Robson Valley Enhanced Forest Management Pilot Project
Coarse Woody Debris Assessment Phase III

(A comparative assessment of coarse woody debris volume and wildlife habitat quality in clearcut silviculture systems using groundbased harvesting methods under pre and postharvest conditions)

Final Report

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February 2002

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Acknowledgments

The author would like to acknowledge the following individuals for their assistance: Susan Stevenson (Silvifauna Research) for editing and input on study rationale; Steve Day (Slocan Forest Products Ltd.), Mike Jackman (McBride Forest Industry Ltd.), and Greg Clements (Robson Valley Forest District) for providing site information; Craig DeLong (BC Ministry of Forests), Aled Hoggett (UBC Forestry Department); Susan Hoyles (BC Ministry of Forests), and Mike Jull and Susan Stevenson (Northern Wetbelt Silviculture Systems Project, UNBC), for supplying information regarding Coarse Woody Debris surveys that have been conducted in the study area to date. Dieter Ayres of UNBC supplied statistical analysis. Fieldwork was done by E.P. Runtz and Associates of McBride B.C.

Summary

In the fall of 2002 a Coarse Woody Debris (CWD) survey was conducted in the Robson Valley Forest District for the Enhanced Forest Management Pilot Project (EFMPP) as a pilot study. Data were collected to determine levels of volume, decay class, and wildlife habitat types found in clearcut versus unharvested areas across biogeoclimatic subzones located in this forest district. Prior to this, information gaps were determined for ecosystems that lacked information on CWD. Allotment of proposed harvest along with utilization of silviculture systems and harvesting methods were also summarized.

Out of 12 biogeoclimatic subzones proposed for harvest, the Engelmann spruce-subalpine fir zone comprises 44.5 % of the harvest. This is considerable in relation to the other subzones. Only 2 subzones, the ESSFwk2 and ICHwk3, were found to have information on CWD. Based on information gathered from The Robson Valley Forest District Small Business Forest Enterprise Program, McBride Forest Industry, and Slocan Forest Products forest development plans, clearcut or clearcut with reserves comprised 85% of the silviculture systems used in the valley, while ground based harvesting methods were used in 54% of the silviculture prescriptions that were reviewed. This knowledge formed the basis for site selection.

Data analysis revealed the following general trends for CWD where groundbased harvesting methods were used in clearcut silviculture systems:

- No significant difference was detected for volume between the clearcut and unharvested units;
- The presence of Decay Class 1 and 2 appears to be higher in the harvested units. This harvesting method may reduce the presence of Decay Class 4 and 5 pieces, along with wildlife habitat Types 1, 3, and 5;
- In the ESSF subzones there was a significant increase in the number of subalpine fir pieces found in the clearcuts over that of the unharvested units;
- In the harvested units, early Decay Classes appear by observation to have more types associated with them than later Decay Classes. Later Decay Classes may be more prone to losing types through destruction or having them covered up by slash

Implications and recommendations based on these findings are discussed at the end of this report.

Introduction

In recent years forest managers have become increasingly aware of the role of trees with special characteristics and of fallen woody material in maintaining biodiversity. They have realized that these forest elements, which often result from damage or disease, provide critical wildlife habitat that will not necessarily be available in managed stands unless special measures are taken to insure their presence. In British Columbia, several initiatives have been taken to provide wildlife trees and coarse woody debris (CWD) in managed stands. In the Biodiversity Guide Book (1995), B.C. Ministry of Forests and B.C. Ministry of Environment Lands and Parks recommend how the retention of those structures should be integrated into forest management at the landscape and stand levels.

Through a series of decay stages, standing trees eventually become non-self supporting and fall to the ground, subsequently becoming CWD. Trees and stumps that are still intact and in the ground are still considered self supporting, and are thus not considered CWD (Resource Inventory Committee, 1997, not seen; cited by Buckland *et al*. 1998).
CWD provides potential habitat by creating nest sites, dens, and security cover for small mammals and birds. It provides ground level and elevated runways across streams, along the forest floor and up into the canopy. It is also an important source of moist microsites for amphibians, insects, plants and ectomycorrhizal fungi (O'neil *et al.* 1997, not seen; cited by Buckland *et al*. 1998). Hollow logs, created by heartwood fungi when the tree was standing are important as cover or denning sites for a variety of large mammals, including snowshoe hares, bushy tailed woodrats, weasels, skunks and black bears (Akenson and Henjum 1994, Maser *et al.* 1979, not seen; cited by Jull *et al.* 2000). Some animals such as red squirrels, cache winter food supplies in hollow logs (Maser *et al.* 1979, not seen; cited by Jull *et al.* 2000). The root wad of uprooted trees is an important habitat feature that is used by flycatchers for perching, by grouse for dusting, by juncos for nesting and by winter wrens for both foraging and nesting (Campbell *et al*. 1997, not seen; cited by Jull *et al.* 2000). However, other factors, such as size, decay stage, orientation and quantity of CWD have a greater influence than mode of death on how the fallen trees are used by wildlife (Caza 1993, not seen; cited by Jull *et al.* 2000).

This survey provides quantitative information about the structural habitat features provided by CWD in the Robson Valley Enhanced Forest Management Pilot Project (EFMPP) area. It was conducted within the Robson Valley Forest District boundary. The Robson Valley Forest District and local licensees Slocan Forest Products Ltd. and McBride Forest Industry Ltd. have facilitated this project with the appropriate site history and site access information.

Study Background

This project is composed of 3 phases. The goal of Phase 1 for the EFMPP CWD survey was to identify information gaps, and to provide those carrying out the 2001 field sampling with site locations and current sampling methodology. This information defines the basis and rationale for Phase 2 (data collection). Phase 3 is the report and recommendations, and will help guide direction of future study of CWD in the Robson Valley Forest District.

The EFMPP requires information regarding CWD volume and wildlife habitat attributes in relation to the predominant harvesting methods and silviculture systems used within the biogeoclimatic subzones of the project area. CWD data meeting current protocol (volume, decay class, and wildlife habitat attributes) were collected in representative harvested areas and adjacent unharvested areas.

Objectives

The objective of this project is to determine the levels of volume, wildlife habitat attributes, and decay class for CWD in harvested and unharvested areas. The ultimate goal is to collect and present data from harvested and unharvested areas representative of the levels of CWD found in the subzone variants that occur within this district. However, this pilot project is limited in budget, and has gathered data on CWD levels only in the subzones that have undergone and are proposed to undergo the highest levels of harvesting.

The specific objectives of the pilot project are:

- To identify biogeoclimatic subzones in the Robson Valley Forest District in which CWD assessments have been done, and to provide a brief descriptive summary of this work (information gaps).

- To locate ecologically representative study sites that have been recently logged, and to collect data based on the most recent CWD protocol used in the study area.

- To compare the amount of CWD found in harvested and unharvested areas in the suzones sampled.

- To compare the wildlife habitat quality of CWD found in harvested and unharvested areas in the subzones sampled.

- To provide recommendations for further study of CWD within these subzones as it pertains to wildlife habitat.

Information gaps

A gap analysis was conducted to determine the history of CWD surveys that have been conducted in the biogeoclimatic subzones of the Robson Valley Forest District (B.C. Ministry of Forests 1996). Based on this survey, it is clear that data on CWD are limited. Current information on CWD in the Robson Valley Forest District EFMPP is as follows:

- In 1999 and 2000 the Northern Wet-belt ICH/ESSF Silviculture Systems Project Phase III conducted CWD surveys in the ICHwk3 subzone. These surveys were carried out according to the CWD inventory methodology of the Resource Inventory Committee (1997) Ground Sampling Procedures. The wildlife habitat classification was based on an earlier draft of Keisker (2001). In this trial, ground based and cable harvesting systems were used, along with variable retention and clearcut silviculture systems. The East Twin and Minnow Creek study sites are located approximately 35 km northwest of McBride BC, and were sampled extensively. The East Twin site has been sampled for pre-harvest and post-harvest CWD. The Minnow Creek site has been sampled for pre-harvest CWD and post-harvest measurements by the Northern Wet-belt field crew in 2001. (For details refer to Jull *et al* 1999). The results of the post harvest measurements are presently being analyzed.

- In 1999 the British Columbia Conservation Foundation carried out CWD surveys in the ICHwk3 and ESSFwk2 subzones for the Robson Valley EFMPP. Transects of 100 m in length were established to sample old growth features. For each 100 m transect, a 30-m segment was randomly selected to measure CWD. For each piece greater than 7.5 cm in diameter at the point of interception, diameter was measured and decay class (according to Maser *et al* 1979) and CWD Wildlife Types according to an earlier draft of Keisker (2001) were assessed. Total volume of CWD for each plot was calculated using the formula described in Lofroth (1992), not seen, cited by Harrison *et al*. 2000.

- A study of Western Hemlock Looper and Forest Disturbance in the ICHwk3 of the Robson Valley was conducted by a Ph.D. candidate from the University of British Columbia in 2000. In this study CWD was defined as any dead stem that formed an angle of less than 45 degrees with the ground, and was greater than 10cm average diameter where it was intersected by the transect line. CWD was classified using a decay class system based on that of Triska and Cromack (1980, not seen, cited by Hogget 2000). A class was added to the classification to allow differentiation between heavily decayed CWD found on the forest floor (Class 5), and heavily decayed CWD that was largely submerged within the forest floor (Class 6) (Hogget 2000).

- In 1997, as part of the Treatment Regime Evaluation Numerical Decision Support (TRENDS) program of the Northern Interior Vegetation Management Association (NIVMA), nine CWD plots were installed and measured for volume and decay class according to Resource Inventory Committee ground sampling protocol (Resource Inventory Committee 1997). Six of the plots are in the ICHwk3, and three are in the ESSFmm1. Six of the plots were re-measured in 2000 for post-harvest CWD. The data can be accessed from the Prince George Region NIVMA Data Base (Industrial Forestry Services Ltd.) (Hoyles S. pers. com., 2001)

- Waste management surveys have also been conducted by licensees to determine the levels of felled timber and slash remaining on cutblocks after harvesting. The objectives of these surveys are to meet license obligations and are not ecologically based.

The ICHwk3 and ESSFwk2 are the only subzones that have been sampled using the desired data collection protocol of the Robson Valley EFMPP. Jull *et al*. (2000) and Harrison *et al*. (2000) used the most recently developed CWD habitat assessment methodology. Jull *et al*. (2000) was the only study to use variable retention treatment with a pre and post-harvest experimental design, although Hoyles (2001) also sampled pre and post-harvest plots.

Table 1 shows the subzones of the Robson Valley Forest District, along with the allocation of proposed harvest blocks based on recent forest development plans. It is clear that information for CWD representative of the subzones that undergo the highest rates of harvest is lacking.

Table 1. Proposed subzones for harvest and subzones with CWD information within the Robson District.

Subzones in EFMPP area.	% of total proposed cutblocks	Subzones with CWD information
ESSFmm1	44.5	
ESSFmm2	0.43	
ESSFwc2	0.43	
ESSFwk1	16.0	
ESSFwk2		Yes
ICHmm	16.0	
ICHvk2	1.00	
ICHwk1	2.00	
ICHwk2	0.64	
ICHwk3	15.0	Yes
SBSdh	2.00	
SBSvk	2.00	

Methods

Site selection and rationale

Ground based harvesting is the most widely used method in the district, and cable harvesting is second. A significant number of proposed cutblocks will be harvested using different combinations of these methods. Other harvesting methods used in this district include helicopter and horse logging, sometimes combined with ground based and/or cable.

Because this is a pilot study and the available budget dictates the scope of sampling, only cutblocks with ground based harvesting and clearcut silviculture systems have been chosen as study sites. Based on current Forest Development Plans from McBride Forest Industries, Robson Valley Small Business Forest Enterprise Program (SBFEP) and Slocan Forest Products, blocks that have been clear-cut with or without reserves were chosen as study sites, because these systems are the most prevalent within the Robson Valley Forest District. Conventional and cable harvesting methods encompass the largest cut-block areas in the district and therefore also formed the basis for study site selection. The percent application of harvesting method and silviculture system shown in Table 2 is based on the number of cut-blocks utilizing these methods and systems in the forest development plans for the Robson Valley Forest District.

Sites were selected on the basis of biogeoclimatic subzone, harvesting method and silviculture system. Therefore, candidate sites were limited to clearcuts with or without reserves, logged using groundbased methods. Appendix 1 lists the subzones and sites that were sampled. For subzone rational refer to the gap analysis section, and for harvesting method and silviculture system rational refer to Tale 2.

Within the Robson Valley Forest District, 11 Biogeoclimatic Subzones were identified as ecosystems lacking any information on Coarse Woody Debris. Subzones where information exists, and the related methodology is mentioned in the Information Gaps section.

Table 2: Percent proposed application of Ground Based (GB), Cable/Ground Based (C/GB), Cable (C) harvesting methods, Clear-cut (CC)/Clear-cut-reserves (CCR) silviculture systems, and other (helicopter and horse logging and all methods combined) in the Robson Valley Forest District, based on the current forest development plans.

Harvesting method/Silviculture system	% harvesting method used in district	% silviculture systems used in district
GB	34	
C/GB	20	
C	16	
CC/CCR		85
other	30	15

Study sites

Candidate cutblocks were provided by local licensees and the forest district, and were plotted throughout the study range on a 1:20,000 scale grid over lay of the Robson Valley Forest District. Silviculture prescriptions with hemlock looper salvage were removed.

Plot location and establishment procedures

Areas that were harvested using ground based harvesting methods have been chosen for this study. Although some blocks selected for the study include portions that were cable-logged, sampling was restricted to the areas where the harvesting was ground based.

A portion of the block edge that met establishment criteria (described in Rogers 2001) and was accessible was chosen, with the tie point located at a randomly chosen point along the edge portion. When locating plot establishment points the following site features were avoided, as these site characteristics may represent inordinate levels of CWD input.

-draws, gullies, and creek beds
-extreme slopes
-bog, marsh or fen
-forest that has been logged or disturbed beyond the cutblock harvest boundary

Paired plots were established in each cut-block. One in the clearcut and one in the unharvested area adjacent to the block edge. Lines perpendicular to the block edge were run for 100 m into the block and into the unharvested area. One transect 24 m in length was established on a random bearing. A coin toss determined which perpendicular direction another 50 m line was run. At that end point another transect was established. Returning to the point of commencement of the first transect a 50 m line was then walked back along the original line, where the third transect was then established. This procedure was repeated in both the harvested treatment unit (TU) and unharvested (UN) areas.

