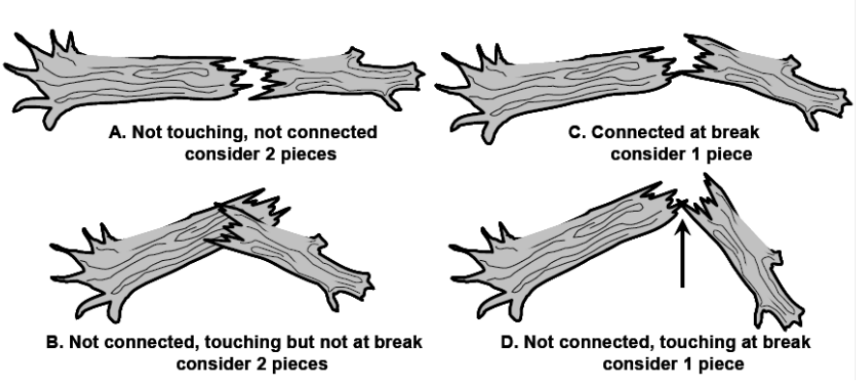

Figure 2: Variations that may be seen in how pieces may be touching vs. not touching along a break (Source: Crawford 2011).

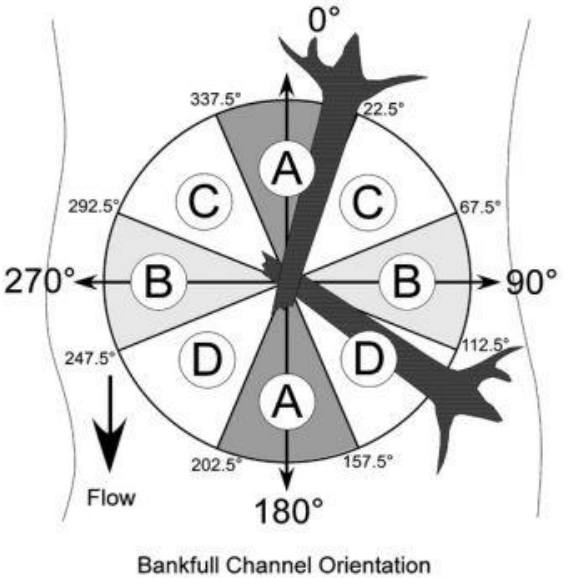

Figure 3: Orientation of LWD by zone (Source: Magilligan et al. 2008). Note, Zone E (i.e., oblique to flow, larger-diameter end unclear) is not pictured.

APPENDIX B:
LARGE WOODY DEBRIS (LWD) & LOGJAM SURVEY FIELD FORMS

Study Reference:		Date:	
Stream Name:		Staff:	
Start Waypoint Name/GPS:		Observer:	
End Waypoint Name/GPS:		Focal Reach Length:	

Piece ID	Large Wood Type (Wet or Dry)	Length (m)	Diameter (m)	Method (Measured or Estimated)	Orientation [1]	Stability [2]	Rootwad Present/Absent	Notes

[1] **Orientation Zones** - A = parallel to flow irrespective of rootwad orientation, B = perpendicular to flow, C = oblique to flow with the larger-diameter end oriented upstream, D = oblique to flow with the larger-diameter end oriented downstream, E = oblique to flow, larger-diameter end is unclear

[2] **Stability Classes** - **Unattached**: Entire piece is contained within bankfull channel and no portion is buried or pinned); **Ramp**: One end in channel, the other end above bankfull channel; **Pinned**: All or a portion is lodged beneath other pieces of wood in the stream; **Buried**: All or a portion is buried in the streambed or in the streambank, below and/or forming bankfull; **Cabled**: LWD piece is anchored in place with cable

Study Reference:		Date:	
Stream Name:		Staff:	
Start Waypoint Name/GPS:		Observer:	
End Waypoint Name/GPS:		Focal Reach Length:	

Jam ID	Location			Total Number of LWD pieces	Logjam Dimensions			Jam Type [1]	Notes
	WPT	Latitude	Longitude		Length (m)	Width (m)	Height (m)		

[1] **Jam Type - Underflow Jam**: Logjam spans the channel at the bank top level. At bankfull flow, water moves primarily under the jam; **Dam Jam**: Logjam spans the channel width and completely blocks the flow. At bankfull flow, water primarily moves through the Logjam; **Deflector Jam**: Logjam is shorter than the channel width so that flow is deflected toward one or both banks.; **Flow Parallel**: Logjam is predominantly aligned parallel to the flow.