Tree Farm Licence 45
Net Volume Adjustment Factor Sampling
Sample Plan

Prepared for

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Project: IFV-017

August 29, 2003

Executive Summary

International Forest Products Ltd. (Interfor) began implementing a Vegetation Resources Inventory (VRI) program on Tree Farm Licence (TFL) 45 in 2001. The preliminary statistical adjustment was completed by J.S. Thrower & Associates Ltd. in March 2003; however, the Net Volume Adjustment Factor (NVAF) component must be completed before the statistical adjustment can be finalized. Interfor's 2003/2004 objectives are to proceed with the NVAF destructive sampling, and if sufficient funds are available, complete the NVAF analysis, and finalize the VRI statistical adjustment.

We propose that 55 live and eight dead trees be sampled. Dead trees were selected randomly among all enhanced dead trees. Live trees were allocated across the main commercial species groups on the TFL and diameter at breast height (DBH) class. Assuming the coefficient of variation (CV) observed on a neighbouring TFL, we expect an overall sampling error of 8%.

The distribution of the live sample and sampling error is as follows:

Stratum	Pop. Volume	Live Sample		Assumed	Smplg Error
	(%)	Size	(%)	CV	(%)
H	56	28	51	35	13
B	18	10	18	15	9
C&Y	18	15	27	15	8
Minor Species	8	2	4		
Total	*100*	*55*	*100*		*8*

In the analysis, the two minor species trees will be grouped with the stratum where they will have the least influence on the NVAF ratio adjustment estimate.

The results of the NVAF analysis will be used to modify the VRI ground volume. The statistically adjusted VRI database will then be corrected accordingly.

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1. INTRODUCTION

1.1 BACKGROUND

International Forest Products Ltd. (Interfor) completed two years of Vegetation Resources Inventory (VRI) Phase II ground sampling on Tree Farm Licence (TFL) 45 in October 2002. A preliminary statistical adjustment[1] of the Phase II sample plots was completed by J.S. Thrower & Associates Ltd. (JST); however, this preliminary adjustment did not include the Net Volume Adjustment Factor (NVAF) volume correction since NVAF had not yet been completed on TFL 45. Interfor plans to complete the NVAF sampling during the 2003 field season and prior to completing the statistical adjustment in 2004. The TFL 45 VRI program is a four-phase process (Figure 1):

1. Phase I (unadjusted inventory data) - Timberline Forest Inventory Consultants estimated the attributes of all polygons using photo-interpretation;
2. Phase II (ground plot data) – Jeff Kerley & Associates (formerly Olympic Resource Management) recorded measurements from randomly located ground samples;
3. NVAF Sampling - Random trees are selected for stem-analysis to develop adjustment ratios that correct for taper and decay estimation bias; and
4. Statistical Adjustment Phase - Phase I estimates are adjusted using the NVAF-corrected Phase II ground samples to give an adjusted unbiased estimate of forest inventory attributes. The final product is an adjusted VRI database.

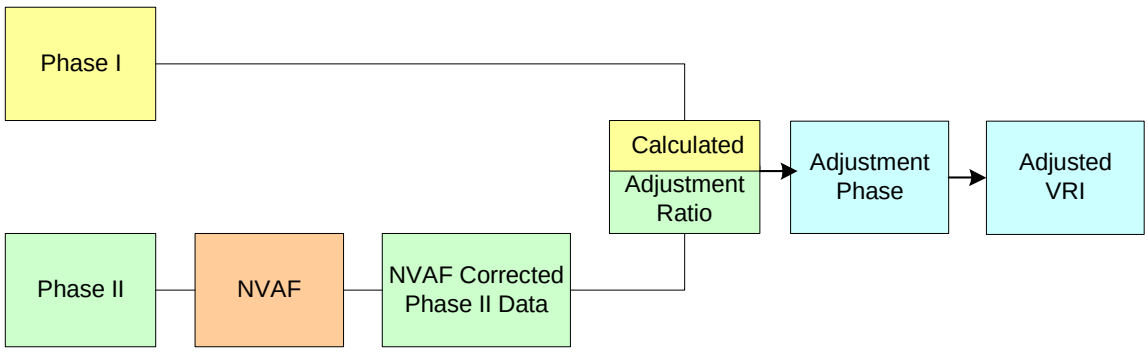

Figure 1. TFL 45 VRI program.