CWD sampling procedures

CWD decay class and volume data were collected as per the Resource Inventory Committee 1997, and CWD Wildlife Types Data was collected consistently with that of the Northern Wetbelt Silviculture Systems Project using Kiesker 2001.

Data Analysis

Volume calculations

CWD volume was calculated according to Van Wagner (1982). Odd shaped pieces were calculated as per Marshall (1999). These formulas were also used to calculate CWD volume in Jull *et al*. 2001. The formulas used were as follows:

$$V = (1.234/L)\ (d^2 \times a)$$

where V is volume in m^3 /ha, L is transect length (m), d is piece diameter in cm at the point of intersection with the sample line, and a is the secant of the tilt angle (away from the horizontal) of each piece sampled.
Odd shaped pieces

$$V = W \times H/L \times 10{,}000\ m^2/ha$$

where V is the volume (m^3 /ha) represented by an odd shaped piece crossed by the line transect, W is the width (m) of the rectangle associated with the odd-shaped piece, as measured along the length of the line transect, H is the effective height (m) of the odd-shaped piece, and L is the length (m) of the line transect.

Statistical analysis

Analysis was carried out using R version 1.4.1 (Copyright 2002, The R Development Core Team).

The primary issue with regards to the data is the sample size. A total of 18 plots were sampled, and these were spread out over 7 Subzones. There were 6 replications of the treatment in ESSFmm1, 3 in ESSFwk1, 2 in ICHwk3, 2 in ICHwk3/SBSvk, 3 in SBSvk, and one in each of ICHmm1 and SBSdh.

Statistical analysis on the ICHmm1 and SBSdh subzones were not performed, because of the lack of replication in these subzones. Similarly, though statistical analysis can be carried out on the Subzones with 2 replications, the results from these analysis are rather suspect, and are not presented in the text. For this reason, only results from the ESSFmm1, ESSFwk1, and SBSdh are presented. Even these should be viewed with caution, due to the small sample sizes.

The statistical analysis of the data consisted of a number of paired sample t-tests. T-tests on approximately 25 dependent variables were carried out for each subzone. The data was visually examined to assess normality.

Variable means by subzone can bee seen in Appendix 8, and statistical analysis output is listed in Appendix 3-7.

Results

Analysis A: Mean Volume

Volume analysis for this study showed no significant differences between clearcut treatment unit (TU) and the unharvested unit (UN) for any subzone. However, the ESSFmm1 did approach significance for the hypothesis; Differences do exist between the harvested and unharvested units.

The mean volume of the coarse woody debris was compared across the treated and untreated plots. This variable was highly skewed, and a transformation was applied to the data prior to the analysis. Logarithmic, square root, and cube root transformations were examined. A cube root transformation was used, because it had the effect of normalizing the data, and seems to be the best choice on theoretical grounds (as volume is measured in units cubed). None of the results are statistically significant, although it is being approached in the subzone ESSFmm1 (p=0.088). In this case the TU is on average 0.735m larger than the UN. Figure 1 shows volume distribution for the mean cube root with standard error. Figure 2 shows the actual Mean volume distribution. Table 3 shows probability values for significance.

Figure 1: Mean cube root Volume Distribution by treatment unit for each subzone

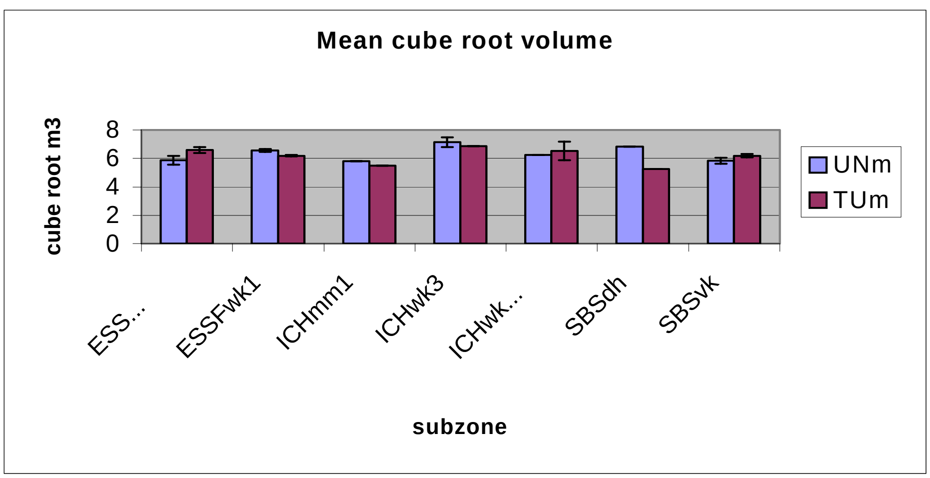


Figure 2: Mean volume distribution by treatment unit for each subzone

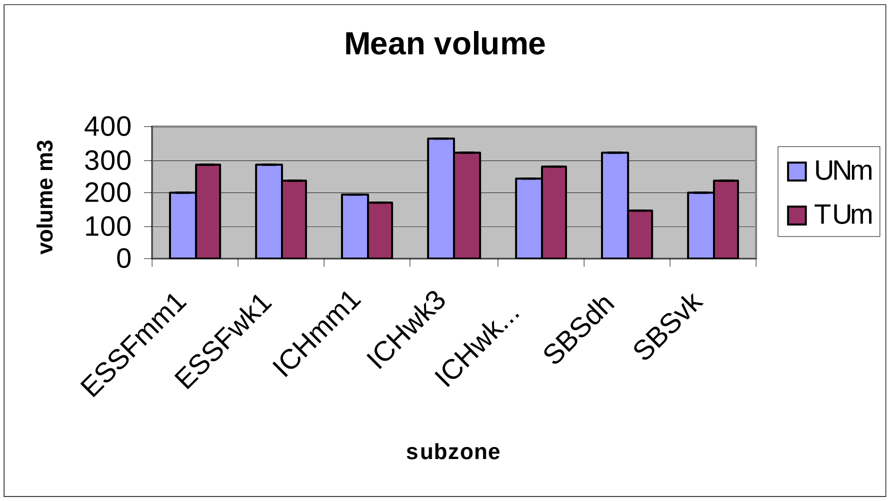


Table 3. Results of testing the hypothesis of no difference between TU and UN for volume

ESSFmm1	P=0.08846
ESSFwk1	P=0.3087
SBSvk	P=0.5464

Analysis B: Mean Decay Class

Mean Decay Class analysis for this study showed no significant difference between the TU and UN, with the exception of Class 1 in the ESSFmm1 and SBSvk, and Class 2 in the ESSFwk1 where there were more of these classes in TU compared to UN.

The data for this analysis consists of counts of the number of classes that were found on a transect. These counts were modified to be counts per hundred-meter unit, rather than simply counts per transect. Following this, means of transects were taken to eliminate the pseudo replication within the plots

Table 4 presents the p values for the t-tests. Asterisks mark those that are below 0.05. Figures 3-7 show the mean distribution of decay classes 1-5 by treatment unit for each subzone. For a description off Decay Classes, see Appendix 3.

Figure 3: Mean Class 1 per 100m by treatment unit for each subzone

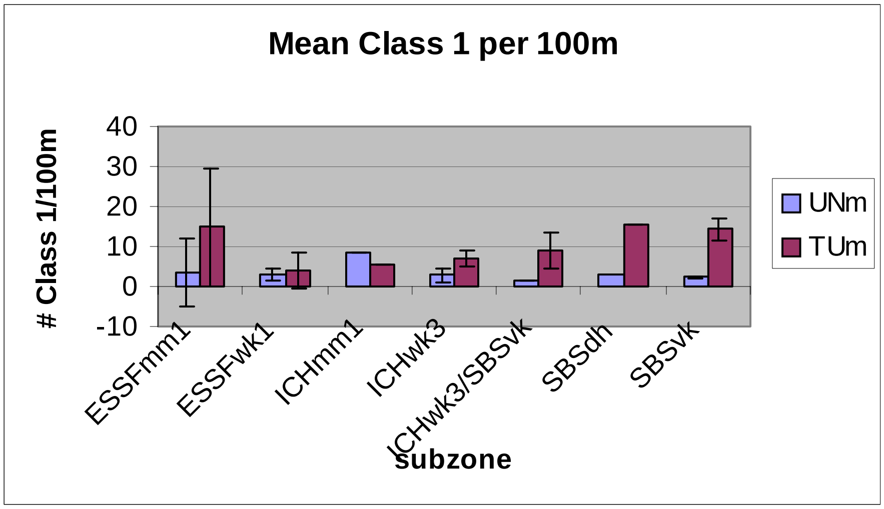


Figure 4: Mean Class 2 per 100m by treatment unit for each subzone

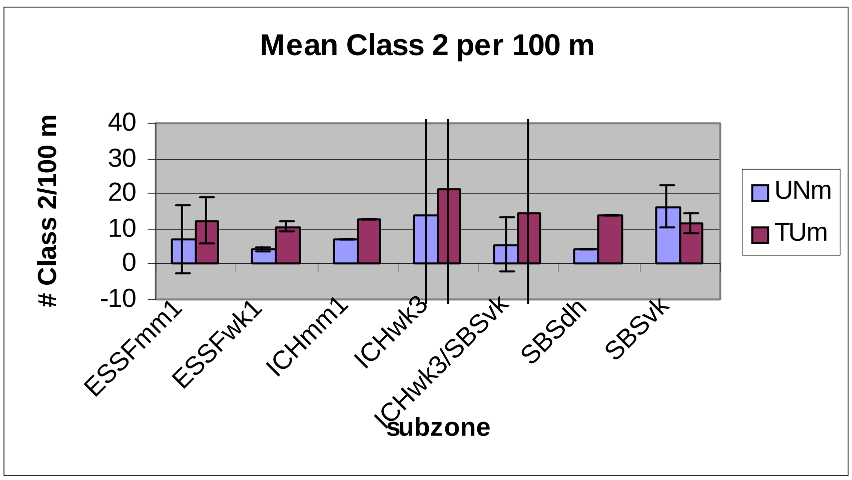


Figure 5: Mean Class 3 per 100m by treatment unit for each subzone

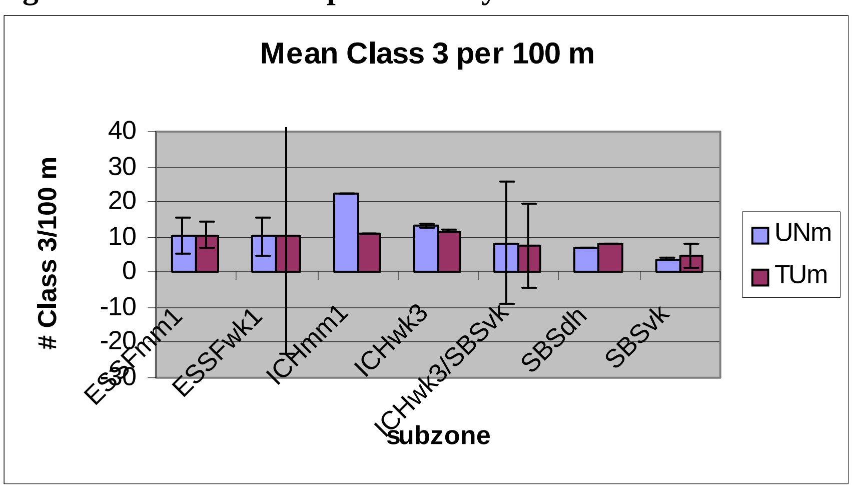


Figure 6: Mean Class 4 per 100m by treatment unit for each subzone

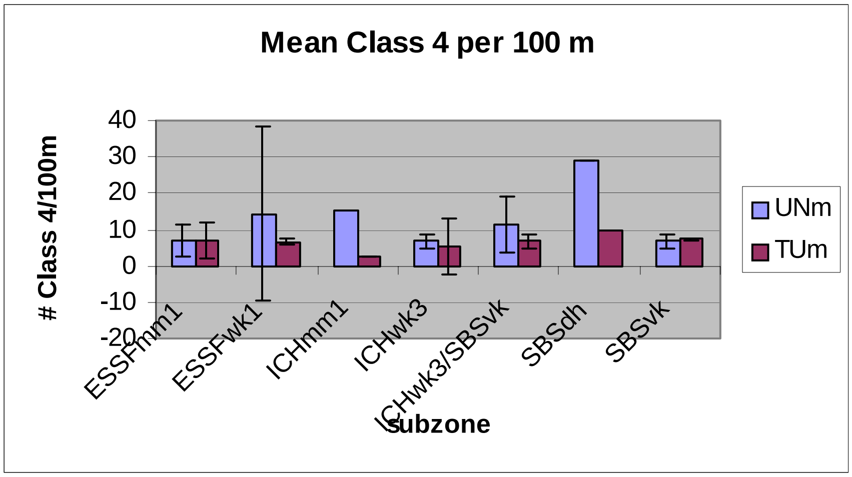


Figure 7: Mean Class 5 per 100m by treatment unit for each subzone

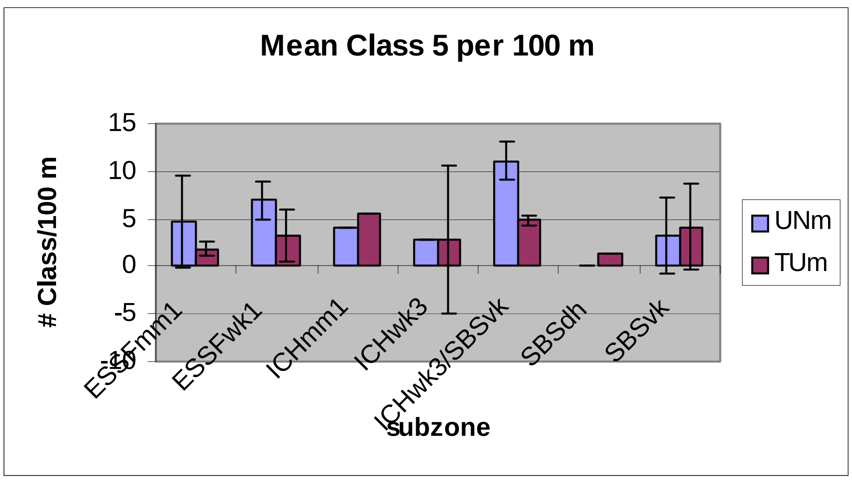


Table 4: Results of testing the hypothesis of no difference between TU and UN for decay class.

