Field Survey Procedure – Stream Canopy Cover (Spherical Densiometer)

Guidance Document

13 November 2024

Document details	**A concise overview of stream canopy cover measurement, including a 1-page field method (Appendix A) and a field data form (Appendix B). Stream Canopy Cover is an estimate of the amount of sky obscured by vegetation or topography from the perspective of the stream.**
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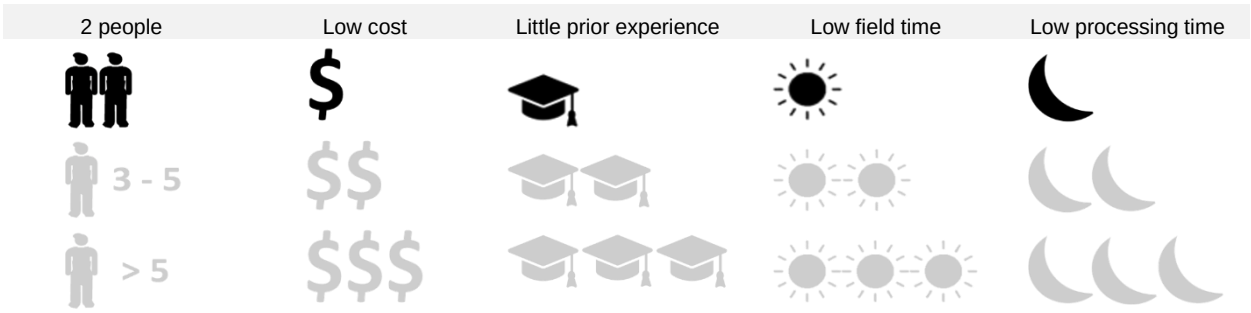
Resource Commitments



CONTENTS

1. OVERVIEW

Please refer to 'APPENDIX A: Stream Canopy Cover 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.

This protocol allows canopy cover, and associated inferences regarding shade, to be measured from the perspective of the water surface. Improved shading of the water surface may be a desired outcome of restoration, often associated with moderating summer water temperatures or managing shade-intolerant invasive species (e.g., reed canarygrass). Note that canopy cover is not necessarily indicative of other aspects of riparian quality important for fish (insect drop, leaf litter, pollutant filtering etc.), but may serve as a useful proxy where such relationships can be established.

The approach here quantifies canopy cover to greater precision and with a greater degree of objectivity than simple visual estimates, such that real changes in canopy cover can be identified from year to year. Although riparian development takes decades, this approach permits measurement of significant and biologically-meaningful changes in stream shading that can occur far sooner.

Canopy cover differs from shade (which is also a function of season, time, location of cover relative to stream) but has been demonstrated to be a strong predictor of the latter (e.g., Oregon Watershed Enhancement Board 2000). Measurement of canopy cover is therefore not dependent on the time of day or cloud cover.

This protocol is recommended for use during periods of summer low flows, which is a time at which salmon are vulnerable to high temperatures. Because this protocol involves measurements within the wetted width, results are sensitive to variations in flow. Because of variations in deciduous cover, results are sensitive to seasonal variation. As such, repeat measurements, and measurements at control/reference reaches, must be conducted at consistent times of year and under similar flow conditions.

Reach-scale measurements from this protocol can be combined with other protocols to explore and quantify causal relationships among restoration actions, riparian recovery, canopy cover, and stream temperature. If temperature is measured, it may also be beneficial to measure stage/discharge to help isolate the effect of flow from that of shading.

A summary of the required equipment for canopy cover measurement is provided in Table 1.

Table 1: Equipment Checklist – Canopy Cover

Item	
Field forms (waterproof) / Tablet	☐
Camera	☐
GPS	☐
Spherical densiometer*	☐

**Other approaches are available (e.g., clinometer, pathfinder). Whichever approach is used must remain consistent among sites and throughout repeat visits. Note that our data analysis assistance (.html and .rmd files) is built for spherical densiometers and not (yet) for alternative approaches.*

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

2. STREAM CANOPY COVER PROCEDURE

Please refer to 'APPENDIX A: Stream Canopy Cover 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.

2.1 Transect Guidance

Canopy cover measurements should be taken along transects that are representative of the focal reach. While variation in riparian vegetation and topography are expected, within the measured reach there should be no major changes in channel (i.e., do not cross reach breaks), in vegetation type (e.g., grassland vs. forest), or in management/land use (e.g., pasture vs. planted riparian restoration). Note that this concerns measurements taken within a reach or section of a reach from which summary statistics (central tendency, variability) are to be calculated. Comparisons of these summary statistics can then be made between reaches, different vegetation types, land uses etc.

Measurements can be taken at established transects, e.g. where cross-sectional stream measurements are conducted. We recommend transects spaced at 2 x bankfull width, or at 15 m intervals if the bankfull width is < 7.5 m. You should initially walk the reach and take several 'representative' measurements of bankfull to establish the transect spacing

The directional measurements obtained in the middle of the wetted width (4 per transect) are used to estimate canopy cover over the channel itself. The measurements taken from the edges of the wetted width (2 per transect: left and right bank) are interpreted separately as indicative of the riparian area / floodplain cover, but may also be of particular interest if undercut banks or overhanging vegetation are considered important aspects of fish habitat in the system.

Where transects are spaced systematically along a reach (or mesohabitat), the canopy density is calculated using the means and standard deviations of measurements (keeping middle channel measurements and edge measurements separate). The summary statistics can be converted to percent canopy cover by dividing by 17, then multiplying by 100.

