TECHNOLOGY TRANSFER NOTES
Forestry Research Applications Pacific Forestry Centre No.2 August, 1997

A Field Estimation Procedure for Downed Coarse Woody Debris

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Importance of Coarse Woody Debris

The management of coarse woody debris (CWD) is an issue of growing importance to foresters, biologists and land managers. Coarse woody debris is important for maintaining biodiversity in some forest ecosystems because it provides food and habitat for a myriad of plants and animals, from lichens and fungi to salamanders, birds and black bears (1). It may also contribute to stabilizing slopes and streams, and to long term site productivity.

In the past, coarse woody debris was often viewed as a fire hazard or as habitat which harbors damaging insects and diseases. While these concerns may still be valid in some circumstances, increased understanding of ecosystem function is changing both how we view and manage downed wood.

For example, the Biodiversity Guidebook of the B.C. Forest Practices Code states that objectives for coarse woody debris must be included in the contents of a Forest Development Plan. It further recommends that CWD be addressed in silviculture and stand management prescriptions, fire management plans, logging plans and range use plans.

Measuring Downed CWD

The line intersect method is usually the most efficient means of assessing the amount of downed woody debris on a site (2,3,4), though fixed-area plots are still used where information on the volume of individual logs and stumps is required (5).

Several standard line intersect sampling procedures are in use in different jurisdictions (6,7,8). However in many practical situations, a simpler method for estimating coarse woody debris would be useful. This note presents a simple procedure that enables field estimation of the total volume and number of pieces of downed woody debris on a site.

The simple CWD assessment procedure also involves establishing line transects, but the number of intersections of debris pieces are tallied by diameter or length class, and volume and piece number are found from look-up tables. This differs from other standard procedures where the diameter and length of CWD pieces are measured and data compilation is done by computer program.

Advantages

The simple CWD assessment procedure:

- speeds up the sampling process since precise measurements are not required;
- enables on-site estimates of CWD volume and piece number;
- can be adapted to different line lengths and arrangements, or to include mass of a particular species;
- has an acceptable level of accuracy.

The size and spatial distribution of CWD in forest stands and logged areas is usually quite variable and results in substantial sampling errors. Intensive sampling is required to estimate CWD attributes on a site with a level of precision within common standards of forestry practice (9) (e.g., ±10% of the mean, with 95% confidence). This note does not address sample size and precision requirements, or sampling design and field layout.

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Accuracy Considerations

The accuracy of the simple field procedure is acceptable for practical purposes. The total error associated with any survey-based estimate is composed of sampling, measurement and computational errors. The use of the simple procedure will result in some additional measurement and computational errors. However, in most situations these will be relatively small in comparison to the sampling error.

This was confirmed by comparing the results obtained using the simple procedure with those of a standard method. CWD survey data were obtained from two sites: a clearcut site and a mature stand. Fifteen transects were assessed on each site. The maximum difference determined by the two methods was 5% for volume and up to 20% for piece number on a individual transect. However, the bias (percentage difference in the site means) was <1% for volume and <5% for piece number and was not significant. The sampling error was 15 to 25 times greater than the difference between the means. The greater error in piece number estimates was because short pieces (<2m) were included in the survey.

When using the procedures and tables in this note, it is assumed that pieces are lying horizontally. In situations where a large proportion of pieces are significantly tilted (>35°) additional corrections are required (12) that are beyond the scope of this note.

Applications

The simple procedure is not a panacea for CWD assessment in that it doesn't eliminate the need for intensive sampling to obtain precise estimates. However, it does speed up the sampling process.

Downed CWD Sampling Rules

1. If the sample line crosses the end of a piece, tally only if the central axis is crossed.
2. If the sample line passes exactly through the end of a piece's central axis, tally every second such piece.
3. Ignore any piece whose central axis coincides with the sample line.
4. If the sample line crosses a curved piece more than once, tally each crossing.

(Source: VanWagner, 1982)

The look-up tables can be used to give a first approximation of CWD volume and piece number on a site. These initial estimates can be useful in determining the number of transects required to obtain estimates within a particular precision and confidence level. Other standard methods should be used if repeated measures are planned or where detailed summaries are required.

With the increasing importance of coarse woody debris, the simple procedure and look-up tables presented in this paper will be a useful tool for foresters and biologists for obtaining field estimates of downed coarse woody debris loading on a site.

Simple Downed CWD Assessment Procedure

1. Locate an appropriate number of transect starting points.
2. Establish a 30 m transect in a random direction from each starting point.
3. Count the number of debris pieces along each transect greater than 7.5 cm, by 5 cm diameter class and/or length class, using the sampling rules. A scale stick may be used to find the diameter class.
4. Enter the tally in the upper row of the worksheet. For pieces greater than 50cm in diameter or 20 m in length, enter the actual diameter in the 50+ cm or 20+ m column.
5. Find the volume and/or number factors corresponding to the number of pieces in each diameter or length class from Tables 1 and 2. If the diameter is greater than 95 cm, then divide the diameter by two, read the corresponding volume, and multiply by four. Enter value on the lower line of the worksheet.
6. Sum the results by transect.
7. The total is CWD volume (m^3/ha) or number of pieces per hectare.
8. Determine the average volume or number of pieces for the site and/or the standard error if a measure of precision is required.
9. The mean piece volume is the total volume/no. of pieces.
10. To obtain an estimate of the mass of woody debris on a site (tons per hectare) multiply the volume (m^3/ha) by the relative density of the most common species.