	Class 1	Class 2	Class 3	Class 4	Class 5
ESSFmm1	p= 0.00397*	p= 0.3175	p= 1	p= 1	p= 0.2474
ESSFwk1	p= 0.4226	p= 0.0339*	p= 0.9374	p= 0.2664	p= 0.1835
SBSvk	p= 0.02286*	p= 0.3624	p= 0.7278	p= 0.7418	p= 0.8399

Analysis C: Mean Wildlife Types

Analysis of Wildlife Types revealed Type 5 in the ESSFwk1 as the only subzone with a statistically significant difference between the TU and UN, with more Type 5 in UN.

This analysis is similar to the last, except that it examines the mean number of types within the plots. Again, the counts were transformed to counts per 100 meters, and then averaged over transects. Figures 8-13 show the distribution of mean types per 100 m by treatment unit for each subzone. Table 5 shows probability values for significance. For a description of Wildlife Types, see Appendix 4.

Figure 8: Mean Type 1 per 100 m by treatment unit for each subzone

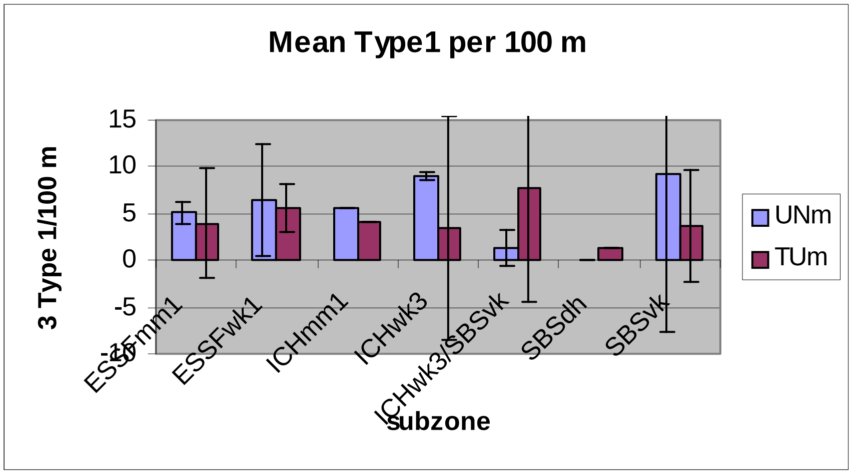


Figure 9: Mean Type 2 per 100 m by treatment unit for each subzone

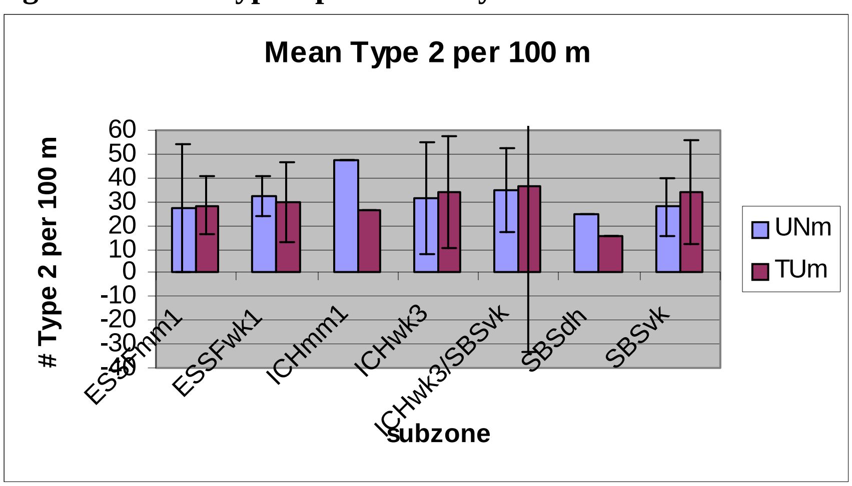


Figure 10: Mean Type 3 per 100 m by treatment unit for each subzone

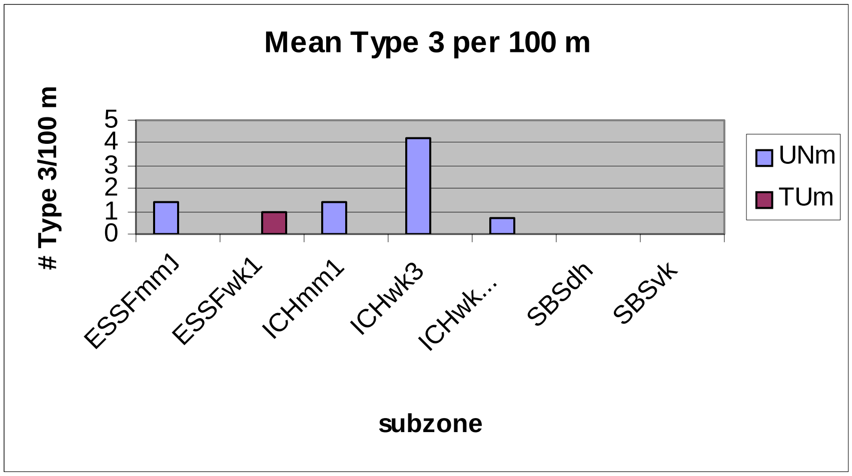


Figure 11: Mean Type 4 per 100 m by treatment unit for each subzone

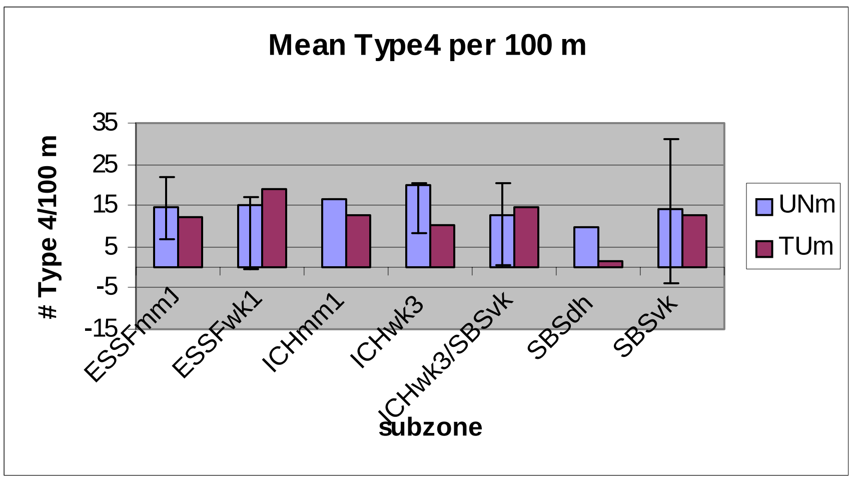


Figure 12: Mean Type 5 per 100 m by treatment unit for each subzone

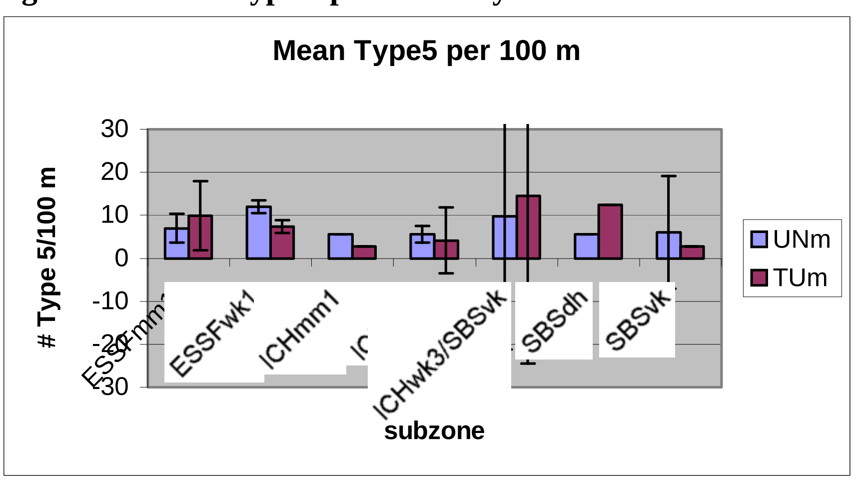


Figure 13: Mean Type 6 per 100 m by treatment unit for each subzone

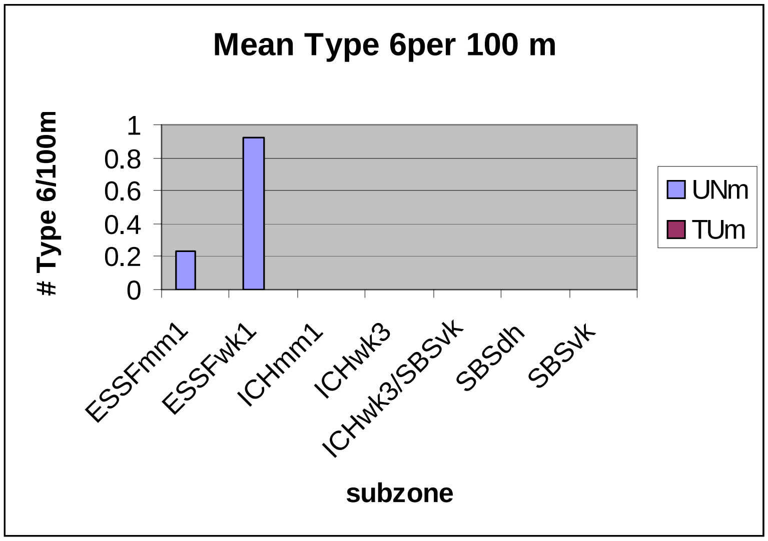


Table 5. Results of testing the hypothesis of no difference between TU and UN for Wildlife type

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
ESSFmm1	p= 0.6685	p= 0.7840	p= 0.2752	p= 0.3094	p= 0.2861	p= 0.3632
ESSFwk1	p= 0.4226	p= 0.5876	p= 0.4226	p= 0.4134	p=0.0099*	p= 0.4226
SBSvk	p= 0.1201	p= 0.9296	p= NA	p= 0.4557	p= 0.4647	p= NA

Analysis D: Mean Number Wildlife Types per piece

Mean number of Wildlife Types per piece analysis showed a significant difference between the TU and UN only for the ESSFmm1, with higher number in UN. The ESSFwk1 and SBSvk did however approach significant p values, exhibiting the same trend for higher in UN.

This analysis consisted of counting the numbers of types per piece of debris. Again, the values of each piece were averaged to produce a single plot value. Figure 14 shows the distribution of pieces with varying numbers of types by treatment unit for each subzone. Table 6 shows probability values for significance.

Figure 14: Mean # of types per piece by treatment unit for each subzone

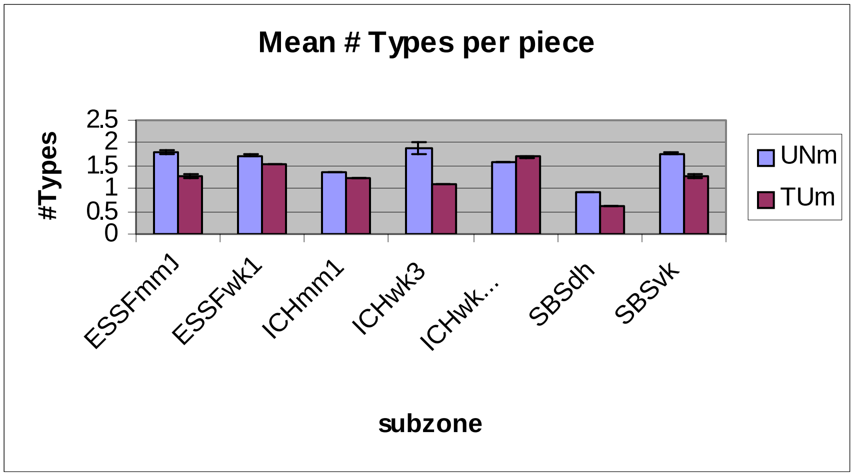


Table 6. Results of testing the hypothesis of no difference between TU and UN for number of Types per piece

	Total Types
ESSFmm1	p= 0.01144
ESSFwk1	p= 0.09884
SBSvk	p= 0.06785

Analysis E: Percent tree species with one or more Wildlife Types

Analysis for percent tree species with 1 or more types showed only subalpine fir with a significant difference between TU and UN.

This analysis was done only on subalpine-fir (Bl) and hybrid spruce (Sx). The other species did not appear frequently enough to produce valid statistical tests. Even in these species, interpretation should be cautious due to the lack of replication of plots. Of the tests performed, only one was significant. That was for species Bl in the ESSFmm1 subzone. In that case the TU was on average 28.5 percentage points higher than the UN. Figures 15 and 16 show percent types per species (for subalpine-fir and spruce only) by treatment unit for each subzone. Table 7 shows probability values for significance

Figure 15: Percent subalpine-fir with 1 or more Types by treatment unit for each subzone

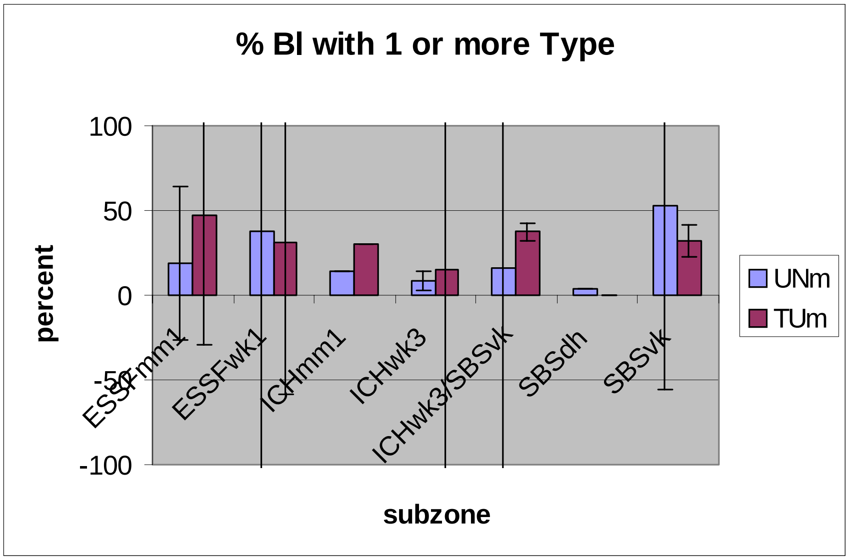


Figure 16: Percent hybrid spruce with 1 or more Type by treatment unit for each subzone

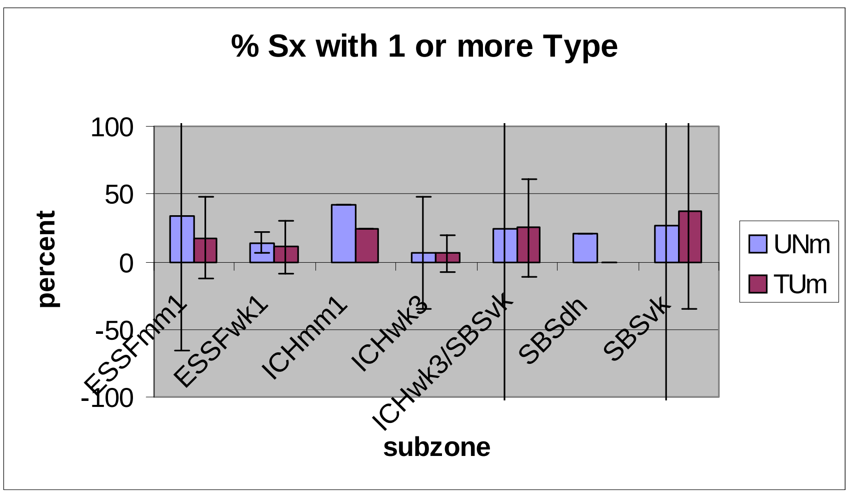


Table 7 Results of testing the hypothesis of no difference between TU and UN % tree species with 1 or more Wildlife Types

	Bl	Sx
ESSFmm1	P=0.04822*	P=0.1242

Analysis F: Mean Number Types per Class

The data for this analysis consists of counts of the number of classes that were found on a transect. These counts were modified to be counts per hundred meter unit, rather than simply counts per transect. Following this, means of transects were taken to eliminate the pseudo replication within the plots.

