Canadian Forest Products Ltd.

Tree Farm Licence 18

Vegetation Resources Inventory
Project Implementation Plan for Ground Sampling and Net Volume Adjustment Factor Sampling

Nona Phillips Forestry Consulting
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Executive Summary

This Vegetation Resources Inventory (VRI) Project Implementation Plan (VPIP) is the 'operational' planning document that will be used as a guide for the Tree Farm Licence (TFL) 18 VRI ground sampling project. The critical work undertaken in preparing this plan for TFL18 includes: completing the sample selection for ground sampling and Net Volume Adjustment Factor (NVAF) destructive sampling, identifying each sample's location, providing documentation of the sample selection and making decisions regarding the sampling details.

This Project Implementation Plan has been prepared following both the VRI Guidelines for Preparing a Project Implementation Plan for Ground Sampling and Net Volume Adjustment Factor Sampling (Version 3.1) **and** the guideline Streamlining VRI Ground Sampling Volume Audit (VA) Sampling.

The Volume Audit Sampling guideline identifies some 'standardized' items on which to build the VRI ground sampling plan for a management unit. These include:

1. Establishing the 'Vegetated Treed' (VT) portion of the TFL as the land base for sample selection.
2. Focusing the VA sampling on two different age populations in the management unit. The populations, termed Mature and Immature, are defined by the following criteria:
   i) Mature – 51 years and older, and
   ii) Immature – 15 to 50 years.

Other key points are the following:

1. In establishing the VRI sampling populations, there have been no exclusions from the TFL18 land base.
2. Sample list development and identification of sample locations within the selected polygons were completed according to the Vegetation Resources Inventory Sample Selection Procedures for Ground Sampling v3.3_rev 2011. Details of this work are provided in the Appendices of this plan.
3. The sample list is comprised of a total of 70 VRI ground samples established without bias throughout the VT portion of the TFL. There are 50 samples in the Mature age population and 20 samples in the Immature age class land base.
4. As part of the development of the sample list, Landsat imagery for TFL18 has been used to identify if the Integrated Plot Centre has been logged or burned for each sample. Samples were replaced if this occurred.
5. An additional group of samples have been selected as 'replacement samples'. A minimum of 20 samples in the Mature and 10 in the Immature age populations are included in the project's sample list in Appendix B.
6. VRI certified field crews will be establishing the 50 samples in the Mature age population following the protocol for a Timber Emphasis (TEP) plot type. Coarse Woody Debris (CWD) data will be collected on these samples according to the VRI procedures.

7. Sample establishment methodology for the 20 samples in the Immature age population has not been determined at the time of the writing of this plan.
8. Net Volume Adjustment Factor destructive sampling will be carried out in the Mature age population only. The NVAF-enhanced samples are a 12 sample sub-set of the original 50 samples.
9. To 'complete' the TFL18 VRI project, once this project's data collection phase is finished, a VRI Analysis should be undertaken to verify the accuracy of volumes and some key attributes of the 'new' Phase I inventory. This analysis will follow protocols which are under development at the time of the writing of this plan.

In the Mature age population, ground sample selection has been completed based on three strata. The strata were developed after analysing the leading species representation in the project land base, greater than 50 years. The number of samples in each stratum is proportional to the species or species grouping representation.

- Stratum 1: Spruce
- Stratum 2: Balsam
- Stratum 3: Pine, Douglas-fir, Cedar, Aspen, Other species

Each stratum in the Mature age population has been subdivided into 3 volume classes, or "sub-stratum" (1-low, 2-medium, and 3-high). The number of samples assigned to each sub-stratum is proportional to their area representation in the stratum.

The Immature age population has not been stratified. It has been sub-stratified by leading species. The strata are as follows:

- Stratum 1: Spruce
- Stratum 2: Pine
- Stratum 3: Balsam
- Stratum 4: Other species

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1.0 Introduction

The Vegetation Resources Inventory (VRI) is the inventory standard for forest cover inventory in the province of British Columbia (BC). It follows a set of Procedures with developed Standards, administered by the Ministry of Forests, Mines and Lands (MFML). The VRI was designed to answer two questions: "Where is the resource located" and "How much of given vegetation resource is within an inventory unit?"[1]

The Vegetation Resources Inventory is a photo based, 2-phased program. Phase 1 or photo interpretation delineates polygons of homogenous land cover types and provides estimates of the vegetation attributes for each polygon. Phase 2 is ground sampling to verify the accuracy of volumes or some of the key Phase 1 vegetation attributes[2].

The VRI planning process creates the foundation for the implementation of a successful VRI project. The 'phase' of the VRI detailed in the Project Implementation Plan (VPIP), photo interpretation or ground sampling, will be dependent on the work being undertaken. "A VPIP is a working document that details the specific operational activities associated with implementation and documentation of an inventory project."[3]

In 2007, a VPIP for a Phase I photo interpretation project was finalized for TFL18 and that project has been completed. This Project Implementation Plan will detail the undertaking of the recommended follow up project, VRI Phase II Ground Sampling and NVAF Sampling.

1.1 Document Objectives

In the TFL18 VSIP, a Business Case was developed recommending that both phases of the VRI be undertaken. The first of these projects was the completion of a new Phase I photo interpretation. Photos were acquired in August of 2007. This project was completed largely in 2008 and was finalized in 2009. Based on the new population of polygons, a VRI Phase II ground sampling program and Net Volume Adjustment Factor (NVAF) destructive sampling would follow up the Phase I.

The objectives of preparing this Project Implementation Plan are two-fold. This document provides a record of the decisions made to develop this VRI ground sampling project. It also serves as a guide for those undertaking the project. Specific details in this plan include: identifying the sampling population, making key decisions to enable

[1] From the MFML Vegetation Resources Inventory website – Overview - http://www.for.gov.bc.ca/hts/vri/intro/index.html

[2] In 2010/11, recognizing that the VRI has not been used to adjust the database, MFML began making some changes in the 'Data Analysis' phase of the VRI program. Both the VRI Phase II sampling program (including the writing of this plan) and the Analysis standards will reflected these changes.