1.2 PROJECT OBJECTIVES

The objectives of the project are to:

1. *Sample a sufficient number of trees to give an adequate level of confidence in the NVAF adjustment ratios for the main commercial species on TFL 45.*
2. *Determine the NVAF adjustment ratios for the main commercial species on TFL 45.*
3. *Finalize the VRI statistical adjustment on TFL 45.*

[1] J.S. Thrower & Associates Ltd. 2003. Tree Farm Licence 45 Vegetation Resources Inventory Statistical Adjustment – Preliminary Report. Unpublished Report, Contract No. IFV-015, 9 pp.

1.3 DOCUMENT OBJECTIVES

The objectives of this NVAF sample plan are:

1. *Determine the NVAF sample size for the main commercial species on TFL 45.*
2. *Determine the sampling weight of each NVAF sample tree.*
3. *Present the implementation plan for the NVAF sampling component.*
4. *Document the sample selection procedures in preparation for the statistical analysis.*

1.4 TERMS OF REFERENCE

This sample plan was prepared for Gerry Sommers, *RPF* of Interfor by Guillaume Thérien, *PhD* of JST. Hamish Robertson, *RPF* is the project manager. This sample plan reflects Interfor's business needs and discussions held with the Ministry of Sustainable Resource Management (MSRM).

2. METHODS

2.1 LANDBASE

TFL 45 is located in the Campbell River Forest District of the Coast Forest Region and covers approximately 232,000 ha, of which 64,677 ha (or 28%) are productive (Table 1). Most of the TFL is situated along the major drainage systems feeding into the northern part of Knight Inlet. The remaining area is located around Phillips Arm on the mainland coast.

Table 1. TFL 45 land base net down.

Land Class	Area (ha)	Area (%)
TFL 45 Landbase	231,866	
Non-Productive	167,189	72
Productive	64,677	28
Non-THLB	36,721	16
THLB	27,956	12
Non Vegetated Treed	2,962	1
Vegetated Treed	24,994	11

2.2 GROUND VOLUME

The main commercial species on the TFL are western hemlock (H), balsam (B), and yellow cedar and western redcedar (C&Y) (Table 2).[2] The inventory shows that volume is uniformly distributed across the range of diameter at breast height (DBH). Douglas-fir is the most important of the minor species; other minor species included Sitka spruce (Ss), lodgepole pine (Pl), red alder (Dr), and cottonwood (Ac).

Table 2. Volume distribution by species and DBH class in the Vegetated Treed population on TFL 45.

	DBH Class (cm)					
Spp	12.5-40	40.1-60	60.1-80	80.1-100	100.1+	Total
H	12%	16%	13%	9%	6%	56%
C&Y	3%	2%	3%	4%	6%	18%
B	3%	5%	7%	2%	1%	18%
Minor	3%	2%	1%	0%	2%	8%
Total	*22%*	*25%*	*23%*	*15%*	*15%*	*100%*

2.3 NVAF SAMPLE – LIVE TREES

Interfor intends to destructively sample 55 live trees, distributed proportionally by species and DBH class (Table 3). The intent is to slightly over-sample the C&Y stratum because it represents the most valuable species on the TFL. The largest DBH classes are also slightly over-sampled for similar reasons.

Table 3. NVAF sample size and distribution (%) by species and DBH class.