Figure 17: Mean number of types per transect associated with Class 1

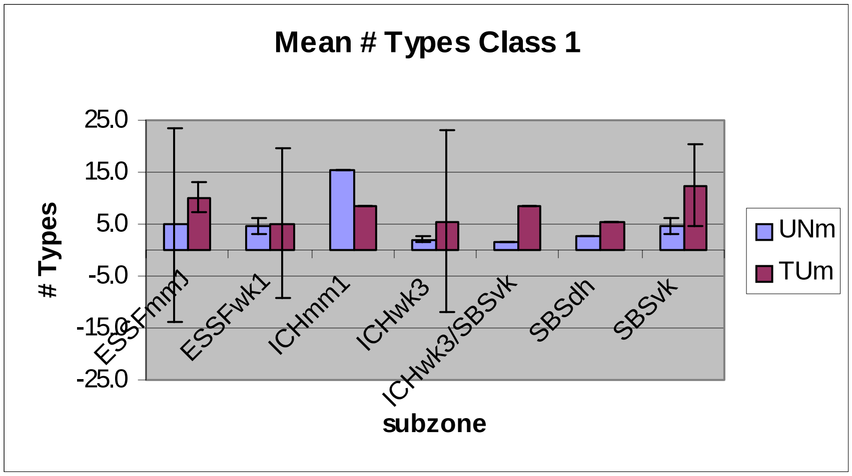


Figure 18: Mean number of types per transect associated with Class 2

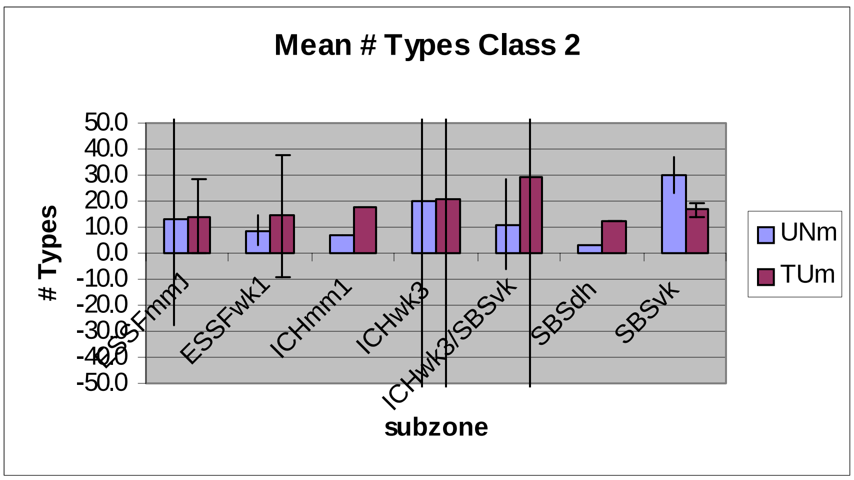


Figure 19: Mean number of types per transect associated with Class 3

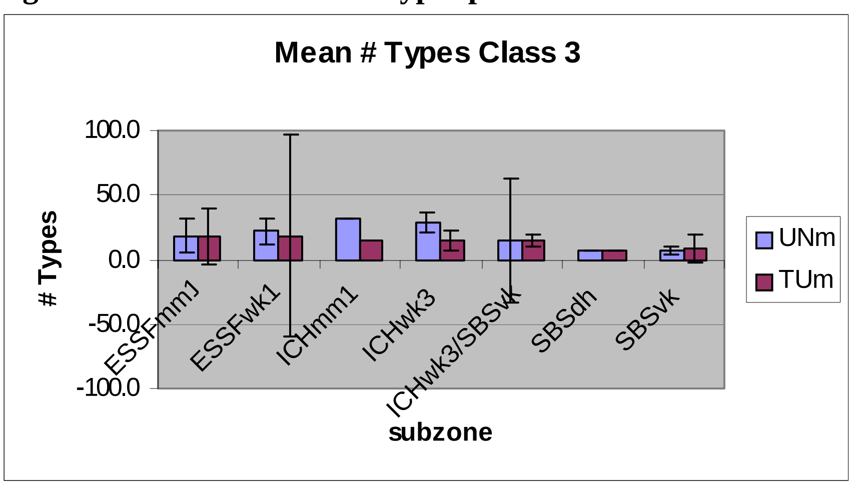


Figure 20: Mean number of types per transect associated with Class 4

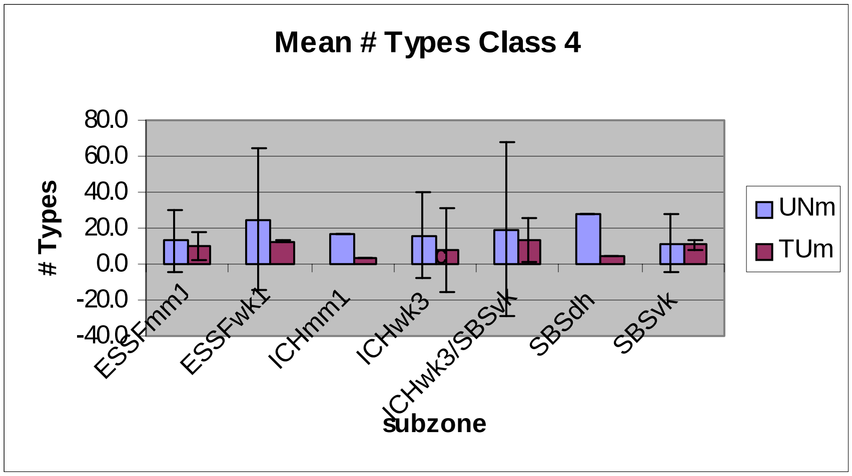
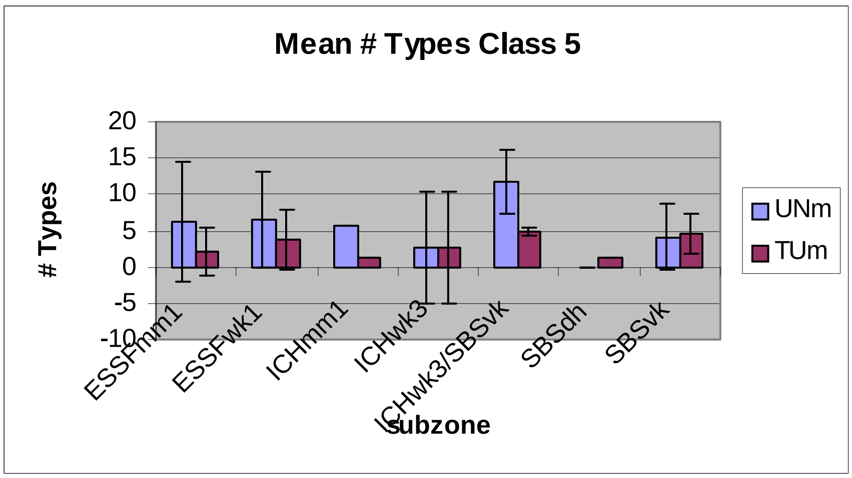


Figure 21: Mean number of types per transect associated with Class 5



Discussion/Recommendations

Ideally all subzones would have had balanced sample sizes. However, due to time and weather constraints (e.g. cannot sample CWD with any snow on the ground), a limited number of plots were sampled. Because cutblocks meeting the study criteria are limited within each subzone, the original intent was to sample all that were available and not randomly choose a subset. Forty sites were originally selected for sampling across all of the subzones with projected harvest, however, due to limited time and budget not all of them were sampled as intensively as had originally been intended. Nineteen sites were sampled in this survey and are listed by subzone in Appendix 1. The ESSFmm1 which contains most of the proposed harvest in this district was sampled more intensely than the other subzones. Some subzones could not be analyzed statistically, and all results must be interpreted cautiously.

Because variability is sometimes high within and between these subzones, it is recommended that further study using this design use the variance seen in this study to establish appropriate sample sizes. For example, the ESSF can be patchy in nature, with many gaps. Small samples may not capture all of the variation and non-normal distribution may be inherent in this type of data, as was seen in the statistical analysis (Stevenson 2001, pers. com.). The ICH, which may not only be patchy, but may also have a much wider piece size range, can also result in non-normal distribution. In some cases it is neither economically nor logistically feasible to approach the sample sizes needed to completely overcome this variation. Therefore, data transformation such as that used in this statistical analysis are warranted. Within-subzone interactions were examined only in the ESSFmm1, ESSFwk1, and SBSvk. Sample sizes were higher in these subzones than others, but were still low enough that the results should be viewed with caution.

Because this is a pilot project and appropriate sampling intensity has not yet been determined, this discussion will focus on apparent differences and their implications, and recommend sampling intensity for future work. All variables should be tested more rigorously in the future work. Parameters in this study that parallel those of Jull *et al.* (2001) will be discussed, as sampling continuity between the two studies is a premise of this study. Only data from the control in this study will be compared to the pre-harvest data of the Northern Wetbelt, as the latter have not yet been evaluated for post-harvest conditions. The Northern Wetbelt study included only ESSF and ICH subzones.

Discussion of analysis and sampling design

Three transects were sampled in each plot, yet these transect are not considered as replicates of the treatments, as the plot is the experimental unit under question, and the transects represent only repeated measurements of the particular plot that they fall within. Treating the transects as replicates will artificially increase the sample size and lead to an increased probability of Type I error (falsely rejecting the null hypothesis). This is a classic case of pseudoreplication (see Hurlbert, 1984), and as such, should be accounted for before analysis. To alleviate this problem, analysis was carried out on the mean values of the transects within a plot.

There were a number of variables that began as counts, such as the number of observed classes and types variables in analysis B and C. To be analyzed with complete statistical rigor, they should have been modeled explicitly as counts, and not been analyzed with t-tests. At the very least, a non-parametric analogue of a t-test such as a Wilcoxon signed rank test (see Sokal 1995) would have produced more correct results. These were not done, for the simple reason that this is a preliminary study, with the aim of providing information to be used in future research. As such, it was decided that the information from t-tests would be more useful than that from other types of analysis.

T-tests were used because they give us more information than the Wilcoxons test does. None of the tests work very well when the sample size is low. The Wilcoxon, because it is non-parametric and based on ranks, can only produce a finite number of p-values, and acts in an incremental way. For example, in some of the analyses done, we could get p-values that were equal to 0, 0.25, 0.5, 0.75, or 1 (due to the small sample size). These are not particularly useful for an exploratory study, Therefore, the t-test which can take any value in (0,1), was chosen because these would at least give more of an indication of possible trends (Ayers, 2002)

Discussion of sampling variables

Results from Jull *et al.* (2001) for Volume, Decay Class and wildlife types for the ICHwk and ESSFwk are presented along with results from this study, in comparative Tables 8-10. Only control (unharvested) treatments are compared as Jull *et al.* (2001) is currently undergoing post-harvest analysis.

A) *Volume*

Volume in the Northern Wetbelt (Jull *et al.* 2001) study's ESSF subzones ranged from 181.6 m^3/ha in the ESSFwk2 to 205.2 m^3/ha in the ESSFwc3. Values for the ESSFmm1 and ESSFwk1in the EFMPP study were 201.0 m^3/ha and 281.9 m^3/ha respectively. In the Jull *et al.* (2001) the ICHwk3 had values ranging from 164.9 m^3/ha to 341.9 m^3/ha, while the EFMPP study showed values ranging from 194.3 m^3/ha in the ICHmm1 to 365.8 m^3/ha in the ICHwk3. Numerical values for volumes from all subzones are listed in Table 2 of Appendix 8.

Although the statistical analysis shows no significant difference in volume between the TU and UN paired plots, this cannot be interpreted as a literal conservation of CWD after harvest, due to the difference in quality of the CWD (Proulx 2001 *pers. com.*). This is examined in the following subsections.

Table 8: Comparative results for volume (m^3)

ICHwk	ICHwk	ESSFmm	ESSFwk
EFMPP	**Wetbelt**	**EFMPP**	**Wetbelt**
365.8	164.9-341.9	201.0	181.6

B) *Decay Class*

Again, no apparent significant difference is seen between harvested and unharvested treatment units in either study. However the ESSFmm1 in the EFMPP study with the highest number of replicates indicates that groundbased harvest may reduce Class 5 pieces. This may be attributed to the same rationale as mentioned for Class 4 pieces. Numerical values for all subzones are listed in Table 7 of Appendix 8.