[3] From the Executive Summary of the VRI Standard – Guidelines for Preparing a Project Implementation Plan for Ground Sampling and Net Volume Adjustment Factor Sampling.

the development of sample lists, clarifying VRI plot data collection that will occur, and deliverables for the project.

The TFL18 VPIP for Phase II Ground Sampling and NVAF Sampling will be stored on the Ministry of Forests, Mines & Lands VRI planning website.[4]

A series of VRI planning documents have been prepared that include this TFL as part of an overall project area or by itself. They can be found on the government's VRI planning website[5] and include:

1. VSIP for Kamloops and Clearwater
2. VSIP for TFL18
3. VPIP for TFL18 Phase I Photo Interpretation. There are three related documents for this VPIP, the original dated November 26, 2006, Addendum #1 dated December 12, 2006 and an Amended VPIP dated September 27, 2007.

1.2 Project Land base[6]

TFL18 is held by Canadian Forest Products Ltd. (Canfor). In 2004, Canfor acquired Slocan Forest Products Ltd. who had previously held the TFL.

TFL 18 is located in central British Columbia in an area known as the North Thompson region. The TFL is located west of the town of Clearwater and Canfor's mill in Vavenby, and south of Wells Gray Provincial Park. The TFL is administered by the Kamloops office of the Ministry of Natural Resource Operations, South Area, Thompson/Okanagan Region. It comprises approximately 74,297 hectares. A high percentage of the TFL is considered to be productive forest (90%). The following table shows the land base distribution.

Table 1: TFL 18 Land Base

Land Classification	Area	% of TSA
Total Area	74297	
Parks	0	0%
Non-Parks	74297	100%
Non-crown Land	0	0%
Crown Land	74297	100%
Non-Vegetated	1411	2%
Vegetated	72886	98%
Non-treed	5187	7%
Treed	67699	91%

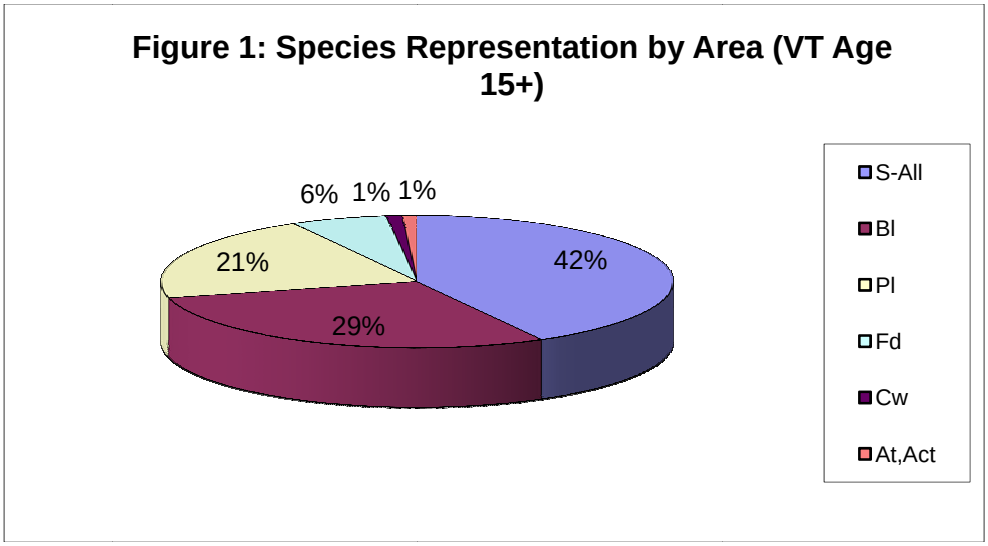
[4] http://www.for.gov.bc.ca/hts/vri/reports&pub/vri_vripub.html#tflvpip
[5] http://www.for.gov.bc.ca/hts/vri/reports&pub/vri_vripub.html#top
[6] Adapted from the TFL18 Rationale for Allowable Annual Cut (AAC) – March 9, 2006

There are no communities located within the TFL area, but Clearwater is nearby. Figure 2 is an overview map of the TFL.

The majority of the TFL is characterized by high-elevation plateau with gently rolling terrain. Numerous small lakes and swamp complexes are location within the TFL. The TFL covers portions of 10 BCGS mapsheets including: 092P068, 092P069, 092P070, 092P078, 092P079, 092P080, 092P088, 092P089, 092P090 and 092P099.

There are three (3) biogeoclimatic zones[7] (BGC) in the TFL including Engelmann Spruce-Subalpine Fir (ESSF), Sub-boreal Spruce (SBS) and Interior Cedar-Hemlock (ICH). The main tree species are Engelmann and white spruce, subalpine fir (balsam), lodgepole pine, Douglas-fir, western hemlock and western red cedar. Approximately 50% of the VT population 15 years plus is greater than 120 years of age. Twenty-six per cent (26%) of this land base has been classified to be between 51 and 120 years.

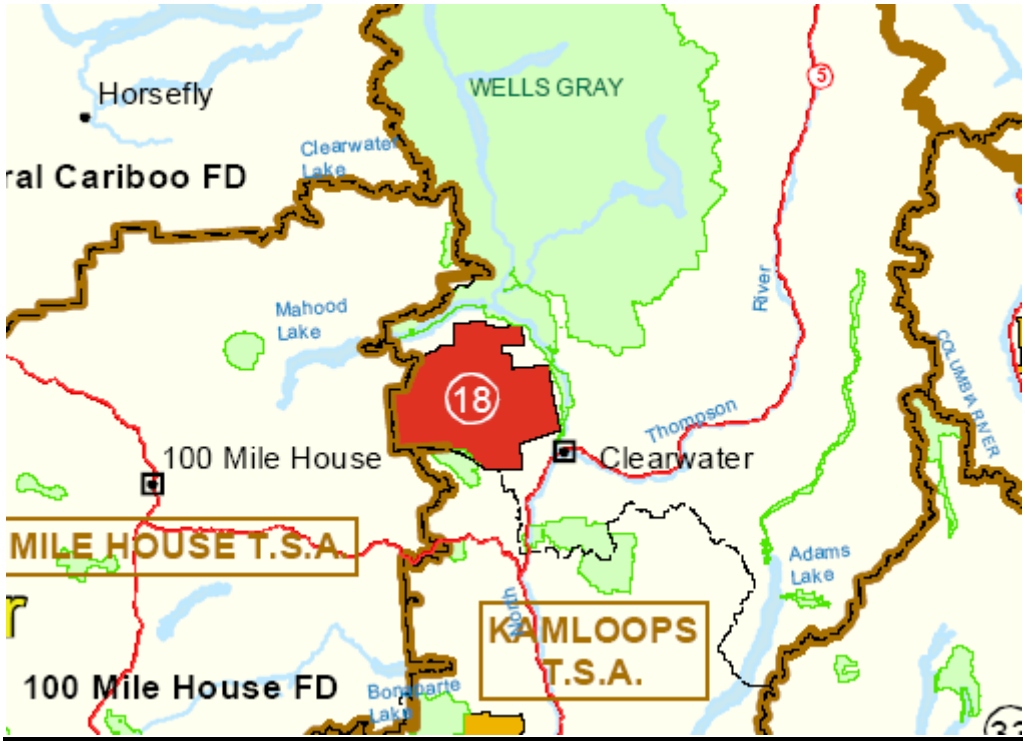
Figure 1: Species Representation by Area (VT Age 15+)



