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Forestry • Foresterie

NODA Note No. 27

SURVEY OF DEAD WOOD USING LARGE SCALE SAMPLING PHOTOS

Dendron Resource Surveys Inc.[1]

INTRODUCTION

Dead or dying trees, standing or fallen, are an important habitat component for many wildlife species, particularly as they provide food and cavities for nesting and escape cover. Dead material is also an essential constituent of the larger, more diverse ecological system that supports micro-organisms, insects, and other flora and fauna on which wildlife ultimately depend for food, shelter, and well-being.

Estimations of the quality, quantities, spatial distribution, and breakdowns by species and size classes of dead or dying trees are required to assess habitat status, and to provide a baseline for evaluating trends and the effect of disturbances and management practices upon the habitat. This information is also necessary to drive habitat supply and suitability models. The conventional collection of such information depends on labor-intensive and expensive field methods. The data are collected using sample plots, strips, or transects selected to represent forest associations, stands, or ecosystems of interest in terms of habitat suitability. Because of extensive variability in the quantity and distribution of dead material, the sampling intensity must be fairly high to achieve reliable results. Field crews may face long road trips and walk considerable distances over rough terrain or through thick cover to locate and establish the samples and to conduct tree assessments and measurements.

Large scale sampling photos (LSP) suggest a more practical alternative—one that usually costs only one-half that of a field survey in reasonably accessible areas, and only a fraction of the cost in remote areas. The LSP potential for this application was investigated and tested during the Northern Ontario Development Agreement (NODA) LSP inventory project. This note summarizes the results of the investigation.

This note is one of a series completed during a NODA project entitled *"Enhancing Ontario's Forest Resource Inventory with Stand Structure Using Large Scale Aerial Photographs"*. These technical notes summarize the results of studies on the survey of dead standing and fallen trees, the estimation of diameter at breast height (DBH) from LSP tree measurements, the estimation of growth rates using LSP data, and a paired comparison between LSP and field measurements of trees. Details concerning methods, procedures, results, and conclusions are documented elsewhere.[2]

METHODOLOGY

The LSP method was originally designed for the measurement of standing live trees for forest inventory purposes. Such an application was central to the NODA LSP inventory project documented in detail in the final report.[3]

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[1] Dendron Resource Surveys Inc., 880 Lady Ellen Place, Suite 206, Ottawa, ON K1Z 5L9. Contact: Udo Nielsen, Telephone: (613)725-2971, Fax: (613)725-1716.

[2] Dendron Resource Surveys Inc. Enhancing Ontario's forest resource inventory using large scale sampling photographs. Nat. Resour. Can., Canadian Forest Service, Great Lakes Forestry Centre, Sault Ste. Marie, ON. NODA/NFP Tech. Rep. TR-45. (In press)

[3] Ibid.

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Standing dead trees, which are often included, can be readily measured and key statistics compiled. In the past the methodology was modified to assess wood residues left in the wake of harvesting operations and disturbances, such as insect infestations and wind damage (Dendron Resource Surveys Inc. 1980, 1984, 1989). The methodology has been used with moderate success to survey quantities of dead material on the ground under undisturbed hardwood stands. The development behind these modifications made the dead tree application to habitat appraisal relatively straightforward.

Sampling Design

The sampling design uses most of the same principles as the forest inventory application. Existing forest cover maps of the target area, together with available information on the habitat preferences of a species and population concentrations, are used to focus on portions of an area that offer the best habitat potential. Forest stands or other mapped characteristics of the target area may be rated in terms of habitat suitability and used to form strata. The sampling intensity of each stratum is determined by a suitability rating; the highest receiving the most attention, and the lowest excluded or lightly sampled. Strips of LSP are acquired according to a statistical design and randomization process, and sample plots consisting of stereo pairs of LSP are selected from the strips. The number chosen, constrained by the overall budget for the survey, is determined by the relative importance of the stratum and the required accuracy of key statistics. A typical LSP stereo pair with an established sample plot is illustrated in Figure 1.