TABLE 1 **Coarse Woody Debris Volume Table**

	Diameter Class (cm)								
	10	15	20	25	30	35	40	45	50
No. of Pieces per 30m	7.5 | 12.5	12.6 | 17.5	17.6 | 22.5	22.6 | 27.5	27.6 | 32.5	32.6 | 37.5	37.6 | 42.5	42.6 | 47.5	47.6 | 52.5
	CWD Volume (m^3/ha)								
1	4	9	16	26	37	50	66	83	103
2	8	19	33	51	74	101	132	167	206
3	12	28	49	77	111	151	197	250	308
4	16	37	66	103	148	202	263	333	411
5	21	46	82	129	185	252	329	416	514
6	25	56	99	154	222	302	395	500	617
7	29	65	115	180	259	353	461	583	720
8	33	74	132	206	296	403	526	666	822
9	37	83	148	231	333	453	592	749	925
10	41	93	164	257	370	504	658	833	1028

	Diameter Class (cm)								
	55	60	65	70	75	80	85	90	95
No. of Pieces per 30m	52.6 | 57.5	57.6 | 62.5	62.6 | 67.5	67.6 | 72.5	72.6 | 77.5	77.6 | 82.5	82.6 | 87.5	87.6 | 92.5	92.6 | 97.5
	CWD Volume (m^3/ha)								
1	124	148	174	202	231	263	297	333	371

(Developed by S. Taylor, Canadian Forest Service)

Coarse Woody Debris Volume Survey

Site | Surveyor: | Date

Plot No. | Diameter Class (cm): 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 50+ | 50+ | Total

Coarse Woody Debris Piece Number Survey

Site | Surveyor: | Date

Plot	Length Class (m)									
1										
2										
3										
4										
5										
6										
8										
10										
15										
20										
20+										
20+										
Total										

TABLE 2 **Coarse Woody Debris Piece Number Table**

	Length Class (m)									
	1	2	3	4	5	6	8	10	15	20
No. of Pieces per 30m	0.5 | 1.5	1.6 | 2.5	2.6 | 3.5	3.6 | 4.5	4.6 | 5.5	5.8 | 7.0	7.1 | 9.0	9.1 | 12.5	12.6 | 17.5	17.6 | 22.5
	Number Factor (no./ha)									
1	524	262	175	131	105	87	65	52	35	26
2	1047	524	349	262	209	175	131	105	70	52
3	1571	785	524	393	314	262	196	157	105	79
4	2094	1047	698	524	419	349	262	209	140	105
5	2618	1309	873	655	524	436	327	262	175	131
6	3142	1571	1047	785	628	524	393	314	209	157
7	3665	1833	1222	916	733	611	458	367	244	183
8	4189	2094	1396	1047	838	698	524	419	279	209
9	4712	2356	1571	1178	942	785	589	471	314	236
10	5236	2618	1745	1309	1047	873	655	524	349	262

	Length Class (m)									
	25	30	35	40	45	50	55	60	65	70
No. of Pieces per 30m	22.6 | 27.5	27.6 | 32.5	32.6 | 37.5	37.6 | 42.5	42.6 | 47.5	47.8 | 52.5	52.6 | 57.5	57.6 | 62.5	62.6 | 67.5	67.6 | 72.5
	Number Factor (no./ha)									
1	21	17	15	13	12	10	10	9	8	7

(Developed by S. Taylor, Canadian Forest Service)

Coarse Woody Debris Volume Survey - Sample

Site	ROBERTS CREEK	Surveyor:	A CRUISER	Date	05.05.95

Plot No.	Diameter Class (cm)											
	10	15	20	25	30	35	40	45	50	50+	50+	Total
1		19		77		101				80 263		460
2	4	19	33	26	37	50	132	167	103			571
3	4	9			74				103	65 174		364
4	8	19		51				88		55 124	60 148	438
5	4	19		26	37		132			55 124	60 148	490
6	12	45		26	37	50						170
14	16	9	16		37			88		85 297		375
15	4	28	33							65 174		327
$\bar{X}$												536

Relative density values for some western trees[10]

bigleaf maple	*Acer macrophyllum*	0.46	Engelmann spruce	*Picea engelmannii*	0.34
alders	*Alnus spp.*	0.40	white spruce	*Picea glauca*	0.38
birches	*Betula spp.*	0.43	black spruce	*Picea mariana*	0.38
trembling aspen	*Populus tremuloides*	0.34	Sitka spruce	*Picea sitchensis*	0.38
			whitebark pine	*Pinus albicaulis*	0.34
amabilis fir	*Abies amabilis*	0.40	lodgepole pine	*Pinus contorta*	0.41
grand fir	*Abies grandis*	0.45	western white pine	*Pinus monticola*	0.34
subalpine fir	*Abies lasiocarpa*	0.40	ponderosa pine	*Pinus ponderosa*	0.51
yellow-cedar	*Chamaecyparis nootkatensis*	0.42	Douglas-fir	*Pseudotsuga menziesii*	0.43
			western yew	*Taxus brevifolia*	0.55
tamarck	*Larix laricina*	0.51	western redcedar	*Thuja plicata*	0.33
alpine larch	*Larix lyallii*	0.55	western hemlock	*Tsuga heterophylla*	0.43
western larch	*Larix occidentalis*	0.55	mountain hemlock	*Tsuga mertensia*	0.43

* Note: For mass estimation, these values are valid for undecayed wood only.

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Acknowledgements

Special thanks to:
Gerry Davis, B.C. Ministry of Forests,
for providing CWD data.
John Parminter, B.C. Ministry of Forests,
Tony Trofymow, CFS, and
Peter Marshall, University of B.C.
for their helpful reviews.
Anne Dickinson, CFS Technology Transfer,
Managing Editor.

This procedure was updated and expanded from earlier work of John Muraro[13].

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Printed on recycled paper

ISSN 1209-6571 Cat. No. Fo29-47/2-1997E
ISBN 0-662-25798-7

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Canada