Class - 1

The only statistically significant relationships were seen for Class 1 in the ESSFmm1 and SBSvk. Values of Jull *et al* (2001) in the ESSFwk2 and wc3 respectively, were 2.4 and 2.6 pieces/100 m, while the EFMPP showed values of 3.2 and 3.5 pieces/100 m in the ESSFwk1 and mm1 respectively. The ICHwk3 in both the Jull *et al. 2001* and EFMPP study respectively showed values of (2.3-2.8 pieces/100 m) to 2.5 pieces/100 m. Class 1 pieces represent new input so the apparent trend of more Class 1's in the harvested unit is intuitive. Numerical values for all subzones are listed in Table 3 of Appendix 8

Class - 2

Numbers seen in this study were comparable with those reported by Jull *et al.* (2001). The ESSFwk1 was the only subzone that showed a statistically significant difference, but there is an apparent trend toward more Class 2 pieces in the harvested area. The apparent increase in class 2's in the TU is most likely a result of standing dead trees being pushed over, adding to the number of Class 2's naturally on the forest floor. Numerical values for all subzones are listed in Table 4 of Appendix 8.

Class – 3

The EFMPP study showed similar results to that of the Jull *et al. 2001* in the ESSF. Figures from the ICH subzones were some what comparable. There does not appear to be an apparent trend towards difference between Class 3 pieces in the harvested and unharvested units. This may be due to the fact that pieces that have reached this decay level in unharvested forest have done so as a function of already being on the forest floor, therefore harvesting activities do not significantly increase input. Numerical values for all subzones are listed in Table 5 of Appendix 8.

Class – 4

Class 4 in the ICHwk for both studies were comparable. The ESSFwk for the EFMPP was considerably higher than that of the Wetbelt study. The other subzone relationships for Class 4 are suspect due to low sample size. If further study reveals that there is indeed no significant difference between harvested and unharvested areas, it may be due to the lower position of these well established pieces on the forest floor, because they are often embedded in the ground. However it has been observed that groundbased harvesting can destroy a significant amount of Class 4 pieces due to their soft nature (author's personal observation). For this reason it has been suggested based on other studies that if CWD were managed operationally in patches on cutblocks, that greater proportions of CWD with natural characteristics may be preserved (Lloyd 2001, *pers. com.*). Numerical values for all subzones are listed in Table 6 of Appendix 8.

Class - 5

Again, no apparent significant difference is seen between harvested and unharvested treatment units in either study. However the ESSFmm1 in the EFMPP study with the highest number of replicates indicates that groundbased harvest may reduce Class 5 pieces. This may be attributed to the same rationale as mentioned for Class 4 pieces. Numerical values for all subzones are listed in Table 7 of Appendix 8.

Table 9: Comparative results for decay class (frequency/100 m)

Class	ICHwk	ICHwk	ESSFwk	ESSFwk
	EFMPP	**Wetbelt**	**EFMPP**	**Wetbelt**
Class 1	2.80	2.30-2.80	3.20	2.40

Class 2	13.90	10.90-8.80	4.20	9.40
Class 3	13.20	6.0-8.60	10.20	8.20
Class 4	6.90	2.30-4.90	14.40	0.40
Class 5	2.80	1.40	6.90	1.20

Classes 1 and 2 appear to increase after harvest while Classes 3 – 5 tend to remain the same with later stage decay classes possibly being diminished after ground-based harvest. Not only is the number of individual decay classes important, but their size and orientation in relation to the ground and/or other pieces plays a role in their functionality (Lloyd 2001**.** In the future, counts could be modeled directly, rather than simply examining the mean with a t-test, as outlined in the results section (Ayers 2002.).

C) ***Wildlife types***

As pointed out in the results section, the only apparent statistically significant difference was seen in the ESSFwk1 for Type 5. Pre and post harvest characteristics have been observed in the field by the author, and will be commented on where appropriate. Data for post harvest measurements for Jull *et al.* 2001 are presently being analyzed. It is recommended that the results of Jull *et al.* 2001 be visited when completed, for a more in depth comparison of pre and post harvest dynamics.

Types 1, 3 5 appeared more in the unharvested units. Some of the overall trends that were seen are as follows;

Type – 1 (Large concealed spaces)

The values presented in this report for pieces with Type 1 for the ESSF are somewhat higher than that of Jull *et al.* 2001. There appears to be more similarities between the figures in both studies for the ICH, however the EFMPP sample size is low.

The apparent trend for Type 1 shows the unharvested units with slightly more than the harvested units. If this is the case, some Type 1 (concealed spaces) may be affected by ground based harvesting. The disappearance of Type 1's has been observed during pre and post harvest measurements during data collection for Jull *et al.* 2001, with the creation of new Type 1's in the harvested areas (personal observation). The natural and newly created Type 1's however, do differ in some characteristics. These differences should be investigated in order to accurately assess habitat quality. Numerical values for all subzones are listed in Table 8 of Appendix 8.

Type – 2 (Small concealed spaces in substrate)

Figures for Type 2 are relatively similar for Jull *et al.* 2001 and the EFMPP study. There appears to be no apparent significant difference between harvested and unharvested units in the EFMPP study. This may be due to the fact that any piece, whether from natural or harvest input, lying on the ground may have Type 2. In other words new Type 2's may replace old Type 2's. Numerical values for all subzones are listed in Table 9 of Appendix 8.

Type – 3 (Small concealed spaces above ground level)

Type 3 in the ESSF and ICH for Jull *et al.* 2001 was highly variable. There is an apparent trend for higher numbers of Type 3 in the unharvested unit for the ESSF and ICH, and extremely low numbers in the SBS in the EFMPP study. The former may be due to the presence of upturned root-wads (often associated with Type 3) found intact in the unharvested units, that may be destroyed in the harvested units. Numerical values for all subzones are listed in Table 10 of Appendix 8.

Type 4 (Long concealed spaces in substrate)

Values for the ICH and ESSF for both studies appear to be similar. There appears to be no apparent significant difference between the harvested and unharvested units in the EFMPP study. As seen with Type 2, there may simply be a replacement of natural Type 4's with Type 4's associated with new input from harvesting. Numerical values for all subzones are listed in Table 11 of Appendix 8.

Type – 5 (Large or elevated structures/runways)

ESSF and ICH values were similar for both studies. The EFMPP study showed no apparent significant difference between the harvested and unharvested units except for the ESSFwk1 where 12.0 Type 5's per 100 m and 7.4 per 100 m were observed in the unharvested unit. If more rigorous testing revealed that the control indeed had more than the clearcut, it may be due to the piece length minimum data collection protocol of 4-5 m depending on evident runway value, that was used in both studies. In Jull *et al.* 2001, the ESSFwc3 showed almost twice as many Type 5's in the control as in the treatment units, although neither treatment unit was a clearcut. Numerical values for all subzones are listed in Table 12 of Appendix 8

Type – 6 (Invertebrates in wood or under bark)

Although numbers appeared somewhat similar between both studies, they were done at different times of the year. Jull *et al.* 2001 was done in early to mid summer, while this study was done in late fall. The lower temperature for the EFMPP study would no doubt have an effect on the number of invertebrates observed. For example, in the clear cut where surface temperature is warmer, carpenter ants are usually seen at higher numbers. Aspect may have an influence on the amount of invertebrates seen at this time of year, again suggesting that there is a need to have more replicates in order to capture this variation. Numerical values for all subzones are listed in Table 13 of Appendix 8

Table 10: Comparative results for wildlife Types (frequency/100 m)

Types	ICHwk	ICHwk	ESSFwk	ESSFwk
	EFMPP	**Wetbelt**	**EFMPP**	**Wetbelt**
Type 1	9.0	2.50-6.0	6.50	2.0

Type 2	31.3	19.20-25.00	31.9	20.7
Type 3	4.20	0.50-2.10	0.00	0.40
Type 4	20.10	14.10-17.60	15.30	18.20
Type 5	5.60	6.90-10.90	12.00	5.40
Type 6	0.00	0.20	0.23	0.10

D) *Mean number of Types per piece*

The number of wildlife Types found per piece is a variable that allows a value to be attached to each piece. The ESSFmm1 showed a significant difference in the number of Types found per piece, with mean values of 1.8 in the unharvested units and 1.3 in the harvested units. The ESSFwk1, and SBSvk had very similar results and approached significant p values. Certain structures such as large concealed spaces (Type 1), raised cavities (Type 3), and runways (Type 5), appear to show up less frequently in the harvested units with this data set. These structures are easily destroyed through harvesting activities such as movement along skid trails and landings (personal observation). The disappearance of some of these structures may explain the lower number of types per piece found in the harvested units.

E) *Percent Types per tree species*

This analysis included only subalpine-fir (Bl) and hybrid spruce (Sx) in the ESSFmm1. There was a significant difference between harvested and unharvested units for Bl. Perhaps because Bl is more likely to be non-merchantable than Sx, and therefore more likely to be left in the cutblock. Bl decays faster than Sx, so nearly half the Types in the harvested unit may not persist long in relation to rotation length. In the unharvested unit Bl had 19% of the Types, while in the harvested unit it had 47.5% of the Types. This observation by itself does not tell us much, however, knowing which tree species has most of the Types, may allow for future predictions of the longevity of structures based on species decay rates (Parminter 2001). It is recommended that future work be based on sample sizes that are large enough to accurately examine this distribution.

F) *Mean Number of Types per Class*

In the harvested units, early Decay Classes appear by observation to have more types associated with them than later Decay Classes. Between Class differences should be tested in future work to determine how the natural dynamic compares to the harvested dynamic over the decay class continuum.. Later Decay Classes such as Class 4 and 5 may be more prone to loosing types through destruction or having them covered up by slash (this needs to be statistically analyzed).

Although the study overall was statistically limited due to low sample size and the lack of replication in some subzones, the ESSFmm1 was the strongest. This subzone is targeted for the highest timber removal in the Robson Valley Forest District. The addition of replicates to each subzone in this study is recommended before making concrete conclusions about the state of

CWD in harvested and unharvested areas. Balanced sample sizes between subzones are also recommended so that between subzone effects may be examined.

General summary of results

- No significant difference was detected for volume between the clearcut and unharvested units.

- The presence of Decay Classes 1 and 2 appears to be higher in the harvested units.

- Harvesting may reduce the presence of Decay Class 4 and 5 pieces, and wildlife habitat Types 1, 3, and 5.

- More CWD Wildlife Types are associated with pieces in the unharvested areas.

- Observation suggests that as decay class increases there are fewer types associated with each piece in the harvested units than in the unharvested.

Recommendations

The influence that the CWD structure left in clearcuts after harvest has on wildlife habitat, will no doubt change over time. If we are to manage for specific wildlife species we not only need to know their habitat requirements, but also what is and will be available for them under a variety disturbances. Some wildlife may not immediately utilize CWD left in clearcuts, while others such as winter wrens, dark eyed junkos and Clark's nutcrackers may take advantage of the newly created structures (personal observation). No matter how much CWD is left in cutblocks, voles will not inhabit these areas until total vegitative ground cover has been re-established. In the absence of proper ground structural complexity, adequate internal connectivity, and prey base (i.e. voles), mustelids such as martin (*Martes americana*) will not venture in openings, even if piles of debris are spread across cutblocks (Proulx 2001-1). Based on this, CWD wildlife use should be monitored over time to capture the frequency of use through stand initiation/regeneration and further succession.

This study serves as a window to view areas of CWD structure and dynamics in relation to the subzones of the Robson Valley Forest District that need to be further understood. Surveys must be conducted on a larger scale in order to overcome ecological variation that is highly inherent to this natural disturbance type (NDT 1), and be able to more accurately predict the implications of CWD management. The following recommended sampling intensities should be used in subsequent CWD studies within these subzones. Future work should also include the following**:**

- The following rationale guided the calculation of suggested sampling intensity:

  -sample size calculations are based on Volume data for the ESSF
  -an estimate for variance of 0.818 was used. This is the variance of the difference between TU and UN in the ESSF groups based on the cube root variable

-For a difference between the means 0.50 was used. This is slightly larger than some of the differences seen in the data.

The following formula was used to calculate sample size

$n=t^2*s/ d^2$

where t is the appropriate critical value of the t distribution. The estimate of the variance is given by s^2, and d represents the difference between the means of the two groups.

for 90% confidence,

$n= (2.13^2)*.818/(0.5)^2 = 15$ plots

and for 95%

$n= 1.8^2*.818/0.5^2 = 11$ plots

These numbers represent the number of plots to sample, and not the number of transects within a plot. For inventory purposes a sample size based on a 95% confidence interval may be logistically impractical. Therefore, sample size based on a 90% confidence interval is also presented.

- CWD sampling in cutblocks with harvest methods and silviculture systems (e.g. group selection, single tree selection etc…) not covered in the 2001 survey.

- Waste and residue surveys should be conducted to determine how varying levels of utilization effect CWD characteristics on cutblocks.

- CWD should be looked at across a variety of site prep methods, as these methods have a direct impact on the levels and condition of CWD on a cut-block.

- Wildlife use should be measured not only to detect when use in the cutblock begins, but also which animal species use the structures the most.

- Investigate the difference in structural characteristics between the same Wildlife Types found under natural conditions and those created by logging, to determine if the sampling protocol should account for any difference in quality.

- Tracking temporal changes in longevity or functionality of Wildlife Types in relation to decay rate will supply information that can be used to predict changes in the habitat quality of a forest floor over time.

- Specific CWD Types associated with particular decay classes should be analyzed to determine if Types are natural or associated with new input, as there may be a difference in quality between the two.

- Between subzone comparisons should be conducted to determine which particular harvesting practices are most appropriate for each ecosystem.

- The knowledge of what structures are there and how they are effected by harvest should be complemented with the knowledge of who uses what and when. For information related to wildlife habitat use of different forest structures see Gillingham (2002). Use of the structures should be examined across a variety of successional and seral stages after harvest.

- The effects of a variety of harvesting machinery on CWD should be examined as seen in Lloyd (2002).