Member nations of the Shuswap Nation Tribal Council, the Simpcw First Nation and the Canim Lake Indian Band have asserted traditional territories within the TFL's boundaries.

[7] In the VT population, age 15+, the BGC zone breakdown is as follows: ESSF-53%, SBS-31% and ICH-16%.

Figure 2. Map of TFL18[8]



The land base figures below in Tables 2, 3 and 4 have been provided both as information regarding the TFL and its inventory and to support decision-making in this plan, such as stratification of the population. Together, the Immature and Mature age populations in the Vegetated Treed land cover classification[9] 15 years of age and greater total approximately 61,857 hectares.[10]

Table 2: Species Distribution – TFL18 Total Vegetated Treed (VT) Land base, Age 15-50

Species	Area	%
SX	7246	50
PL	3849	27
BL	2227	15
FD	1008	7
AT	211	1

[8] Map adapted from BC government website: http://www.for.gov.bc.ca/ftp/hth/external/!publish/web/timber-tenures/tfl-regions-tsas-districts-map-150-dpi-sep-13-2007.pdf

[9] B.C. Land Cover Classification Scheme

[10] Numbers related to identifying the sampling population are the result of analytical work completed by Nona Phillips Forestry Consulting using current MFML provided data files and documented in the sample selection report provided to the government, following the VRI Sample Selection Standard.

EP	29	0
CW	29	0
AC	8	0
Total	**14607**	**100**

Table 3: Species Distribution – TFL18 Total Vegetated Treed (VT) Land base, Age 51+

SPECIES	AREA	%
SX	18336	39
BL	15873	33
PL	8947	19
FD	2634	6
CW	715	2
AT	480	1
HW	209	0
EP	23	0
SE	17	0
SW	14	0
AC	2	0
Total	**47250**	**100**

Table 4: Age class Distribution, All Species – TFL18 Total Vegetated Treed (VT) Land base, Age 51+

Age Class	Area	%
3	967	2
4	3384	7
5	5500	12
6	6469	14
7	8062	17
8	18090	38
9	4778	10
Total	**47250**	**100**

1.3 State of the Inventory

The licensee, Canadian Forest Products Ltd. (Canfor) completed a new VRI Phase I photo interpretation in 2009 with the support of the Ministry of Forests & Range and Forest Investment Account (FIA) funds. The photo interpretation was conducted on August 2007 photos. The most current disturbance update for the VRI files for TFL18 would be based on these photos, therefore in 2007. Key attributes have been projected to 2009 in the VRI database.

The 'new' Phase I inventory for TFL18 will be the basis for this Volume Audit sampling project. Therefore, reference to earlier inventories and the provincial audit discussed in both the TFL18 VSIP and the VPIP for Photo Interpretation will not be included in this plan as they are not relevant to this study.

2.0 Ground Sampling Plan

2.1 Sampling objectives

An essential element of the VRI ground sampling program has been its statistical foundation that involves the establishment of unbiased sample location across a management unit.

The 2005 VSIP for TFL18 identifies a long list of management issues in relation to potential benefits of undertaking VRI activities. The VRI Phase I photo interpretation inventory project was undertaken to address some of these local issues including:

- Bringing the inventory to VRI Standards
- Improving polygon attributes including species composition and stand heights
- Improving stand structure identification especially in residual balsam stands
- Determining the change resulting from MPB and other insect and disease issues
- Identifying understory in MPB affected stands
- Identifying details on deciduous leading stands.

A Phase II VRI ground sampling and NVAF sampling project is being addressed in this plan. The sampling objective for this project is to verify the accuracy of volumes and other key attributes in the inventory. A sampling error of 15% (net volume) is the target set for the Mature age population. No sampling error target will be set for the Immature age population.

The completion of this project should also provide answers or at least show trends related to issues in TFL18 identified by the Deputy Chief Forester in the 2006 Rationale for the TSR process including:

- Volume estimates for existing unmanaged (high volume) stands
- Residual balsam stand volumes and site index
- Forest Health issues – MPB, spruce bark beetle

- Non- pine volumes in ‘mixed wood stands’ attacked by MPB
- Current attributes and volumes of MPB stands
- Dead wood volumes

Completing the VRI Analysis Report at the end of this project will at a minimum provide statistical information related to the accuracy of the ‘new’ TFL18 inventory.

2.2 Target Population

The population of interest for this project is the Vegetated Treed (VT) land classification, 15 years of age and greater.

There have been no exclusions from the land base. There is no Private land, parks, Indian Reserves, Community Forests or Woodlots in the TFL18 land base.

The Volume Audit sampling guideline identifies the focus for sampling to be two different age populations. The two populations are:

1. 15 to 50 years (Immature age population)
2. 51 years and older (Mature age population)[11]

In the TFL18, the target population in the Immature age population encompasses a total area of 14,607 hectares and the Mature age population land base is 47,250 hectares.