	DBH Class (cm)					
Spp	12.5-40	40.1-60	60.1-80	80.1-100	100.1+	Total
H	6 (11)	8 (15)	6 (11)	4 (7)	4 (7)	28 (51)
C&Y	2 (4)	2 (4)	2 (4)	4 (7)	5 (9)	15 (27)
B	2 (4)	3 (5)	4 (7)	1 (2)	0 (0)	10 (18)
Minor	1 (2)	0 (0)	0 (0)	0 (0)	1 (2)	2 (4)
Total	*11 (20)*	*13 (24)*	*12 (22)*	*9 (16)*	*10 (18)*	*55 (100)*

2.4 NVAF SAMPLE – DEAD TREES

We propose to sample eight dead trees. Due to the small sample size, no stratification is necessary before selecting dead trees. Having accurate dead volumes is a secondary priority of Interfor's and so sampling of these trees may be completed at a later date.

[2] The volume distribution by species and diameter class was estimated using the 75 VRI Phase II ground plots established in the target population.

3. IMPLEMENTATION PLAN

3.1 TREE SELECTION

3.1.1 Overview

A total of 315 trees from 27 samples were enhanced from Phase II auxiliary plots enhanced during the 2001 and 2002 ground sampling. Sixty (60) enhanced trees were below the minimum DBH of 12.5 cm and 24 more dead trees were enhanced than required[3], leaving 231 (213 live, 18 dead) trees for NVAF sampling. A tree selection matrix was first built using the 231 trees. Trees were selected within each cell of the selection matrix. Finally, sampling weights were computed for each sample tree. The list of NVAF sample trees is in Appendix I.

3.1.2 Selection Matrix

The 231 trees available for NVAF sampling were split into a three-dimensional matrix using live/dead status, species, and DBH class. Only one species group/DBH class was used for dead trees and eight trees were selected among the 18 available trees. Four species groups and five DBH classes were used for live trees (Table 4).

Table 4. NVAF live tree selection matrix.

	DBH Class (cm)											
	12.5-40		40.1-60		60.1-80		80.1-100		100.1+		Total	
Spp	N	N	N	N	n	N	n	N	n	N	n	N
H	6	41	8	38	6	23	4	10	4	6	28	118
C&Y	2	9	2	7	2	4	4	6	5	8	15	34
B	2	15	3	9	4	5	1	6	0	1	10	36
Minor	1	17	0	3	0	1	0	0	1	4	2	25
Total	*11*	*82*	*13*	*57*	*12*	*33*	*9*	*22*	*10*	*19*	*55*	

3.1.3 Tree Selection Within The Selection Matrix

Dead trees were systematically selected with a random start after the tree list was sorted by DBH. Live trees were selected randomly within each matrix cell.

3.1.4 Sampling Weights

The sampling weight of an NVAF tree (W) is the product of three weight components. The first component (W_1) is the number of hectares each NVAF polygon represents. The second component (W_2) is the number of trees/ha each enhanced tree represents. The third component (W_3) is the number of trees within the matrix cell the selected NVAF sample tree represents. The sampling weight of an NVAF tree is therefore:

$$W = W_1 \times W_2 \times W_3$$

[3] Field crews were supposed to enhance dead trees only on a sub-sample of the NVAF sample plots. However, they mistakenly enhanced dead trees on all plots.

3.2 FIELD SAMPLING

3.2.1 Overview

Field sampling is scheduled for the 2003 field season (depending on available budget). Interfor will offer the destructive sampling to three select bidders to ensure that the most qualified samplers are doing the destructive sampling on the difficult terrain on TFL 45. Interfor expects that requests-for-proposals will be sent out to qualified bidders in early-September. Given the access and terrain issues, the proposal will be weighted to contractors with the most experience doing NVAF sampling.

3.2.2 Sample Packages

Interfor developed the NVAF sample packages for the recently completed Phase II ground sampling program. Photocopies of the relevant Phase II plot cards will be provided to the field crews to improve access to the plot.