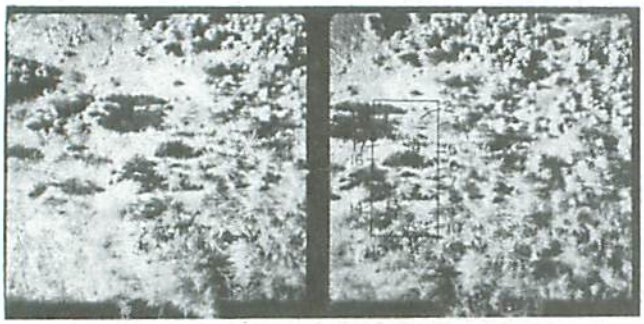

Figure 1. Stereo pair of large-scale photographs with sample plot.

Sampling Unit

The preferred sampling unit is a rectangular (10 m x 20 m) plot, established midway between the principal points of a stereo pair of LSP photos (Fig. 1). A plot is used rather than a strip or transect because it easily accommodates both the standing dead trees and fallen material. The exact plot area is measured from digitized locations of the four plot corners on the stereo model. A properly scaled and rectified (corrected for pitch and roll of photos) model on a photogrammetric plotter/computer system generates the X, Y, and Z (elevation) data of any point in the model.

Plot Measurement

Standing dead trees or snags are numbered and only the height is measured. If the tree has a broken top, nearby live trees of similar size are used to approximate the height of the tree before breakage. The total height and the height at the break point are used to improve the volume estimate of the remaining snag. The algorithm for making this estimate is described in the final project report. The X, Y position of the tree on the plot is digitized and recorded at the time that the height is digitized. Figure 2 shows the tree dimensions involved. The species of a snag tree is usually inferred from surrounding trees, because of obvious species recognition difficulties. Even in the field, the species of dead trees may be difficult to identify.

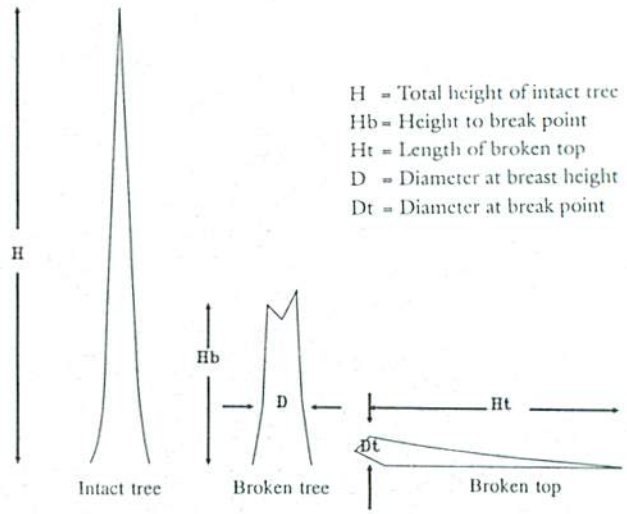

Figure 2. Diagram showing the dimensions measured on dead and broken trees.

The dead material on the ground—broken tops, large branches, fallen trees, or portions thereof—are measured only within the plot itself. Each piece is numbered and the length of the portion within the plot is measured as shown in Figure 3. The diameter at the midpoint is digitized and recorded. The species is usually inferred from nearby living trees. This information is recorded and used later to compile key statistics, accuracy estimates, and distribution tables.

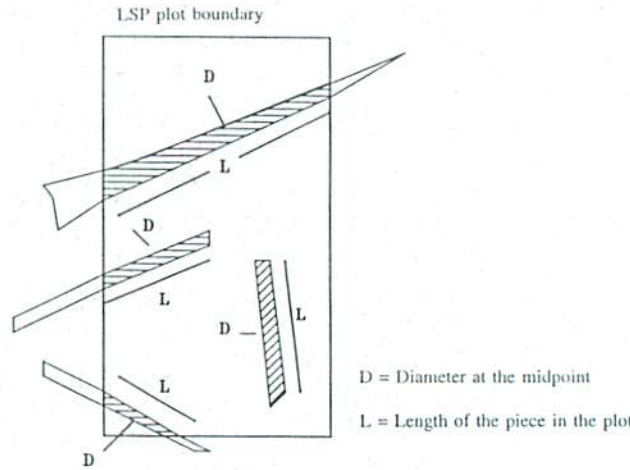

Figure 3. Diagram showing the dimensions of dead fallen residues measured.