2.2 Additional Guidance

- Where transects span across vegetated islands, transects should be conducted across each channel separately (each with four middle measurements and two edge measurements), clarifying in the comments which channel is which.
- When considering the wetted width, only include wetted areas that are contiguous with the channel (i.e., not isolated ponds, puddles) and not distinct channels (i.e., tributaries, side-channels separated by vegetated islands).
- Where transects span across bars, the middle measurement is to be taken at the midpoint of the wetted channel, even if this is on a dry bar.
- Where the channel is dry at the transect, take the middle measurement at the midpoint of bankfull, and the edge measurements at the scour lines, noting that the channel is dry.
- For non-wadeable watercourses or waterbodies, record values from four directions (upstream, downstream, looking into the riparian vegetation and looking across the stream), all taken from the accessible bank. Note whether it was possible to conduct assessment on only one or both banks.

Additional information regarding measurement of canopy cover can be found in Oregon Watershed Enhancement Board (2000), Lazorchak et al. (2000) and USEPA (2022), among others.

3. REFERENCES

Lazorchak, J.M., Hill, B.H., Averill, D.K., D.V. Peck, and D.J. Klemm (editors). 2000. Environmental Monitoring and Assessment Program -Surface Waters: Field Operations and Methods for Measuring the Ecological Condition of Non-Wadeable Rivers and Streams U.S. Environmental Protection Agency, Cincinnati OH.

Mulvey, M., L. Caton, and R. Hafele. 1992. Oregon Nonpoint Source Monitoring Protocols Stream Bioassessment Field Manual for Macroinvertebrates and Habitat Assessment. Oregon Department of Environmental Quality, Laboratory Biomonitoring Section. 1712 S.W. 11th Ave. Portland, Oregon, 97201. 40 p.

Oregon Watershed Enhancement Board. 2000. Addendum to Water Quality Monitoring Technical Guide Book: Chapter 14. Stream Shade and Canopy Cover Monitoring Methods [online]. Available at: Stream Shade and Canopy Cover, Water Quality Guidebook Addendum, Chapter 14 (oregon.gov)

USEPA. 2022. National Rivers and Streams Assessment 2023/24: Field Operations Manual – Wadeable. EPA-841-B-22-006. U.S. Environmental Protection Agency, Office of Water Washington, DC

APPENDIX A: STREAM CANOPY COVER 1-PAGER

Canopy cover, measured with a convex spherical densiometer, is a fast quantitative measurement that can be used to estimate shade. Stream shade is an important factor affecting stream temperature, and is often a target of restoration.

1. **Identify the transect:** Conduct at established reach transects, noting if riparian or shading conditions appear distinct from others in the reach. If no transects are established, we recommend spacing at 2 x bankfull width, or 15 m if bankfull width is <7.5 m.
2. Ensure the convex spherical densiometer is taped as shown in Figure 1, with 17 lens intersections visible above the tape (intersections below the tape are to be ignored).
3. The same observer should conduct all readings, closing one eye to focus, and using the same eye throughout.
4. Stand on the transect **at the middle of the wetted width** facing upstream.
5. Hold the spherical densiometer **0.3 m above the water surface, level** (using bubble indicator), and with the top of your head touching the point of the taped 'V' (see Figure 1).
6. Count the number of **lens intersections that are 'touching' reflected vegetation or topography** (valley walls, undercut banks etc.). 0 = no canopy cover, 17 = full canopy cover. Record the number on the field form.
7. Repeat Steps 5 and 6 **at the middle of the wetted width** but **facing Left Bank, Downstream, and then Right Bank**, recording on the field form.
8. Move to the **left edge of the wetted channel** facing the left bank and repeat Steps 5 and 6 (requires only one direction, toward the bank).
9. Move to the **right edge of the wetted channel** facing the right bank and repeat Steps 5 and 6 (requires only one direction, toward the bank).
10. Take representative photos and take brief notes of riparian vegetation at each transect: List notable plants at canopy, midlayer, and groundcover.
11. Ensure you have **6 measurements recorded per transect**, then proceed to the next transect.

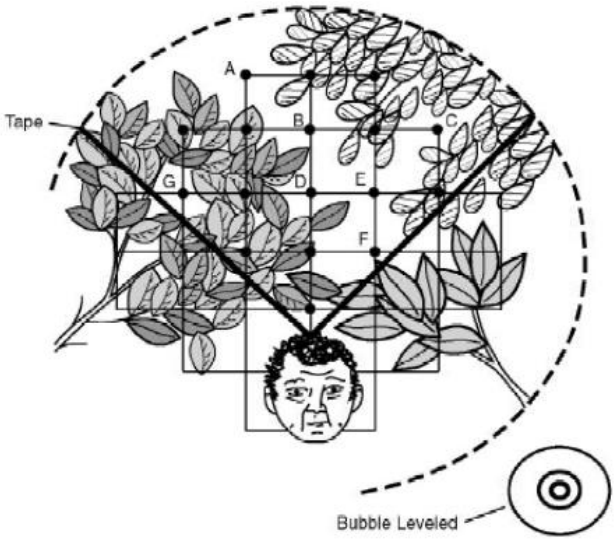


Figure 1 - Convex spherical densiometer showing taped lines, 17 intersections, and the position of observer's head. This example has a cover value of 10. Image from Mulvey et al 1992

APPENDIX B: STREAM CANOPY COVER FIELD FORM

Stream Canopy Cover - Spherical Densiometer

Study Ref	Stream Name	Date
Start Waypoint Name/GPS		Observer:
End Waypoint Name/GPS		Transect spacing (m):

Transect #	Left Bank	Middle - left	Middle - upstream	Middle - downstream	Middle - right	Right Bank	Comments

0 = no cover at lens intersections

17 = cover at every lens intersection

View level and at 0.3 m above water surface