3.2.3 Field Work

Field work is scheduled for the 2003 field season and will be completed as soon as both helicopters and field crews are available. We expect that a two-person and three-person crew will use an A-Star to access all plots. It is expected that both crews will complete destructive sampling in one 10-day shift.

3.2.4 Quality Assurance

Ken Richardson, RPF of JST will provide the mentoring and quality assurance for the project. Approximately 10% of the samples will be audited.

3.3 DATA ENTRY

Data entry will be completed by field crews and passed to JST for compilation and analysis.

3.4 DATA COMPILATION

JST will compile the NVAF data using the most recent NVAF data compiler. Since no standard procedures exist for NVAF data compilation, JST will consult with the MSRM before proceeding with the data compilation. Compilation will be completed following field sampling.

3.5 STATISTICAL ANALYSIS

JST will complete the statistical analysis using methods recommended by the MSRM. The analysis is scheduled for this year; however, this will depend on the available budget. A memo presenting the average NVAF adjustment ratio and sampling error as well as graphical interpretation will be prepared and included in an appendix in the statistical adjustment report (or submitted separately if the statistical adjustment is not completed). The preliminary VRI statistical adjustment completed in March 2003 will be finalized using the NVAF corrected volume and the final statistical adjustment and report will be completed before March 2004.

4. BUDGET AND SCHEDULE

4.1 BUDGET

The proposed budget for this project is $105,000; however the actual project cost is mostly a function of the field crew and helicopter bid costs. The goal is to complete the destructive sampling and analysis for this amount, but Interfor will review the deliverables once the bids have been received and then again at the conclusion of the field program.

All plots in the field program are helicopter plots, and so costs may vary depending upon efficient use of the helicopter. The budget is based on using a two-person crew and a three-person crew in the helicopter each day and allocating the three-person crew to the most challenging plot that day. The crews will meet the helicopter at a specified time at the end of each day, and having an extra sampler on the plot will minimize the number of plots being revisited for a second day.

4.2 SCHEDULE

The proposed schedule is to determine the successful bidder by the end of September and target sampling for October. However, the timing of the field program is a function of the crew and helicopter schedules. The fires ongoing in the southern interior of the province have utilized all coastal helicopters and delayed start-up of many different projects scheduled for the coast. This impacts not only the availability of the helicopters but also the field crews.

APPENDIX I – SAMPLE TREE LIST

Table 5. TFL 45 NVAF sample list (live trees).