2.3 Sample Size

After a review of the document ‘Streamlining VRI Ground Sampling Volume Audit Sampling’ and discussions with Ministry staff, it was confirmed that a total of 70 ground samples will be established in the Immature and Mature age populations. Sample establishment in the Vegetated Treed land base of the TFL will be as follows:

- 20 samples in the Immature age population, and
- 50 samples in the Mature age population.

[11] The two different age populations for the overall Phase II sampling will be termed the Immature and Mature age populations throughout this plan. This should help to keep these populations in the overall project separate from the ‘Mature and Immature’ divisions in the NVAF sample population.

2.4 Strata

2.4.1 Ground Sampling

Mature Age Population Land base

The Mature age population has been stratified into species and species groupings as follows:

- Stratum 1: Spruce
- Stratum 2: Balsam
- Stratum 3: Pine, Douglas-fir, Cedar, Aspen, Larch, Other species

The development of these strata was based on distributing the samples proportional to species representation. Each of the strata was further divided into 3 sub-strata based on volume classes with equal numbers of polygons to ensure a good distribution of samples. The criteria for this sub-stratification are described in Appendix A.

Immature Age Population Land base

There is only one stratum in the immature population. It was further divided into 4 sub-strata but by different criteria than in the mature population. There are only 842 polygons in the Immature age population of the Vegetated treed land base. 569 of these polygons have 0 volume. This does not lend itself to 3 volume sub-strata, which is the 'usual' approach. It was decided by the Ministry of Forests, Lands and Mines staff to sub-stratify this population by species composition. The sub-strata are therefore as follows:

- Sub-stratum 1: Spruce
- Sub-stratum 2: Balsam
- Sub-stratum 3: Pine
- Sub-stratum 4 Other species

The planned distribution of samples is shown in Table 5, below.

Table 5: Planned Distribution of Ground Samples

Land base	Stratum	Population Area (ha)	% of area	Planned number of samples	Number of hectares represented by each sample
Mature age class	Spruce	18,368	39	20	918.4
	Balsam	15,873	33	16	992.1
	Pine, Douglas-fir, Cedar, Aspen, Other species	13,009	28	14	929.2
	Total	47,250	100	50	
Immature age class	Immature	14,607	100	20	730.3

For the Mature age population areas, the strata have been divided into sub-strata based on 3 volume classes.

Table 6. Sample breakdown by Volume Class – VT – Mature age Population

Vol class	Sx	Bl	Pl-Fd-Cw-At-Other spp.
1	5	4	3
2	7	5	5
3	8	7	6
Total	**20**	**16**	**14**

For the Immature age population areas, the strata have been divided into sub-strata based on 4 species groupings.

Table 7. Sample breakdown by Sub-strata for VT –Immature age Population

Sub-strata	Area	%	Samples
Spruce	7247	50	10
Pine	3848	27	5
Balsam	2227	15	3
Other species	1285	8	2
All species	**14,607**	**100**	**20**

Appendix A shows how strata and volume class sub-strata are defined and how samples were distributed among them.

2.4.2 NVAF

The destructive sampling analysis will be by species and age class distribution. For NVAF sampling, the Mature age population is divided further into two age classes:

Immature (age 51+ to 120) and Mature (121+). In TFL18, the Mature age population of the Vegetated Treed land base is 35% Immature and 65% Mature. Table 8 below shows the distribution of ground samples for NVAF-enhancement by age class.

Table 8: NVAF Ground Sample Distribution

Land base	Age Class (years)	NVAF Samples
Mature age population (All VT,51+)	Immature 51-120	3
Mature age population (All VT,51+)	Mature 121+	9
	Total	**12**

In this project planning process, only the samples that are to be enhanced to the NVAF standard are identified. The complete NVAF profile can be found in Appendix D.

2.5 Sample Selection

The Standard 'VRI Sample Selection Procedures for Ground Sampling' outlines the process in detail and has been used as a guideline for this work. Documentation of the Sample Selection process followed is included in Appendix A.

2.5.1 Ground Sampling

The initial step was to identify the population of the TFL18 for both the Immature and Mature age population land base. Appendix A details the process of identifying the population areas, developing strata and sub-strata, and how samples were distributed within these.

Two sample lists (combined) were developed for both the Immature age population and Mature age population areas. The first lists contained the initial 50 samples for the Mature Age Population area and 20 samples for the Immature Age Population area. The second lists provided additional "contingency" samples for each sub stratum in the likely event that some of the initial samples are rejected in the field for any reason, including safety concerns, following field reconnaissance. A total of 49 samples were provided for the Mature Age Population and 20 samples were provided for the Immature Age Population.

Sample polygons were selected according to procedures outlined in 'Vegetation Resources Inventory –*Sample Selection Procedures for Ground Sampling*-Section 4.0'. That is by "probability proportional to size with replacement" (PPSWR). Sample points were located randomly within the sample polygon using ARCMAP 10 GIS techniques and random numbers generated by Excel. Sample locations were reviewed against recent Landsat imagery. Where a sample fell within a recent

disturbance area (e.g. Cutover) the sample was replaced with a replacement polygon/sample from the same stratum and sub-stratum.

Where there is a need to replace a sample in the field the replacement should also be from the same stratum and sub-stratum.

Appendix B includes the sample list and identifies which initial samples were replaced at the sample location stage and the reason why.

2.5.2 NVAF

The NVAF samples are a subset of the VRI sample selection. Ministry of Forests, Mines and Lands staff have been involved in decisions related to the NVAF sample selection. Based on their direction, a list of 12 samples has been derived from the 'final' ground sample list, following the NVAF Standard's methodology.

Enhancement of auxiliary plots will be completed at the time of the establishment of the ground samples according to the NVAF Sampling Standards and Procedures. Following the Standard, all four auxiliary plots will be enhanced, with all live and dead trees 12.5 cm dbh or greater included in the data collection. Also following this protocol, a tally of dead fallen trees will only be included at one auxiliary plot per sample. This data collection will occur on the north auxiliary only.

2.6 Sample Type

The protocols developed for the ground sampling enable forest managers to select from several options to collect timber and ecology data, dependent on their objectives. The ground samples established for the TFL18 project in the Mature age population will be 'Timber Emphasis' completed by certified VRI Timber contractors. The following additional data will be collected at each sample:

- Coarse Woody Debris

The sampling methodology on the samples in the Immature age population has not been determined at the time of the writing of this plan, but will be decided by MFML staff prior to the project start up.