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Appendix 1 Study sites chosen for 2001 CWD survey

Plot No.	Map No.	BEC zone	Location	Block No.	Air Phot. No	Company	Comments
2	93A-099	ESSFmm1	Castle Creek	3		District	
4	83A-099	ESSFmm1	Castle Creek	4		District	
5	83A-099	Essfmm1	Casle Creek	A48095-1		District	
6	83A-099	ESSFmm1	Castle Creek	A48095-2		District	
9	83D-038	ESSFmm1 ICHmm1	6 km up stream in Hugh Allen drainage	322-h1	BCB 91162 160 & 161	Slocan	
15	83E 032	ICHmm1	Holmes River	524-A	BCB 7505, 84, 85, 86	MFI	
16	83E-003-15	SBSdh	Highway 16 E.Small River to Spittal Creek area	1		District	
18	83E-032	ESSFmm1	Holmes River	524-E	BCB 7505 84, 85, 86	MFI	
19	93H-027	ESSFwk1	Milk River	127-C	BCB 7294, 99, 100, 101	MFI	
20	93H-027	ESSFwk1	Milk River	127-B	BCB 7294 99, 100, 101	MFI	
21	93H-037	ESSFwk1	Milk Creek	121-A	BCB 7294 48	MFI	
23	93H-047	ICHwk3 SBSvk	Snoeshoe/Catfish	83-T44	30 BCB 91089, 228	MFI	
24	93H-047	ICHwk3	Snowshoe/Catfish	83-T46	30 BCB 91089, 292	MFI	
25	93H-057	SBSvk	Snowshoe/Catfish	83-T41		MFI	
26	93H-057	SBSvk ICHwk3	Snowshoe/Catfish	83-T42		MFI	
27	93H-057	SBSvk	Snowshoe/Catfish	83-T43	30 BCB 91089, 228	MFI	
28	93H-057	SBSvk	Snowshoe/Catfish	83-T40	30 BCB 91089, 227	MFI	
30	93H-057	ICHwk3	Catfish Creek	82-C	BCB 91089 250	MFI	
99	83-012	ESSFmm1		2	30BCC 9118 #144	MFI	

Appendix 2: Mean Values of variables

Table 1: Cube Root Volumes

	UNm	Tum		
ESSFmm1	5.9	6.6	0.3	0.2
ESSFwk1	6.6	6.2	0.1	0.1
ICHmm1	5.8	5.5	NA	NA
ICHwk3	7.2	6.9	0.3	0.0
ICHwk3/SB Svk	6.2	6.5	0.0	0.7
SBSdh	6.8	5.2	NA	NA
SBSvk	5.8	6.2	0.2	0.1

Table 2: Volume (m^3)

	UNm	TUm
ESSFmm1	201.0	286.5
ESSFwk1	281.9	236.6
ICHmm1	194.3	167.3
ICHwk3	365.8	323.6
ICHwk3/SB Svk	243.6	277.9
SBSdh	320.5	144.4
SBSvk	198.3	237.6

Table 3: Mean Class 1

	UNm	TUm	UNse	TUse
ESSFmm1	3.5	14.8	8.7	14.7
ESSFwk1	3.2	4.2	1.5	4.5
ICHmm1	8.3	5.6	NA	NA
ICHwk3	2.8	6.9	1.9	1.9
ICHwk3/SB Svk	1.4	9.0	0.0	4.3
SBSdh	2.8	15.3	NA	NA
SBSvk	2.3	14.4	0.2	2.8

Table 4: Mean Class 2

	UNm	TUm	UNse	TUse
ESSFmm1	7.2	12.3	9.6	6.6
ESSFwk1	4.2	10.6	0.6	1.5
ICHmm1	6.9	12.5	NA	NA
ICHwk3	13.9	21.5	123.5	174.1
ICHwk3/SB Svk	5.6	14.6	7.7	81.5

SBSdh	4.2	13.9	NA	NA
SBSvk	16.2	11.6	6.0	2.8

Table 5: Mean Class 3

	UNm	TUm	UNse	TUse
ESSFmm1	10.6	10.6	5.1	3.7
ESSFwk1	10.2	10.6	5.4	33.7
ICHmm1	22.2	11.1	NA	NA
ICHwk3	13.2	11.8	0.5	0.5
ICHwk3/SBSvk	8.3	7.6	17.4	12.1
SBSdh	6.9	8.3	NA	NA
SBSvk	3.7	4.6	0.2	3.4

Table 6: Mean Class 4

	UNm	TUm	UNse	TUse
ESSFmm1	6.9	6.9	4.2	5.0
ESSFwk1	14.4	6.5	24.0	0.9
ICHmm1	15.3	2.8	NA	NA
ICHwk3	6.9	5.6	1.9	7.7
ICHwk3/SBSvk	11.1	6.9	7.7	1.9
SBSdh	29.2	9.7	NA	NA
SBSvk	6.9	7.4	1.9	0.2

Table 7: Mean Class 5

	Unm	TUm	UNse	TUse
ESSFmm1	4.6	1.9	4.8	0.7
ESSFwk1	6.9	3.2	1.9	2.8
ICHmm1	4.2	5.6	NA	NA
ICHwk3	2.8	2.8	0.0	7.7
ICHwk3/SBSvk	11.1	4.9	1.9	0.5
SBSdh	0.0	1.4	NA	NA
SBSvk	3.2	4.2	4.1	4.5

Table 8: Mean Type 1

	UNm	TUm	UNse	TUse
ESSFmm1	5.1	3.9	1.2	5.8
ESSFwk1	6.5	5.6	6.0	2.6
ICHmm1	5.6	4.2	NA	NA
ICHwk3	9.0	3.5	0.5	12.1
ICHwk3/SBSvk	1.4	7.6	1.9	12.1
SBSdh	0.0	1.4	NA	NA

SBSvk	9.3	3.7	16.9	6.0

Table 9: Mean Type 2

	UNm	TUm	UNse	TUse
ESSFmm1	27.3	28.2	26.6	12.0
ESSFwk1	31.9	29.6	8.4	16.9
ICHmm1	47.2	26.4	NA	NA
ICHwk3	31.3	34.0	23.6	23.6
ICHwk3/SBSvk	34.7	36.1	17.4	69.4
SBSdh	25.0	15.3	NA	NA
SBSvk	27.8	33.8	12.2	22.1

Table 10: Mean Type 3

	UNm	TUm	UNse	TUse
ESSFmm1	1.4	0.0	1.3	0.0
ESSFwk1	0.0	0.9	0.0	0.9
ICHmm1	1.4	0.0	NA	NA
ICHwk3	4.2	0.0	1.9	0.0
ICHwk3/SBSvk	0.7	0.0	0.5	0.0
SBSdh	0.0	0.0	NA	NA
SBSvk	0.0	0.0	0.0	0.0

Table 11: Mean Type 4

ESSFmm1	14.6	12.0	7.4	7.5
ESSFwk1	15.3	19.0	1.9	15.6
ICHmm1	16.7	12.5	NA	NA
ICHwk3	20.1	10.4	0.5	12.1
ICHwk3/SBSvk	12.5	14.6	7.7	12.1
SBSdh	9.7	1.4	NA	NA
SBSvk	14.4	12.5	16.9	18.0

Table 12: Mean Type 5

	UNm	TUm	UNse	TUse
ESSFmm1	6.9	10.0	3.3	8.0
ESSFwk1	12.0	7.4	1.5	1.5
ICHmm1	5.6	2.8	NA	NA
ICHwk3	5.6	4.2	1.9	7.7
ICHwk3/SBSvk	9.7	14.6	30.9	39.1
SBSdh	5.6	12.5	NA	NA
SBSvk	6.0	2.8	13.1	0.0

Table 13: Mean Type 6

	UNm	TUm	UNse	TUse
ESSFmm1	0.231482	0	0.053584	0
ESSFwk1	0.925926	0	0.857339	0
ICHmm1	0	0	NA	NA
ICHwk3	0	0	0	0
ICHwk3/SBSvk	0	0	0	0
SBSdh	0	0	NA	NA
SBSvk	0	0	0	0

Table 14: Mean # Types Per Piece

	UNm	TUm	UNse	TUse
ESSFmm1	1.8	1.3	0.0	0.0
ESSFwk1	1.7	1.5	0.0	0.0
ICHmm1	1.3	1.2	NA	NA
ICHwk3	1.9	1.1	0.1	0.0
ICHwk3/SBSvk	1.6	1.7	0.0	0.0
SBSdh	0.9	0.6	NA	NA
SBSvk	1.8	1.3	0.0	0.0

Table 15: % Types per Species

	UNm	TUm	UNse	TUse
ESSFmm1	19.0	47.5	45.3	77.0
ESSFwk1	38.0	31.5	152.7	89.6
ICHmm1	14.5	30.3	NA	NA
ICHwk3	8.8	15.6	5.5	241.8
ICHwk3/SBSvk	16.0	37.4	254.4	5.3
SBSdh	3.4	0.0	NA	NA
SBSvk	53.2	32.2	109.3	9.3

Table 16: Mean # Types per Class 1

	UNm	TUm	UNse	TUse
ESSFmm1	4.9	10.2	18.7	2.8
ESSFwk1	4.6	5.1	1.5	14.4
ICHmm1	15.3	8.3	NA	NA
ICHwk3	2.1	5.6	0.5	17.4
ICHwk3/SBSvk	1.4	8.3	0.0	0.0
SBSdh	2.8	5.6	NA	NA
SBSvk	4.6	12.5	1.5	7.7

Table 17: Mean # Types per Class 1

	UNm	TUm	UNse	TUse
ESSFmm1	4.9	10.2	18.7	2.8
ESSFwk1	4.6	5.1	1.5	14.4
ICHmm1	15.3	8.3	NA	NA
ICHwk3	2.1	5.6	0.5	17.4
ICHwk3/SBSvk	1.4	8.3	0.0	0.0
SBSdh	2.8	5.6	NA	NA
SBSvk	4.6	12.5	1.5	7.7

Table 18: Mean # Types per Class 2

	UNm	TUm	UNse	TUse
ESSFmm1	13.2	14.1	40.7	14.2
ESSFwk1	8.8	14.4	6.0	23.4
ICHmm1	6.9	18.1	NA	NA
ICHwk3	20.1	20.8	212.7	94.5
ICHwk3/SBSvk	11.1	29.2	17.4	378.1
SBSdh	2.8	12.5	NA	NA
SBSvk	30.1	16.7	6.6	2.6

Table 19: Mean # Types per Class 3

ESSFmm1	18.1	17.8	13.1	21.0
ESSFwk1	21.8	18.5	10.5	78.0
ICHmm1	31.9	15.3	NA	NA
ICHwk3	29.2	15.3	7.7	7.7
ICHwk3/SBSvk	15.3	14.6	48.2	4.3
SBSdh	6.9	6.9	NA	NA
SBSvk	6.9	8.3	2.6	10.3

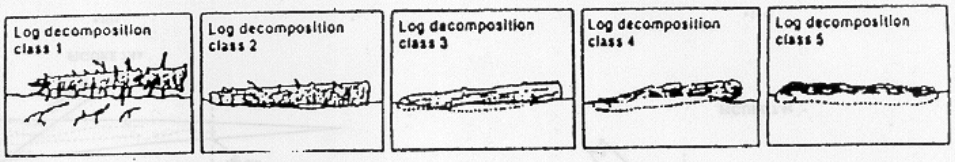
Table 20: Mean # Types per Class 4

	UNm	TUm	UNse	TUse
ESSFmm1	13.2	10.0	17.2	7.5
ESSFwk1	25.0	12.5	39.2	0.6
ICHmm1	16.7	2.8	NA	NA
ICHwk3	16.0	7.6	23.6	23.6
ICHwk3/SBSvk	19.4	13.2	48.2	12.1
SBSdh	27.8	4.2	NA	NA
SBSvk	11.6	10.6	16.3	2.8

Table 21: Mean # Types per Class 5

	UNm	TUm	UNse	TUse
ESSFmm1	6.3	2.1	8.3	3.3
ESSFwk1	6.5	3.7	6.6	4.1
ICHmm1	5.6	1.4	NA	NA
ICHwk3	2.8	2.8	7.7	7.7
ICHwk3/SBSvk	11.8	4.9	4.3	0.5
SBSdh	0.0	1.4	NA	NA
SBSvk	4.2	4.6	4.5	2.8

Appendix 3: CWD Decay Classes



	Class 1	Class 2	Class 3	Class 4	Class 5
Wood Texture	Intact, hard	Intact, hard to partly decaying	Hard, large pieces, partly decaying	Small, blocky pieces	Many small pieces, soft portions
Portion on Ground	Elevated on support points	Elevated but sagging slightly	Sagging near ground, or broken	All of log on ground, sinking	All of log on ground, partly sunken
Twigs < 3 cm (if originally present)	Present	Absent	Absent	Absent	Absent
Bark	Intact	Intact or partly missing	Trace	Absent	Absent
Shape	Round	Round	Round	Round to oval	Oval
Invading Roots	None	None	In sapwood	In heartwood	In heartwood

Appendix 4; CWD Wildlife Types

COARSE WOODY DEBRIS (CWD) TABLE 1		
MAIN FUNCTIONS OF COARSE WOODY DEBRIS	CONFIGURATIONS OF FEATURES OF COARSE WOODY DEBRIS REQUIRED BY WILDLIFE SPECIES OCCURRING IN THE SBS, ESSF, AND ICH ZONES	MAIN USERS OF EACH TYPE
Reproduction/Resting/Escape: Concealed Spaces	**CWD-1: Large Concealed Spaces**	Grouse, hare, woodrat, Porcupine, fox, cats, some mustelids, bears
	CWD-2: Small Concealed Spaces (or Soft Substrate Allowing Excavation of such Spaces) at or below Ground-level beneath Hard Material	Salamander, toad, treefrog, snakes, wrens, shrews, voles, Deer Mouse, Golden-mantled Ground Squirrel, chipmunk, jumping mice, weasels
	CWD-3: Small Concealed Spaces above Ground-level	Treefrog, Yellow-bellied Flycatcher, wrens, solitaire, some wood-warblers, some sparrows ?
Travel: a. Concealed Runways	**CWD-4: Long Concealed Spaces (or Soft Substrate Allowing Construction of Runways)**	Salamander, some snakes, wrens, shrews, voles, Deer Mouse, weasels
Travel: b. Exposed, Raised Travel Lanes	**CWD-5: Large or Elevated, Long Material Clear of Dense Vegetation**	Tree squirrels, chipmunk
Foraging: Feeding Substrates	**CWD-6: Invertebrates in Wood, under Bark or Moss-cover, or in Litter/Humus Accumulated around CWD**	Salamander, treefrog, woodpeckers, wrens, some sparrows ?, shrews, Deer Mouse, skunk, bears

Appendix 5. Full output from mean volume analysis

```
> A.ESSFmm1.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = -2.1115, df = 5, p-value = 0.08846
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -1.6297031  0.1598066
sample estimates:
mean of the differences
             -0.7349483

> A.ESSFwk1.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = 1.3529, df = 2, p-value = 0.3087
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.8115992  1.5560946
sample estimates:
mean of the differences
              0.3722477

> A.ICHmm1.t
Error: Object "A.ICHmm1.t" not found
> A.ICHwk3.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = 0.4535, df = 1, p-value = 0.729
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -7.721153  8.292734
sample estimates:
mean of the differences
              0.2857902

> A.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = -0.3949, df = 1, p-value = 0.7605
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -9.311684  8.750288
sample estimates:
mean of the differences
              -0.280698

> A.SBSdh.t
Error: Object "A.SBSdh.t" not found
> A.SBSvk.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = -0.7197, df = 2, p-value = 0.5464
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -2.529599  1.804619
sample estimates:
mean of the differences
             -0.3624896
```