Spp	DBH class (cm)	Sample No	Plot No	Tree No	Species	DBH (cm)	W_1	W_2	W_3	W
B	12.5-40	21	W	1	BA	37.4	83	755	8	468,466
B	12.5-40	36	N	1	BA	24.9	84	1112	8	702,309
B	40.1-60	31	W	5	BA	50.7	47	631	3	88,502
B	40.1-60	36	E	4	BA	53.8	84	238	3	60,176
B	40.1-60	63	S	5	BA	54.5	95	268	3	76,591
B	60.1-80	16	E	1	BA	69.5	92	341	1	39,248
B	60.1-80	19	W	2	BA	65.8	77	173	1	16,762
B	60.1-80	63	E	5	BA	64.9	95	189	1	22,505
B	60.1-80	63	S	1	BA	64.4	95	192	1	22,855
B	80.1-100	19	W	1	BA	94.9	77	83	6	38,680
C&Y	100.1+	19	E	5	YC	129.5	77	45	2	5,539
C&Y	100.1+	31	N	2	CW	110.1	47	134	2	10,009
C&Y	100.1+	31	N	9	CW	110.3	47	133	2	9,973
C&Y	100.1+	65	W	1	CW	130.0	77	58	2	7,179
C&Y	100.1+	78	W	1	CW	118.7	154	35	2	8,611
C&Y	12.5-40	19	E	2	CW	37.3	77	540	5	187,785
C&Y	12.5-40	78	W	2	CW	24.0	154	856	5	592,433
C&Y	40.1-60	71	S	3	CW	50.7	96	630	4	211,595
C&Y	40.1-60	78	N	9	CW	50.4	154	194	4	104,486
C&Y	60.1-80	78	N	8	CW	61.6	154	130	2	39,969
C&Y	60.1-80	79	E	1	CW	67.5	42	606	2	50,970
C&Y	80.1-100	16	E	4	YC	99	92	168	2	23,211
C&Y	80.1-100	31	W	1	CW	93.8	47	184	2	12,928
C&Y	80.1-100	46	N	2	CW	83.7	117	337	2	59,152
C&Y	80.1-100	72	S	3	CW	92.1	35	391	2	20,534
H	100.1+	16	S	5	HW	127.5	92	51	2	6,997
H	100.1+	19	W	5	HM	129.2	77	45	2	5,217
H	100.1+	48	S	3	HM	115.1	79	56	2	6,574
H	100.1+	65	W	2	HW	105	77	89	2	10,317
H	12.5-40	5	W	6	HW	38.6	51	1404	7	485,036
H	12.5-40	6	E	5	HM	23	62	1778	7	749,968
H	12.5-40	27	E	1	HW	35.3	161	578	7	636,764
H	12.5-40	48	W	1	HM	33.1	79	671	7	362,111
H	12.5-40	71	S	5	HW	28.5	96	1994	7	1,307,360
H	12.5-40	72	S	4	HW	30.5	35	3567	7	852,960
H	40.1-60	5	W	4	HW	50.5	51	820	5	196,982
H	40.1-60	14	W	6	HW	51.8	197	200	5	187,219
H	40.1-60	16	S	10	HM	59.1	92	236	5	103,126
H	40.1-60	19	E	7	HM	53.9	77	258	5	94,925
H	40.1-60	36	N	7	HW	58.5	84	201	5	80,584
H	40.1-60	38	E	7	HW	44.1	264	113	5	141,802
H	40.1-60	63	E	4	HW	52.6	95	288	5	130,188
H	40.1-60	72	W	3	HW	47.3	35	742	5	123,264
H	60.1-80	31	W	2	HW	77.8	47	268	4	48,025
H	60.1-80	36	E	8	HW	65.0	84	163	4	52,676
H	60.1-80	48	S	4	HW	64.7	79	176	4	53,166
H	60.1-80	72	W	5	HW	60.4	35	455	4	61,005
H	60.1-80	79	E	2	HW	70.4	42	557	4	89,810
H	60.1-80	79	W	5	HW	61.9	42	721	4	116,169
H	80.1-100	25	S	3	HW	96.8	40	202	3	20,232
H	80.1-100	36	N	3	HW	92.8	84	80	3	16,854
H	80.1-100	63	S	3	HM	80.5	95	123	3	29,255
H	80.1-100	72	W	8	HW	88.3	35	213	3	18,616
Minor	100.1+	44	W	2	ACT	105.2	92	74	4	27,408
Minor	12.5-40	78	N	1	FDC	39.2	154	321	17	838,931

Table 6. TFL 45 NVAF sample list (dead trees).

Spp	DBH class	Sample No	Plot No	Tree No	Species	DBH (cm)	W_1	W_2	W_3	W
Minor	12.5+	44	N	3	SS	14.5	387	3913	2	2,724,472
H	12.5+	14	W	7	HW	18.3	454	1601	2	1,309,581
Minor	12.5+	9	N	5	DR	38.7	667	244	2	292,828
H	12.5+	63	S	6	HW	48.0	400	345	2	248,620
H	12.5+	9	E	7	HW	58.9	667	105	2	126,417
H	12.5+	36	N	2	HW	63.5	353	171	2	108,764
Minor	12.5+	38	E	2	FDC	92.5	1,109	26	2	51,257
C&Y	12.5+	56	S	2	CW	100.0	516	19	2	18,115