3.0 Project Implementation

3.1 Sample Packages

Based on the sample selection process that is a key component in the content of the VPIP, sample packages will be prepared for each sample. They will include tools that support the field crews in their efforts to navigate to, and establish each sample in the

correct location. They will be prepared according to the document *Guidelines for Preparing a VPIP for Ground Sampling and NVAF Sampling*.

3.2 Standards

The most recent edition of the Vegetation Resources Inventory Standards and Procedures will be followed to complete this project. The Standards relevant to this project at this point in time are listed in this document, following the Bibliography. The Ministry of Forests, Mines and Lands maintains the following website that provides the current version of each Standard:

http://www.for.gov.bc.ca/hts/vri/standards/index.html

3.3 Sample List

A complete sample list is provided in Appendix B. A description of how samples were distributed across the population is included in Appendix A.

3.4 Deliverables

The primary task of the Project Manager overseeing the execution of this project is to insure that all of the work outlined in this plan is undertaken following the current VRI Procedures and meeting the appropriate Standards. Monitoring is critical to guarantee that all deliverables from the ground sampling projects are submitted, reviewed and approved by the appropriate staff in Forest Analysis & Inventory Branch, Ministry of Forests, Mines & Lands, both in the Region and in Victoria. Creating a record related to the project undertaken, following the format suggested in the VRI Standards "VRI Phase 2 Post-Project Documentation and Deliverables" is recommended for both the project's records and to support the VRI Analysis project.

Overall project delivery, attributed to the key party responsible, is summarized below.

From the VRI Plan Author

- Ground sampling plan and Sample Selection documentation and reporting according to the VRI Sample Selection Procedures for Ground Sampling standard.

From the Field contractors

- Completed Project packages following the VRI Phase II ground sampling or NVAF procedures.
- Digital sample data as per the contract, including the NVAF checklist for NVAF-enhanced samples.

- Documentation of any modifications to the sample lists, with records that any changes had key management knowledge and support.

From the VRI Ground Sampling & NVAF Project Manager

- All project records related to the field work, including a record of any bidding processes.
- Quality Assurance records including spreadsheets on the work completed and the QA reports and sign off by the 3rd party contractor.
- Documentation of any modifications to the sample lists.
- Overall Phase II project report as per VRI Standards.

From the NVAF Tree Selector

- Tree list
- Documentation of the Tree list selection

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8. Nimchuk, Warren. November, 2006. TFL18 Photo Interpretation VPIP.

9. Phillips, Nona. Revelstoke, Robson Valley and Lakes TFL Vegetation Resources Project Implementation Plans, November 2006 (Lakes), May 2007 (Robson).and March 2008 (Revelstoke), February 2011 (Cranbrook).

10. Swarz, David. September, 2007. TFL18. Photo Interpretation VPIP. Warren Nimchuk plan, Amended by David Swarz.

11. Various. Personal Communication with MFML staff including Chris Mulvihill, Gary Johansen and Matt Makar regarding issues related to the preparing of this VPIP.

VRI Standards & Procedures

The ‘current’ edition of the **Vegetation Resources Inventory Standards and Procedures** will be followed when this project is undertaken. They are located at the website:

http://www.for.gov.bc.ca/hts/vri/standards/index.html

The following is a list of the key Standards and Procedures for a VRI Phase II and NVAF sampling project from this website.

Plan Preparation and Project Delivery:

Preparing a VRI Strategic Inventory Plan (VSIP) for Ground Sampling and Photo Interpretation, January 2005

Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling and Net Volume Adjustment Factor Sampling Version 3.1, March 2010

VRI Phase 2 Post-Project Documentation and Deliverables, June, 2007

Vegetation Resources Inventory Sample Selection Procedures for Ground Sampling Version 3.3, December 2002_rev 2011

Vegetation Resources Inventory Sample Selection Procedures for Ground Sampling Version 3.3 Errata No. 1, April 2005

Ground Sampling, including Phase II Sampling and NVAF:

Vegetation Resources Inventory Ground Sampling Procedures Version 4.9, March 2010

Ground Sampling Procedure Appendices Version 4.6, March 2010

Vegetation Resources Inventory Ground Sampling Quality Assurance Procedures and Standards for VRI Ground Sampling Version 3.1, March 2008

Vegetation Resources Inventory Ground Sampling Data Collection Procedures for Inaccessible Samples Version 1.0, March 2003

Net Volume Adjustment Factor Sampling Standards and Procedures Version 4.4, March 2010

VRI – Analysis and Adjustment

At the time of the writing of this plan, the section under the Standards for the Data Analysis and Adjustments stated the following:
“The Forest Analysis and Inventory Branch is currently updating procedures for the analysis of VRI ground sample data. New procedures will be posted later in the 2010/11 fiscal year. In the interim, all analyses for new and ongoing projects will be evaluated on a case-by-case basis to determine the most appropriate option.”

Appendix A

Sampling Selection Process and Methodology for TFL18

Sampling Process and Methodology for TFL18

The sample selection process followed the *Sample Selection Procedures for Ground Sampling* document (2002) produced by the MFR.

The VRI shapefiles, clipped to the TFL18 boundary were provided by Chris Mulvihill (MFML Regional Inventory Forester). An overlay of the ownership shapefile showed there were no ownership polygons that required erasing from the VRI layer.

The 'streamlined' planning process has pre-determined that 70 samples should be selected proportionally by area. The 'Volume Audit' (VA) sampling will focus on two different age population units. The two populations will be:

1. A total of 50 samples in the 'Mature' age class, 51 years and older, and
2. A total of 20 samples in the 'Immature' age class, 15 years to 50 years.

The Immature population is not further divided to select the sample polygons. Based on discussions with Chris Mulvihill, the Mature population was divided into 3 strata. The division of the TFL is shown in the table below.