Summary

The measurements enable the number or stems per hectare, diameter at breast height, basal area, and tree or snag height to be estimated, and the volume to be calculated. The X, Y location of the tree on the plot allows spatial distribution, competition, and residue concentrations to be analyzed. When the data are compiled with other plots in the same stratum, key statistics, accuracy estimates, and the distribution by species and size class are tabulated to provide a picture of the stand structure. This may be compared to the live tree counterpart for the stratum. Table 1 is an example of the key statistics, accuracy estimates, and distribution summary. Table 2 presents the live tree counterpart.

Likewise, residue on the ground is compiled and used to estimate the number of pieces per hectare, diameter, length, and wood volume. The X, Y location of the material can be used to analyze the spatial distribution and concentrations. Table 3 provides an example of the key statistics and distribution pattern of fallen material.

Table 1. Example of dead standing tree statistics and a table showing the distribution of volume by species and size classes.

QUNO Corporation

KEY INVENTORY STATISTICS
STAND: TIMMINS 160 Sample size: 30 09-09-1994

Dead standing trees	Mean	Standard error Absolute	66 percent
Stems per hectare	235.0	38.2	16.3
Basal area per hectare (m^2)	4.6	0.8	17.2
Total volume per hectare (m^3)	17.5	3.3	19.1
Merch. volume per hectare (m^3)	11.5	2.8	24.1
Average height of dead trees (m)	5.4	0.7	13.5

Total volume per hectare (cu. m)

Mean (dead trees)	17.5	Minimum DBH (cm)	15.0
Standard error (66 percent)	3.3	Top diameter (cm)	6.5
Sample size	30	Stump height (cm)	30.0

DBH	Softwoods					Hardwoods				All
(cm)	Spruce[1]	Pine[2]	Fir[3]	Larch[4]	Other	Poplar[5]	Birch[6]	Other	Unknown	species
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
8	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.2
10	0.1	0.0	0.0	0.1	0.0	0.0	0.5	0.0	0.0	0.8
12	0.1	0.1	0.1	0.0	0.0	0.0	1.0	0.0	0.0	1.3
14	0.0	0.0	0.0	0.2	0.0	0.0	1.3	0.0	0.0	1.5
16	0.0	0.2	0.0	0.2	0.0	0.0	2.5	0.0	0.2	3.1
18	0.0	0.2	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.2
20	0.0	0.3	0.0	0.0	0.0	0.1	1.1	0.0	0.0	1.5
22	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	2.3
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.5	0.0	0.0	0.0	0.9	0.0	0.0	1.4
28	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2
30	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
32	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4
34	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.9
38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	1.3
44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.5	1.1	0.6	0.4	0.0	2.8	11.6	0.0	0.4	17.5

[1] *Picea* spp.
[2] *Pinus* spp.
[3] *Abies* spp.
[4] *Larix* spp.
[5] *Populus* spp.
[6] *Betula* spp.

Table 2. Example of live standing tree statistics and a table showing the distribution of volume by species and size classes.

QUNO Corporation

KEY INVENTORY STATISTICS
STAND: TIMMINS 160 Sample size: 5 09-16-1994

Dead standing trees	Mean	Standard error Absolute	66 percent
Stems per hectare	1030.0	191.4	18.6
Basal area per hectare (m^2)	21.6	2.4	10.9
Total volume per hectare (m^3)	147.8	14.2	9.6
Merch. volume per hectare (m^3)	113.9	10.1	8.8
Average height of dead trees (m)	11.1	0.5	4.3

Total volume per hectare (cu. m)

Mean (dead trees)	147.8	Minimum DBH (cm)	15.0
Standard error (66 percent)	14.2	Top diameter (cm)	10.0
Sample size	5	Stump height (cm)	30.0