Appendix 6. Full output from Mean Class Data Analysis

```
Class 1

> B1.ESSFmm1.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = -5.0379, df = 5, p-value = 0.003974
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -17.130122  -5.555063
sample estimates:
mean of the differences
              -11.34259

> B1.ESSFwk1.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = -1, df = 2, p-value = 0.4226
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -4.909864  3.058012
sample estimates:
mean of the differences
              -0.925926

> B1.ICHwk3.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = -6.634429e+15, df = 1, p-value = < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -4.166667 -4.166667
sample estimates:
mean of the differences
              -4.166667

> B1.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = -3.6667, df = 1, p-value = 0.1695
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -34.11015  18.83237
sample estimates:
mean of the differences
              -7.638889

> B1.SBSvk.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = -6.5, df = 2, p-value = 0.02286
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -20.004912  -4.069162
sample estimates:
mean of the differences
              -12.03704
```

Class 2

```
> B2.ESSFmm1.t

        Paired t-test

data:  test.subset[, 3] and test.subset[, 4]
t = 1.11, df = 5, p-value = 0.3175
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -6.700655 16.885840
sample estimates:

mean of the differences
               5.092593

> B2.ESSFwk1.t

        Paired t-test

data:  test.subset[, 3] and test.subset[, 4]
t = 5.2915, df = 2, p-value = 0.03391
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
  1.211227 11.751736
sample estimates:
mean of the differences
               6.481481

> B2.ICHwk3.t

        Paired t-test

data:  test.subset[, 3] and test.subset[, 4]
t = 3.6667, df = 1, p-value = 0.1695
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -18.83237  34.11015
sample estimates:
mean of the differences
               7.638889

> B2.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 3] and test.subset[, 4]
t = 0.7647, df = 1, p-value = 0.5844
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -140.9760  159.0316
sample estimates:
mean of the differences
               9.027778

> B2.SBSvk.t

        Paired t-test

data:  test.subset[, 3] and test.subset[, 4]
t = -1.1704, df = 2, p-value = 0.3624
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -21.64902  12.38976
sample estimates:
mean of the differences
               -4.62963
```

Class 3

```
> B3.ESSFmm1.t
```

```
        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = 0, df = 5, p-value = 1
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -5.049099  5.049099
sample estimates:
mean of the differences
          -2.960595e-16

> B3.ESSFwk1.t

        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = 0.0887, df = 2, p-value = 0.9374
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -21.98539  22.91131
sample estimates:
mean of the differences
               0.462963

> B3.ICHwk3.t

        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = -1, df = 1, p-value = 0.5
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -19.03640  16.25862
sample estimates:
mean of the differences
              -1.388889

> B3.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = -0.0909, df = 1, p-value = 0.9423
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -97.75573  96.36684
sample estimates:
mean of the differences
             -0.6944444

> B3.SBSvk.t

        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = 0.4, df = 2, p-value = 0.7278
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -9.033918 10.885770
sample estimates:
mean of the differences
               0.925926

Class 4

> B4.ESSFmm1.t

        Paired t-test

data:  test.subset[, 7] and test.subset[, 8]
```

```
t = 0, df = 5, p-value = 1
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -4.420966  4.420966
sample estimates:
mean of the differences
           4.440892e-16

> B4.ESSFwk1.t

        Paired t-test

data:  test.subset[, 7] and test.subset[, 8]
t = -1.5266, df = 2, p-value = 0.2664
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -30.05200  14.31126
sample estimates:
mean of the differences
               -7.87037

> B4.ICHwk3.t

        Paired t-test

data:  test.subset[, 7] and test.subset[, 8]
t = -1, df = 1, p-value = 0.5
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -19.03640  16.25862
sample estimates:
mean of the differences
              -1.388889

> B4.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 7] and test.subset[, 8]
t = -1, df = 1, p-value = 0.5
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -57.10919  48.77585
sample estimates:
mean of the differences
              -4.166667

> B4.SBSvk.t

        Paired t-test

data:  test.subset[, 7] and test.subset[, 8]
t = 0.378, df = 2, p-value = 0.7418
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -4.807291  5.733217
sample estimates:
mean of the differences
               0.462963

>
Class 5

> B5.ESSFmm1.t

        Paired t-test

data:  test.subset[, 9] and test.subset[, 10]
t = -1.3093, df = 5, p-value = 0.2474
alternative hypothesis: true difference in means is not equal to 0
```

```
95 percent confidence interval:
 -8.231428  2.675873
sample estimates:
mean of the differences
              -2.777778

> B5.ESSFwk1.t

        Paired t-test

data:  test.subset[, 9] and test.subset[, 10]
t = -2, df = 2, p-value = 0.1835
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -11.671579   4.264172
sample estimates:
mean of the differences
              -3.703704

> B5.ICHwk3.t

        Paired t-test

data:  test.subset[, 9] and test.subset[, 10]
t = 0, df = 1, p-value = 1
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -35.29501  35.29501
sample estimates:
mean of the differences
                      0

> B5.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 9] and test.subset[, 10]
t = -3, df = 1, p-value = 0.2048
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -32.72126  20.22126
sample estimates:
mean of the differences
                  -6.25

> B5.SBSvk.t

        Paired t-test

data:  test.subset[, 9] and test.subset[, 10]
t = 0.2294, df = 2, p-value = 0.8399
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -16.43966  18.29151
sample estimates:
mean of the differences
               0.925926
```

Appendix 7. Full output from Mean types Data Analysis

```
Type 1

> C1.ESSFmm1.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 3]
t = -0.4545, df = 5, p-value = 0.6685
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -7.702870  5.388055
sample estimates:
mean of the differences
              -1.157407

> C1.ESSFwk1.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 3]
t = -1, df = 2, p-value = 0.4226
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -4.909864  3.058012
sample estimates:
mean of the differences
              -0.925926

> C1.ICHwk3.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 3]
t = -1.3333, df = 1, p-value = 0.4097
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -58.49808  47.38696
sample estimates:
mean of the differences
              -5.555556

> C1.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 3]

t = 3, df = 1, p-value = 0.2048
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -20.22126  32.72126
sample estimates:
mean of the differences
                   6.25


> C1.SBSvk.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 3]
t = -2.6186, df = 2, p-value = 0.1201
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -14.683904   3.572793
sample estimates:
mean of the differences
              -5.555556
```

Type 2

```
> C2.ESSFmm1.t

        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = 0.2893, df = 5, p-value = 0.784
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -7.302023  9.153875
sample estimates:
mean of the differences
               0.925926

> C2.ESSFwk1.t

        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = -0.6402, df = 2, p-value = 0.5876
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -17.87259  13.24296
sample estimates:
mean of the differences
              -2.314815


> C2.ICHwk3.t

        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = Inf, df = 1, p-value = < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
               2.777778

> C2.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = 0.1111, df = 1, p-value = 0.9296
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -157.4387  160.2164
sample estimates:
mean of the differences
               1.388889


> C2.SBSvk.t

        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = 0.7419, df = 2, p-value = 0.5354
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -28.88360  40.92063
sample estimates:
mean of the differences
               6.018519
```

Type 3

```
> C3.ESSFmm1.t

        Paired t-test

data:  test.subset[, 8] and test.subset[, 9]
t = -1.2247, df = 5, p-value = 0.2752
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -4.303988  1.526210
sample estimates:
mean of the differences
              -1.388889

> C3.ESSFwk1.t

        Paired t-test

data:  test.subset[, 8] and test.subset[, 9]
t = 1, df = 2, p-value = 0.4226
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -3.058012  4.909864
sample estimates:
mean of the differences
               0.925926


> C3.ICHwk3.t

        Paired t-test

data:  test.subset[, 8] and test.subset[, 9]
t = -3, df = 1, p-value = 0.2048
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -21.81417  13.48084
sample estimates:
mean of the differences
              -4.166667

> C3.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 8] and test.subset[, 9]
t = -1, df = 1, p-value = 0.5
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -9.518198  8.129309
sample estimates:
mean of the differences
             -0.6944444

> C3.SBSvk.t

        Paired t-test

data:  test.subset[, 8] and test.subset[, 9]
t = NaN, df = 2, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

Type4

> C4.ESSFmm1.t
```

```
        Paired t-test

data:  test.subset[, 11] and test.subset[, 12]
t = -1.131, df = 5, p-value = 0.3094
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -8.333826  3.241233
sample estimates:
mean of the differences
              -2.546296

> C4.ESSFwk1.t

        Paired t-test

data:  test.subset[, 11] and test.subset[, 12]
t = 1.0243, df = 2, p-value = 0.4134
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -11.85407  19.26148
sample estimates:
mean of the differences
               3.703704

> C4.ICHwk3.t

        Paired t-test

data:  test.subset[, 11] and test.subset[, 12]
t = -3.5, df = 1, p-value = 0.1772
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -45.01724  25.57279
sample estimates:
mean of the differences
              -9.722222

> C4.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 11] and test.subset[, 12]
t = 3, df = 1, p-value = 0.2048
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -6.74042 10.90709
sample estimates:
mean of the differences
               2.083333


> C4.SBSvk.t

        Paired t-test

data:  test.subset[, 11] and test.subset[, 12]
t = -0.9177, df = 2, p-value = 0.4557
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -10.534643   6.830939
sample estimates:
mean of the differences
              -1.851852


Type 5

> C5.ESSFmm1.t

        Paired t-test
```

```
data:  test.subset[, 14] and test.subset[, 15]
t = 1.1937, df = 5, p-value = 0.2861
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -3.470965  9.489483
sample estimates:
mean of the differences
               3.009259

> C5.ESSFwk1.t

        Paired t-test

data:  test.subset[, 14] and test.subset[, 15]
t = -10, df = 2, p-value = 0.009852
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -6.621598 -2.637661
sample estimates:
mean of the differences
               -4.62963


> C5.ICHwk3.t

        Paired t-test

data:  test.subset[, 14] and test.subset[, 15]
t = -0.3333, df = 1, p-value = 0.7952
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -54.33141  51.55363
sample estimates:
mean of the differences
              -1.388889

> C5.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 14] and test.subset[, 15]
t = 0.4118, df = 1, p-value = 0.7513
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -145.1427  154.8649
sample estimates:
mean of the differences
               4.861111


> C5.SBSvk.t

        Paired t-test

data:  test.subset[, 14] and test.subset[, 15]
t = -0.8963, df = 2, p-value = 0.4647
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -18.79851  12.31703
sample estimates:
mean of the differences
              -3.240741


Type 6

> C6.ESSFmm1.t

        Paired t-test

data:  test.subset[, 17] and test.subset[, 18]
```

```
t = -1, df = 5, p-value = 0.3632
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.8265235  0.3635606
sample estimates:
mean of the differences
             -0.2314815

> C6.ESSFwk1.t

        Paired t-test

data:  test.subset[, 17] and test.subset[, 18]
t = -1, df = 2, p-value = 0.4226
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -4.909864  3.058012
sample estimates:
mean of the differences
              -0.925926


> C6.ICHwk3.t

        Paired t-test

data:  test.subset[, 17] and test.subset[, 18]
t = NaN, df = 1, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

> C6.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 17] and test.subset[, 18]
t = NaN, df = 1, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

> C6.SBSvk.t

        Paired t-test

data:  test.subset[, 17] and test.subset[, 18]
t = NaN, df = 2, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

>
```

Appendix 8. Full output from Mean #Types per Piece Data Analysis

```
> tt.ESSFmm1.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = 3.8974, df = 5, p-value = 0.01144
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.1778322 0.8668972
sample estimates:
mean of the differences
              0.5223647

> tt.ESSFwk1.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = 2.94, df = 2, p-value = 0.09884
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.0920411  0.4892090
sample estimates:
mean of the differences
              0.1985840

> tt.ICHwk3.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = 2.2203, df = 1, p-value = 0.2694
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -3.682536  5.242060
sample estimates:
mean of the differences
              0.7797619

> tt.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = -0.7625, df = 1, p-value = 0.5853
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -1.878218  1.665568
sample estimates:
mean of the differences
             -0.1063247

> tt.SBSvk.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = 3.641, df = 2, p-value = 0.06785
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.0886995  1.0648747
sample estimates:
mean of the differences
              0.4880876
```