APPENDIX II - DISTRIBUTION OF THE INVENTORY VOLUME AND NVAF SAMPLE

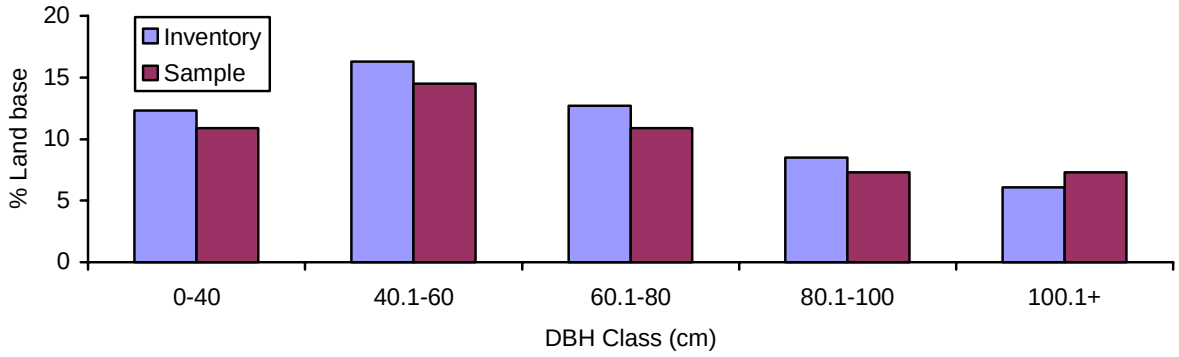

Figure 2. Distribution of the inventory and sample net merchantable volume on TFL 45 (H stratum).

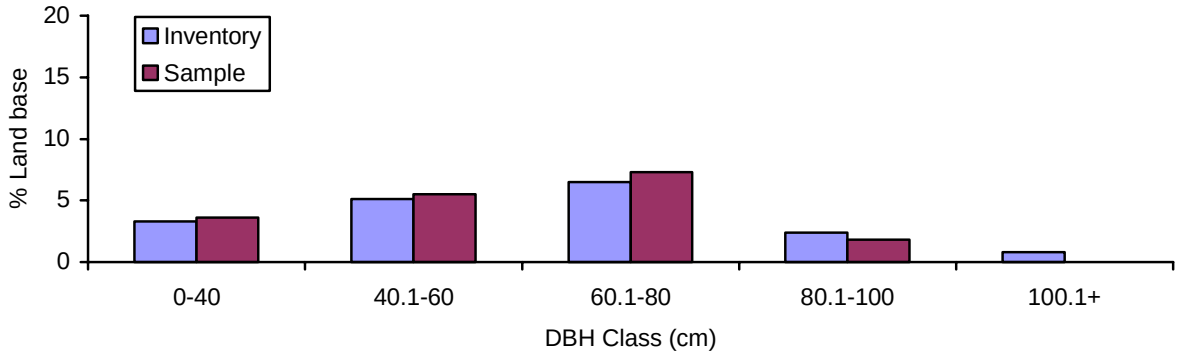

Figure 3. Distribution of the inventory and sample net merchantable volume on TFL 45 (B stratum).