Strata	**Description**
Immature	All species
Mature-1	All Spruce species
Mature-2	Balsam
Mature-3	All other species

Some statistics for the populations and populations and strata are shown below:

	Total	**Immature**	**Mat-Strata 1**	**Mat-Strata 2**	**Mat-Strata 3**
No. of polygons		842	1436	1465	1287
Area (ha)		14606	18367	15872	13009
Minimum Age		15	52	51	52
Maximum Age		50	366	26	402
Mean Age		25	170	118	125
Minimum Height		.8	1.5	4.1	9.2
Maximum Height		19.9	38.5	30.9	38.1
Mean Height		6.4	27.4	17.9	24.2

Samples have been selected using the probability proportional to size with replacement (PPSWR) method according to the published procedures noted above. The table below illustrates the strata proportions and the distribution of samples selected across the

populations/strata. The samples in the Mature population were distributed across the 3 stratum proportional to their size.

Strata/Population	Area	%	Distribution of Samples
Mat Stratum 1	18367	39	20
Mat Stratum 2	15872	33	16
Mat Stratum 3	13009	28	14
Total Mature	472248	100	50
Immature	14606	100	20

As specified in the *Sample Selection Procedures for Ground Sampling* each stratum was further subdivided into 3 (except as noted below for the immature population) sub-strata based on volume classes. The procedure also indicates that the strata will be divided into sub-strata with approximately equal numbers of polygons. This was the procedure used in this project. The only variation was in the Immature stratum. In this case the 0 volume class comprised 569 of 842 polygons so it was decided in conversation with Chris Mulvihill that leading species would be used as the sub-stratification criteria. The table below describes the sub-strata.

Strata	Sub-strata	# of Polygons	Volume Range	
			From	To
Immature	1-Spruce	347	NA	NA
	2-Pine	248	NA	NA
	3-Balsam	171	NA	NA
	4-Other	76	NA	NA
Mature-1	1	479	0	168.4
	2	479	168.5	309.2
	3	478	309.3	+
Mature-2	1	488	0	47.4
	2	488	47.5	141.33
	3	489	141.34	+
Mature-3	1	428	0	182.3
	2	429	182.6	302.0
	3	430	302.7	+

The samples were distributed proportional to the area of each sub-stratum. The table below shows the size of each sub-strata and the distribution of samples.

Strata	Sub-Strata	Area (ha)	Percent	Samples
Immature	1	7246	50	10
	2	3848	26	5
	3	2227	15	3
	4	1285	9	2

Mature-1	1	4311	23	5
	2	6348	35	7
	3	7708	42	8
Mature-2	1	3694	23	4
	2	5492	35	5
	3	6687	42	7
Mature-3	1	2811	21	3
	2	4503	35	5
	3	5695	44	6

Two sample lists (combined) were developed for both the Immature age population and Mature age population areas. The first lists contained the initial 50 samples for the Mature Age Population area and 20 samples for the Immature Age Population area. The second lists provided additional “contingency” samples for each sub stratum in the likely event that some of the initial samples are rejected in the field for any reason, including safety concerns, following field reconnaissance. Forty-nine (49) samples were provided for the Mature Age Population and twenty (20) samples were provided for the Immature Age Population.

Appendix B

Sample Lists for Ground Samples

Sample List

The following are sample list for each of the two populations. Each list contains initial samples for data collection (S) and replacement samples in the event that some of the initial samples need to be replaced during data collection. For the 15-50 population there are 20 initial samples and 20 replacement samples. No samples in this population were dropped at the sample locating stage.

For the 51+ population there are 51 initial samples but please note that 1 was dropped (in cutover) so must not be considered for field data collection. The sample was replaced an R sample as noted in the lists. There remain 50 initial samples and 49 replacement samples.

Samples can be rejected at the field sampling stage if they are in an unsafe location or in a cutover. When replacing samples they must be from the same stratum and sub-stratum (volume class). The Project Manager must be consulted if samples are rejected, prior to replacement. A record of any replacements and the reason must be maintained for the project's records.

Sample List for 15-50 Year Population

Samp	S_or_R*	POP	Strat	Vol_Cls	Map_id	Polygon	Zone	E	N	Dropped
1	s	15		B	92P078	11900126	10	672882	5738317	
2	S	15		B	92P090	30445259	10	693433	5745530	
3	S	15		B	92P069	61244251	10	680742	5727954	
7	S	15		P	92P078	34436383	10	676601	5731643	
8	S	15		P	92P078	93060949	10	669533	5739568	
9	S	15		P	92P069	79775812	10	684145	5730209	
10	S	15		P	92P079	64372281	10	681730	5741336	
11	S	15		P	92P079	54172303	10	679931	5741312	
17	S	15		O	92P070	55235216	10	696898	5728645	
18	S	15		O	92P069	97064326	10	686452	5728004	
21	S	15		S	92P068	20954692	10	674065	5728752	
22	S	15		S	92P070	61716783	10	697524	5731524	
23	S	15		S	92P090	31063899	10	693052	5743641	
24	S	15		S	92P080	44238369	10	694834	5734048	
25	S	15		S	92P079	21797965	10	691016	5733813	
26	S	15		S	92P089	21814548	10	692009	5744990	
27	S	15		S	92P079	669555	10	690152	5736954	
28	S	15		S	92P079	17148827	10	690361	5734949	
29	S	15		S	92P089	18944674	10	691313	5745122	
30	S	15		S	92P078	44222293	10	678338	5741588	
Total										

Initial Samp is 20										
4	R	15		B	92P079	72849056	10	683002	5736070	
5	R	15		B	92P079	76231482	10	682061	5739625	
6	R	15		B	92P078	48388774	10	678759	5735355	
12	R	15		P	92P078	89787958	10	668921	5734784	
13	R	15		P	92P078	92810217	10	669786	5738452	
14	R	15		P	92P088	24033924	10	675056	5744434	
15	R	15		P	92P079	60926585	10	680993	5731451	
16	R	15		P	92P089	60583590	10	681323	5743457	
19	R	15		O	92P070	68256877	10	699024	5731458	
20	R	15		O	92P078	47739341	10	678905	5736250	
31	R	15		S	92P078	25060108	10	674966	5737824	
32	R	15		S	92P068	33224274	10	675929	5727867	
33	R	15		S	92P088	31293105	10	675892	5742894	
34	R	15		S	92P080	51717234	10	696463	5732374	
35	R	15		S	92P069	99836167	10	687276	5730773	
36	R	15		S	92P079	7887866	10	689298	5733487	
37	R	15		S	92P089	78725158	10	684457	5746426	
38	R	15		S	92P089	10945363	10	690868	5746344	
39	R	15		S	92P069	69755652	10	682234	5729996	
40	R	15		S	92P079	68442513	10	682435	5741507	