DBH	Softwoods					Hardwoods				All
(cm)	Spruce[1]	Pine[2]	Fir[3]	Larch[4]	Other	Poplar[5]	Birch[6]	Other	Unknown	species
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	1.0	0.8	0.9	0.0	0.0	0.0	0.8	0.0	0.0	3.6
12	1.1	0.0	1.7	0.0	0.0	0.0	0.5	0.0	0.0	3.3
14	3.6	0.8	0.9	0.0	0.0	0.0	4.9	0.0	0.0	10.2
16	2.6	1.4	0.0	0.0	0.0	0.0	1.4	0.0	0.0	5.3
18	4.9	4.6	3.4	0.0	0.0	0.0	14.3	0.0	0.0	26.3
20	2.4	2.1	0.0	0.0	0.0	0.0	12.3	0.0	0.0	16.8
22	5.3	0.0	0.0	0.0	0.0	0.0	19.5	0.0	0.0	24.8
24	10.5	0.0	3.2	0.0	0.0	0.0	12.9	0.0	0.0	26.6
26	3.9	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	8.3
28	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	4.8
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6
36	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0
38	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	52.9	9.8	10.0	0.0	0.0	0.0	75.1	0.0	0.0	147.8

[1] *Picea* spp.
[2] *Pinus* spp.
[3] *Abies* spp.
[4] *Larix* spp.
[5] *Populus* spp.
[6] *Betula* spp.

Table 3. Example of dead fallen tree statistics and a table showing the distribution of volume by species and size classes.

QUNO Corporation

KEY INVENTORY STATISTICS
STAND: TIMMINS 160 Sample size: 30 09-09-1994

Dead standing trees	Mean	Standard error Absolute	66 percent
Stems per hectare	433.3	96.9	22.4
Basal area per hectare (m^2)	5.4	1.3	23.9
Total volume per hectare (m^3)	19.7	4.1	25.6
Merch. volume per hectare (m^3)	9.7	3.1	32.0
Average height of dead trees (m)	4.3	0.5	12.1

Total volume per hectare (cu. m)

Mean (dead trees)	19.7	Minimum DBH (cm)	15.0
Standard error (66 percent)	5.1	Top diameter (cm)	10.0
Sample size	30	Stump height (cm)	30.0

DBH	Softwoods					Hardwoods				All
(cm)	Spruce[1]	Pine[2]	Fir[3]	Larch[4]	Other	Poplar[5]	Birch[6]	Other	Unknown	species
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
6	0.3	0.0	0.2	0.2	0.0	0.0	0.1	0.0	0.1	0.9
8	0.3	0.2	0.1	0.0	0.0	0.0	0.4	0.0	0.1	1.1
10	0.1	0.1	0.2	0.0	0.0	0.1	1.7	0.0	0.2	2.4
12	0.1	0.7	0.1	0.0	0.0	0.0	1.5	0.0	0.1	2.5
14	0.5	0.8	0.3	0.0	0.0	0.0	2.5	0.0	0.0	4.1
16	0.7	0.5	0.0	0.0	0.0	0.0	1.8	0.0	0.4	3.4
18	0.0	0.0	0.0	0.0	0.0	0.3	0.7	0.0	0.0	1.0
20	0.0	0.0	0.0	0.1	0.0	0.0	0.6	0.0	0.0	0.7
22	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.6	1.0
24	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2
26	0.0	0.0	1.0	0.0	0.0	0.0	0.3	0.0	0.0	1.2
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	1.1
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	2.3	3.3	1.0	0.2	0.0	0.5	10.0	0.0	2.5	19.7

[1] *Picea* spp.
[2] *Pinus* spp.
[3] *Abies* spp.
[4] *Larix* spp.
[5] *Populus* spp.
[6] *Betula* spp.

CONCLUSION

Traditional photo interpretation and mapping provide a means for identifying the general habitat suitability of forest stands for particular wildlife species. The maps and database provide a good general picture of suitability, but lack information on why the habitat is of a certain quality, quantity, and distribution. LSP sampling is an efficient means of providing the level of detail normally obtained from costly field sampling. Application of LSP to the survey of dead material will be particularly practical and cost-effective if combined with ongoing LSP forest inventory work. For either living or dead trees, the LSP methodology will provide an excellent summary of the species, size (length/height, diameter, basal area, and volume), frequency, and spatial distribution of dead and living trees. It will also provide breakdowns by species and size class of the material, as well as accuracy estimates. Such information should complement habitat suitability models, which frequently lack details on the quantity and quality of living or dead trees for escape cover, winter or thermal cover, food, and shelter.

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