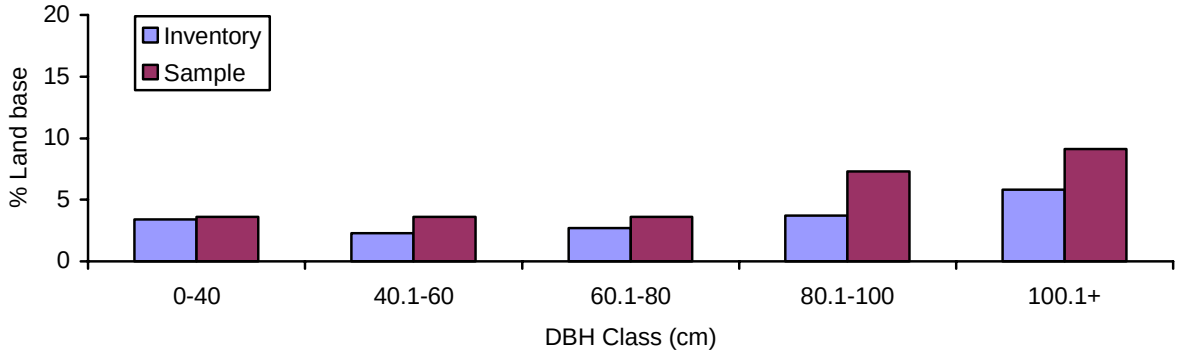

Figure 4. Distribution of the inventory and sample net merchantable volume on TFL 45 (C&Y stratum).

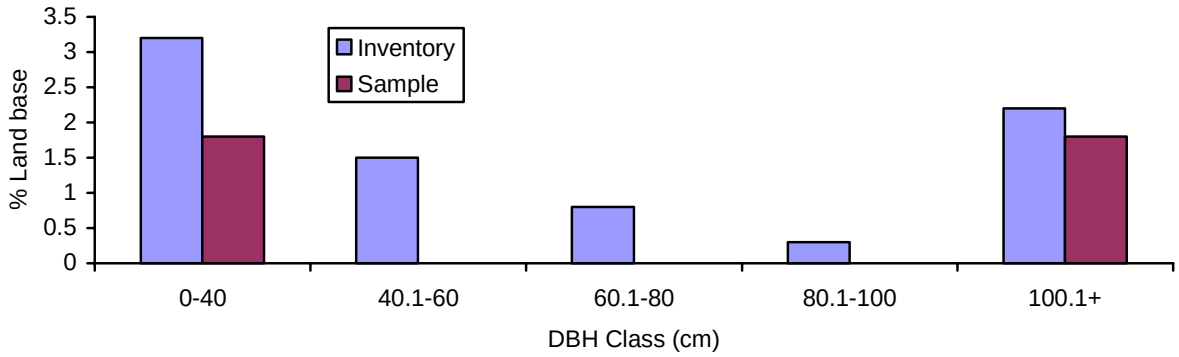

Figure 5. Distribution of the inventory and sample net merchantable volume on TFL 45 (Minor Species stratum).

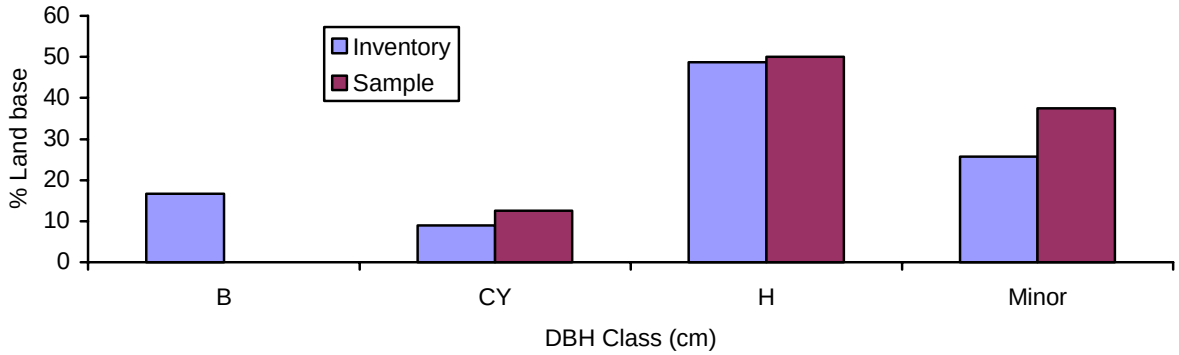

Figure 6. Distribution of the inventory and sample net merchantable volume on TFL 45 (Dead stratum).