Total Replacement Samples is 20

S=Initial Sample and R= Replacement Sample

Sample List for 51+ Year Population

Sample	S_or_R*	POP	Strat	Vol Cls	Map_id	Polygon	Zone	E	N	Dropped
41	S	51	S	3	92P078	10280057	10	671978	5738258	
42	S	51	S	3	92P090	45656975	10	695982	5748723	
43	S	51	S	3	92P079	78701350	10	684175	5739924	
44	S	51	S	3	92P089	18125079	10	690954	5745939	
45	S	51	S	3	92P089	66948033	10	682470	5751320	
46	S	51	S	3	92P089	69863575	10	682927	5743486	
47	S	51	S	3	92P089	48134471	10	679296	5745062	
56	S	51	S	1	92P078	16116144	10	673176	5731294	
57	S	51	S	1	922P078	96087602	10	669783	5733847	
58	S	51	S	1	92P080	53103355	10	697007	5742465	
59	S	51	S	1	92P079	11457810	10	689599	5733476	
60	S	51	S	1	92P089	87308059	10	686367	5751049	

65	S	51	S	3	92P078	29060489	10	675892	5738388	
66	S	51	S	2	92P078	42708327	10	678033	5734687	
67	S	51	S	2	92P090	30628781	10	693322	5752043	
68	S	51	S	2	92P079	33727219	10	693053	5732321	
69	S	51	S	2	92P079	93649557	10	686332	5736625	
70	S	51	S	2	92P089	13158673	10	690107	5751786	
71	S	51	S	2	92P089	82418206	10	685578	5751384	
72	S	51	S	2	92P089	50273093	10	679388	5742740	
80	S	51	B	1	92P088	21944289	10	674671	5744852	
81	S	51	B	1	92P080	48308252	10	695824	5733802	
82	S	51	B	1	92P080	34222166	10	693720	5740604	
83	S	51	B	1	92P079	61019260	10	681198	5736051	
88	S	51	B	2	92P088	17223064	10	673894	5743082	
89	S	51	B	2	92P080	80709987	10	701371	5736864	
90	S	51	B	2	92P080	53987040	10	696637	5731764	
91	S	51	B	2	92P070	55206347	10	696378	5730469	
92	S	51	B	2	92P089	84934914	10	685718	5745468	
98	S	51	B	3	92P070	64986802	10	698627	5731474	
99	S	51	B	3	92P070	39316337	10	693698	5730989	
100	S	51	B	3	92P079	82320468	10	684689	5738007	X dropped (in CO) - replaced with repl sample 105
105	S	51	B	3	92P068	8134707	10	671763	5728752	
101	S	51	B	3	92P079	21459667	10	691427	5736301	
102	S	51	B	3	92P079	77502119	10	683815	5740846	
103	S	51	B	3	92P069	90305258	10	685697	5729038	
104	S	51	B	3	92P068	98023994	10	670308	5727614	
112	S	51	O	1	92P068	31634701	10	675570	5728786	
113	S	51	O	1	92P079	121551	10	687870	5739763	
114	S	51	O	1	92P079	76696660	10	683490	5731238	
118	S	51	O	2	92P078	33350148	10	676175	5737975	
119	S	51	O	2	92P090	47559043	10	696438	5752308	
120	S	51	O	2	92P090	34903931	10	694066	5743899	
121	S	51	O	2	92P079	99721149	10	687636	5738871	
122	S	51	O	2	92P079	97439291	10	687309	5736081	
128	S	51	O	3	92P069	33942816	10	692520	5724733	
129	S	51	O	3	92P069	38312819	10	693723	5724788	
130	S	51	O	3	92P078	21597369	10	673848	5732868	
131	S	51	O	3	92P070	93737125	10	703542	5731658	
132	S	51	O	3	92P070	60385674	10	697830	5729304	

133	S	51	O	3	92P090	44659070	10	696044	5752425	
Total Initial Samples is 51-1 (dropped)=50										
55	R	51	S	3	92P089	48395630	10	679859	5746843	
54	R	51	S	3	92P079	64712050	10	681507	5740847	
53	R	51	S	3	92P089	15756307	10	691031	5747736	
52	R	51	S	3	92P079	12661808	10	690006	5740467	
51	R	51	S	3	92P079	26343145	10	692401	5742467	
50	R	51	S	3	92P079	18588184	10	690818	5733922	
49	R	51	S	3	92P068	18135698	10	673540	5730477	
48	R	51	S	3	92P078	27120772	10	675231	5739317	
61	R	51	S	1	92P079	26160916	10	692107	5738175	
62	R	51	S	1	92P079	86017289	10	685254	5732666	
63	R	51	S	1	92P079	97972245	10	688043	5741357	
64	R	51	S	1	92P089	15585590	10	690872	5746442	
73	R	51	S	2	92P068	22815197	10	673897	5729459	
74	R	51	S	2	92P069	12705835	10	689628	5729670	
75	R	51	S	2	92P089	92424356	10	686493	5744831	
76	R	51	S	2	92P089	15324400	10	690677	5744348	
77	R	51	S	2	92P079	81331415	10	684565	5739807	
78	R	51	S	2	92P089	80505101	10	685223	5745589	
79	R	51	S	2	92P089	50264665	10	679429	5745843	
84	R	51	B	1	92P080	63797752	10	698413	5733491	
85	R	51	B	1	92P079	4476815	10	688428	5732025	
86	R	51	B	1	92P069	68875984	10	682150	5730399	
87	R	51	B	1	92P079	59337392	10	681051	5732751	
93	R	51	B	2	92P080	72539906	10	700268	5736811	
94	R	51	B	2	92P080	64730618	10	699012	5737870	
95	R	51	B	2	92P080	52321348	10	696654	5738973	
96	R	51	B	2	92P079	68446	10	687850	5734653	
97	R	51	B	2	92P089	71956008	10	683409	5747572	
106	R	51	B	3	92P080	63189375	10	698191	5735302	
107	R	51	B	3	92P080	47550638	10	695800	5737510	
108	R	51	B	3	92P080	43318989	10	694985	5735241	
109	R	51	B	3	92P089	21147762	10	692421	5749882	
110	R	51	B	3	92P079	76500434	10	683999	5738230	
111	R	51	B	3	92P089	70716803	10	683858	5748655	
115	R	51	O	1	92P090	55503946	10	697452	5743448	