Appendix 9. Output from % Types by Species Data Analysis

```
Species =Bi
> E1.ESSFmm1.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = 2.6004, df = 5, p-value = 0.04822
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
  0.3271596 56.6728404
sample estimates:
mean of the differences
                   28.5

> E1.ESSFwk1.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -0.6611, df = 2, p-value = 0.5765
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -48.80407  35.80407
sample estimates:
mean of the differences
                   -6.5

> E1.ICHwk3.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = 0.5152, df = 1, p-value = 0.6972
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -160.9219  174.5219
sample estimates:
mean of the differences
                    6.8

> E1.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = 1.1753, df = 1, p-value = 0.4488
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -210.4382  253.3382
sample estimates:
mean of the differences
                  21.45

> E1.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -2.4516, df = 2, p-value = 0.1338
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -58.03973  15.90639
sample estimates:
mean of the differences
              -21.06667


Species =Cw
```

```
> E1.ESSFmm1.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = 1, df = 5, p-value = 0.3632
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -1.596758  3.630091
sample estimates:
mean of the differences
               1.016667

> E1.ESSFwk1.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = NaN, df = 2, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

> E1.ICHwk3.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -1, df = 1, p-value = 0.5
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -33.5802  28.6802
sample estimates:
mean of the differences
                  -2.45

> E1.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = NaN, df = 1, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

> E1.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = NaN, df = 2, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

Species=Ep

> E1.ESSFmm1.t

        Paired t-test
```

```
data:  test.subset[, i] and test.subset[, i + 16]
t = -1, df = 5, p-value = 0.3632
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -1.7852908  0.7852908
sample estimates:
mean of the differences
                   -0.5

> E1.ESSFwk1.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = NaN, df = 2, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

> E1.ICHwk3.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = NaN, df = 1, p-value = NA

alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

> E1.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = NaN, df = 1, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

> E1.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = NaN, df = 2, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

Species= Fd

> E1.ESSFmm1.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = NaN, df = 5, p-value = NA
```

```
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

> E1.ESSFwk1.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = NaN, df = 2, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

> E1.ICHwk3.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = NaN, df = 1, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

> E1.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = 1, df = 1, p-value = 0.5
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -8.779654 10.279654
sample estimates:
mean of the differences
                   0.75

> E1.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = NaN, df = 2, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

Species= Hw

> E1.ESSFmm1.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = NaN, df = 5, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
```

```
mean of the differences
                      0

> E1.ESSFwk1.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = NaN, df = 2, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

> E1.ICHwk3.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = 0.0158, df = 1, p-value = 0.99
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -201.1433  201.6433
sample estimates:
mean of the differences
                   0.25

> E1.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -1, df = 1, p-value = 0.5
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -123.3558  105.3558
sample estimates:
mean of the differences
                     -9

> E1.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = 2.3275, df = 2, p-value = 0.1454
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -14.34192  48.14192
sample estimates:
mean of the differences
                   16.9


Species= S1

> E1.ESSFmm1.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -1.8462, df = 5, p-value = 0.1242
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -39.713518   6.513518
sample estimates:
mean of the differences
                  -16.6
```

```
> E1.ESSFwk1.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -0.5684, df = 2, p-value = 0.6271
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -29.42356  22.55689
sample estimates:
mean of the differences
              -3.433333

> E1.ICHwk3.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -0.1698, df = 1, p-value = 0.893
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -34.12144  33.22144
sample estimates:
mean of the differences
                  -0.45

> E1.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = 0.009, df = 1, p-value = 0.9943
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -211.4083  211.7083
sample estimates:
mean of the differences
                   0.15

> E1.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = 1.6928, df = 2, p-value = 0.2326
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -16.03361  36.83361
sample estimates:
mean of the differences
                   10.4

Species =U

> E1.ESSFmm1.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -1.1633, df = 5, p-value = 0.2972
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -37.82215  14.25548
sample estimates:
mean of the differences
              -11.78333

> E1.ESSFwk1.t

        Paired t-test
```

```
data:  test.subset[, i] and test.subset[, i + 16]
t = 0.6396, df = 2, p-value = 0.5879
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -37.98812  51.25479
sample estimates:
mean of the differences
               6.633333

> E1.ICHwk3.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -1.7917, df = 1, p-value = 0.3241
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -34.79489  26.19489
sample estimates:
mean of the differences
                   -4.3

> E1.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -1.9778, df = 1, p-value = 0.298
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -99.11688  72.41688
sample estimates:
mean of the differences
                 -13.35

> E1.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -1.2146, df = 2, p-value = 0.3485
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -28.46648  15.93315
sample estimates:
mean of the differences
              -6.266667



Species = Totals>

> E1.ESSFmm1.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -0.1405, df = 5, p-value = 0.8938
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -19.29753  17.29753
sample estimates:
mean of the differences
                     -1

> E1.ESSFwk1.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -0.9686, df = 2, p-value = 0.4349
```

```
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -48.97841  30.97841
sample estimates:
mean of the differences
                     -9

> E1.ICHwk3.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -3.5714, df = 1, p-value = 0.1738
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -56.97172  31.97172
sample estimates:
mean of the differences
                  -12.5

> E1.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = 0.5, df = 1, p-value = 0.7048
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -244.1241  264.1241
sample estimates:
mean of the differences
                     10

> E1.SBSvk.t

        Paired t-test

data:  test.subset[, i] and test.subset[, i + 16]
t = -0.4981, df = 2, p-value = 0.6678
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -32.12505  25.45838
sample estimates:
mean of the differences
              -3.333333
```

Appendix 10 – Output From Mean # Types per class Data Analysis

```
> F1.ESSFmm1.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = -1.9425, df = 5, p-value = 0.1097
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:

 -12.369734   1.721586
sample estimates:
mean of the differences
              -5.324074

> F1.ESSFwk1.t

        Paired t-test
```

```
data:  test.subset[, 2] and test.subset[, 1]
t = -0.117, df = 2, p-value = 0.9175
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -17.48235  16.55643
sample estimates:
mean of the differences
              -0.462963

> F1.ICHmm1.t
Error: Object "F1.ICHmm1.t" not found
> F1.ICHwk3.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = -1, df = 1, p-value = 0.5
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -47.59099  40.64654
sample estimates:
mean of the differences

              -3.472222

> F1.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = -Inf, df = 1, p-value = < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
              -6.944444

> F1.SBSdh.t
Error: Object "F1.SBSdh.t" not found
> F1.SBSvk.t

        Paired t-test

data:  test.subset[, 2] and test.subset[, 1]
t = -2.7948, df = 2, p-value = 0.1077
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -19.987044   4.246303
sample estimates:
mean of the differences
               -7.87037

>
> #Testing class 2 means
> test.subset <- TabF3[rownames(TabF3)=="ESSFmm1",]
> F2.ESSFmm1.t<-t.test(test.subset[,3],test.subset[,4], paired=T)
```

```
> test.subset <- TabF3[rownames(TabF3)=="ESSFwk1",]
> F2.ESSFwk1.t <-t.test(test.subset[,3],test.subset[,4], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="ICHmm1",]
> F2.ICHmm1.t <-t.test(test.subset[,3],test.subset[,4], paired=T)
Error in test.subset[, 3] : incorrect number of dimensions
> test.subset <- TabF3[rownames(TabF3)=="ICHwk3",]
> F2.ICHwk3.t <-t.test(test.subset[,3],test.subset[,4], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="ICHwk3/SBSvk",]
> F2.ICHwk3.SBSvk.t <-t.test(test.subset[,3],test.subset[,4], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="SBSdh",]
> F2.SBSdh.t <-t.test(test.subset[,3],test.subset[,4], paired=T)
Error in test.subset[, 3] : incorrect number of dimensions
> test.subset <- TabF3[rownames(TabF3)=="SBSvk",]
> F2.SBSvk.t <- t.test(test.subset[,3],test.subset[,4], paired=T)
>
>
> F2.ESSFmm1.t

        Paired t-test

data:  test.subset[, 3] and test.subset[, 4]
t = 0.1118, df = 5, p-value = 0.9154
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -20.36960  22.22145
sample estimates:
mean of the differences
               0.925926

> F2.ESSFwk1.t

        Paired t-test

data:  test.subset[, 3] and test.subset[, 4]
t = 1.139, df = 2, p-value = 0.3727
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -15.43114  26.54225
sample estimates:
mean of the differences
               5.555556

> F2.ICHmm1.t
Error: Object "F2.ICHmm1.t" not found
> F2.ICHwk3.t

        Paired t-test

data:  test.subset[, 3] and test.subset[, 4]
t = 0.1429, df = 1, p-value = 0.9097
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -61.07183  62.46072
sample estimates:
mean of the differences
              0.6944444
```

```
> F2.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 3] and test.subset[, 4]
t = 0.7647, df = 1, p-value = 0.5844
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -281.9521  318.0632
sample estimates:
mean of the differences
               18.05556

> F2.SBSdh.t
Error: Object "F2.SBSdh.t" not found
> F2.SBSvk.t

        Paired t-test

data:  test.subset[, 3] and test.subset[, 4]
t = -4.1429, df = 2, p-value = 0.05362
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -27.3697079   0.5178561
sample estimates:
mean of the differences
              -13.42593

>
>
> #Testing class 3 means
> test.subset <- TabF3[rownames(TabF3)=="ESSFmm1",]
> F3.ESSFmm1.t<-t.test(test.subset[,5],test.subset[,6], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="ESSFwk1",]
> F3.ESSFwk1.t <-t.test(test.subset[,5],test.subset[,6], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="ICHmm1",]
> F3.ICHmm1.t <-t.test(test.subset[,5],test.subset[,6], paired=T)
Error in test.subset[, 5] : incorrect number of dimensions
> test.subset <- TabF3[rownames(TabF3)=="ICHwk3",]
> F3.ICHwk3.t <-t.test(test.subset[,5],test.subset[,6], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="ICHwk3/SBSvk",]
> F3.ICHwk3.SBSvk.t <-t.test(test.subset[,5],test.subset[,6], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="SBSdh",]
> F3.SBSdh.t <-t.test(test.subset[,5],test.subset[,6], paired=T)
Error in test.subset[, 5] : incorrect number of dimensions
> test.subset <- TabF3[rownames(TabF3)=="SBSvk",]
> F3.SBSvk.t <- t.test(test.subset[,5],test.subset[,6], paired=T)
>
>
> F3.ESSFmm1.t

        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = -0.0661, df = 5, p-value = 0.9499
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
```

```
 -9.236102  8.773139
sample estimates:
mean of the differences
             -0.2314815

> F3.ESSFwk1.t

        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = -0.3212, df = 2, p-value = 0.7785
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -46.65470  40.17321
sample estimates:
mean of the differences
              -3.240741

> F3.ICHmm1.t
Error: Object "F3.ICHmm1.t" not found
> F3.ICHwk3.t

        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = -2.5, df = 1, p-value = 0.2422
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -84.47892  56.70114
sample estimates:
mean of the differences
              -13.88889

> F3.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = -0.0769, df = 1, p-value = 0.9511
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -115.4032  114.0143
sample estimates:
mean of the differences
             -0.6944444


> F3.SBSdh.t
Error: Object "F3.SBSdh.t" not found
> F3.SBSvk.t

        Paired t-test

data:  test.subset[, 5] and test.subset[, 6]
t = 0.2887, df = 2, p-value = 0.8
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
```

```
 -19.31226  22.09004
sample estimates:
mean of the differences
               1.388889

>
>
> #Testing class 4 means
> test.subset <- TabF3[rownames(TabF3)=="ESSFmm1",]
> F4.ESSFmm1.t<-t.test(test.subset[,7],test.subset[,8], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="ESSFwk1",]
> F4.ESSFwk1.t <-t.test(test.subset[,7],test.subset[,8], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="ICHmm1",]
> F4.ICHmm1.t <-t.test(test.subset[,7],test.subset[,8], paired=T)
Error in test.subset[, 7] : incorrect number of dimensions
> test.subset <- TabF3[rownames(TabF3)=="ICHwk3",]
> F4.ICHwk3.t <-t.test(test.subset[,7],test.subset[,8], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="ICHwk3/SBSvk",]
> F4.ICHwk3.SBSvk.t <-t.test(test.subset[,7],test.subset[,8], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="SBSdh",]
> F4.SBSdh.t <-t.test(test.subset[,7],test.subset[,8], paired=T)
Error in test.subset[, 7] : incorrect number of dimensions
> test.subset <- TabF3[rownames(TabF3)=="SBSvk",]
> F4.SBSvk.t <- t.test(test.subset[,7],test.subset[,8], paired=T)
>
>
> F4.ESSFmm1.t

        Paired t-test

data:  test.subset[, 7] and test.subset[, 8]
t = -0.859, df = 5, p-value = 0.4296
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -12.938283   6.456802
sample estimates:
mean of the differences
              -3.240741

> F4.ESSFwk1.t

        Paired t-test

data:  test.subset[, 7] and test.subset[, 8]
t = -1.8, df = 2, p-value = 0.2137
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -42.37953  17.37953
sample estimates:
mean of the differences
                  -12.5

> F4.ICHmm1.t
Error: Object "F4.ICHmm1.t" not found
> F4.ICHwk3.t

        Paired t-test
```

```
data:  test.subset[, 7] and test.subset[, 8]
t = -4.69125e+15, df = 1, p-value = < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -8.333333 -8.333333
sample estimates:
mean of the differences
              -8.333333

> F4.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 7] and test.subset[, 8]
t = -0.6, df = 1, p-value = 0.656
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -138.6063  126.1063
sample estimates:
mean of the differences
                  -6.25

> F4.SBSdh.t
Error: Object "F4.SBSdh.t" not found
> F4.SBSvk.t

        Paired t-test

data:  test.subset[, 7] and test.subset[, 8]
t = -0.3592, df = 2, p-value = 0.7538
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -12.01674  10.16489
sample estimates:
mean of the differences
              -0.925926

>
>
> #Testing class 5 means
> test.subset <- TabF3[rownames(TabF3)=="ESSFmm1",]
> F5.ESSFmm1.t<-t.test(test.subset[,9],test.subset[,10], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="ESSFwk1",]
> F5.ESSFwk1.t <-t.test(test.subset[,9],test.subset[,10], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="ICHmm1",]
> F5.ICHmm1.t <-t.test(test.subset[,9],test.subset[,10], paired=T)
Error in test.subset[, 9] : incorrect number of dimensions
> test.subset <- TabF3[rownames(TabF3)=="ICHwk3",]
> F5.ICHwk3.t <-t.test(test.subset[,9],test.subset[,10], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="ICHwk3/SBSvk",]
> F5.ICHwk3.SBSvk.t <-t.test(test.subset[,9],test.subset[,10], paired=T)
> test.subset <- TabF3[rownames(TabF3)=="SBSdh",]
> F5.SBSdh.t <-t.test(test.subset[,9],test.subset[,10], paired=T)
Error in test.subset[, 9] : incorrect number of dimensions
> test.subset <- TabF3[rownames(TabF3)=="SBSvk",]
> F5.SBSvk.t <- t.test(test.subset[,9],test.subset[,10], paired=T)
```

```
>
>
> F5.ESSFmm1.t

        Paired t-test

data:  test.subset[, 9] and test.subset[, 10]
t = -1.3072, df = 5, p-value = 0.248
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -12.360117   4.026784
sample estimates:
mean of the differences
              -4.166667

> F5.ESSFwk1.t

        Paired t-test

data:  test.subset[, 9] and test.subset[, 10]
t = -0.866, df = 2, p-value = 0.4778
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -16.57854  11.02299
sample estimates:
mean of the differences
              -2.777778

> F5.ICHmm1.t
Error: Object "F5.ICHmm1.t" not found
> F5.ICHwk3.t

        Paired t-test

data:  test.subset[, 9] and test.subset[, 10]
t = NaN, df = 1, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0

> F5.ICHwk3.SBSvk.t

        Paired t-test

data:  test.subset[, 9] and test.subset[, 10]
t = -2.5, df = 1, p-value = 0.2422
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -42.23946  28.35057
sample estimates:
mean of the differences
              -6.944444

> F5.SBSdh.t
```

```
Error: Object "F5.SBSdh.t" not found
> F5.SBSvk.t

        Paired t-test

data:  test.subset[, 9] and test.subset[, 10]
t = 0.128, df = 2, p-value = 0.9098
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -15.09481  16.02074
sample estimates:
mean of the differences
               0.462963
```