116	R	51	O	1	92P090	39403431	10	694615	5742671	
117	R	51	O	1	92P078	45086465	10	678201	5731672	
123	R	51	O	2	92P068	12074709	10	672270	5728929	
124	R	51	O	2	92P078	27172068	10	675421	5741312	
125	R	51	O	2	92P069	8805461	10	688718	5729409	
126	R	51	O	2	92P079	6311495	10	688792	5740128	
127	R	51	O	2	92P089	64095556	10	681967	5746733	
134	R	51	O	3	92P078	31096259	10	676078	5731268	
135	R	51	O	3	92P078	35661946	10	676812	5741151	
136	R	51	O	3	92P070	69355743	10	699113	5728947	
137	R	51	O	3	92P079	73756587	10	682915	5731868	
138	R	51	O	3	92P068	52325781	10	679248	5730426	
139	R	51	O	3	92P068	44204453	10	678055	5728373	
140	R	51	O	3	92P079	97182592	10	687335	5741186	

Total Replacement Samples is 50-1 (replaced sample 100 with 105)= 49

Appendix C

Comparison of the Sample Characteristics to the Population

Sample/Population Comparison

The following tables show how the sample distribution compares to the population distribution for leading species, age class, and volume class. Sample and populations compare very closely in all cases.

The comparisons will be grouped by the two populations.

15-50 Year Old Population

Comparison of Samples vs. Population for Species Distribution -Population 15-50 Years

Species	Number of Samples	% of Total	Species Area Rep in Pop	% of Tot Area
Spruce	10	**50**	7246	**50**
Pine	5	**25**	3849	**27**
Balsam	3	**15**	2227	**15**
Fir	1	**5**	1008	**7**
Aspen	1	**5**	219	**1**
Birch			29	**0**
Cedar			29	**0**
Total	20	**100**	14607	**100**

Comparison of Samples vs. Population for Age Class Distribution -Population 15-50 Years

Age Class	Number of Samples	% of Total	AC Area Rep in Pop	% of Tot Area
1	9	**45**	5666	**39**
2	11	**55**	7707	**53**
3	0	**0**	1234	**8**
Total	20	**100**	14607	**100**

Comparison of Samples vs. Population for Ht Class -Population 15-50 Years

Ht Cls	Number of Samples	% of Total	Species Area Rep in Pop	% of Tot Area
1	19	**95**	11626	**80**
2	1	**5**	2921	**20**
3	0	**0**	60	**0**
Total	20	**100**	14607	**100**

51+ Year Old Population

Comparison of Samples vs. Population for Species Distribution -Population 51+ Years

Species	Number of Samples	% of Total	Species Area Rep in Pop	% of Tot Area
Spruce	20	**40**	18352	**39**
Balsam	16	**32**	15873	**33**
Pine	11	**22**	8947	**19**
Fir	3	**6**	2634	**6**
Cedar			715	**2**
Aspen			482	**1**
Hemlock			209	**0**
Birch			23	**0**
Total	50	**100**	47250	**100**

Comparison of Samples vs. Population for Age Class Distribution -Population 51+ Years

Age Class	Number of Samples	% of Total	AC Area Rep in Pop	% of Tot Area
3	2	**4**	966	**2**
4	7	**14**	3384	**7**
5	6	**12**	550	**12**
6	5	**10**	6469	**14**
7	6	**12**	8062	**17**
8+	24	**48**	22867	**48**
Total	50	**100**	47250	**100**

Comparison of Samples vs. Population for Ht Class -Population 51+ Years

Ht Cls	Number of Samples	% of Total	Species Area Rep in Pop	% of Tot Area
1	1	**2**	779	**2**
2	13	**26**	10766	**23**
3	20	**40**	21506	**45**
4	16	**32**	14144	**30**
5	0	**0**	55	**0**
Total	50	**100**	47250	**100**

The following table shows the sample distribution (both mature and immature populations) by mapsheet.

Sample Distribution by Mapsheet

MAP_ID	Area	%	Samples	%
092P068	2,541	4%	4	6%
092P069	7,216	12%	6	9%
092P070	3,381	5%	7	10%
092P078	8,489	14%	11	16%
092P079	13,285	21%	16	23%
092P080	9,892	16%	6	9%
092P088	2,715	4%	2	3%
092P089	11,471	19%	11	16%
092P090	2,665	4%	7	10%
092P099	202	0%	0	0%
Total	**61,857**	**100%**	**70**	**100%**

Appendix D

NVAF Profile - NVAF Sample Selection Process and Methodology for TFL18

NVAF Sample Selection

In the 'streamlined' VRI Ground Sampling Volume Audit Sampling, 12 of the Mature age population samples were selected from the original 50 to be completed as part of the Net Volume Adjustment Factor sampling. This involved a further age sub-division of the 'Mature' population into 51-120 and 121+ groups. The resultant breakdown of these samples was directed to be:

Age breakdown	# of samples
51-120	3
121+	9
TOTAL	**12**

The following 2 tables show how the NVAF samples were chosen. The process was as specified in *NVAF Sampling Standards And Procedures* section 2.5.

The table of selected VRI samples for each age grouping was sorted by leading species then by age. The NVAF sample selection interval (K) was determined (K=(number of VRI samples in the grouping/number of NVAF samples)). A random number between 1 and K was generated using Excel and this was the first VRI sample on the sorted list chosen for NVAF sampling. The next NVAF sample was K samples down the list -and so on until all of the NVAF samples were selected.

The following tables show the tables from which NVAF samples were selected.

List for NVAF Sample Selection -51-120

Sample	MAP_ID	POLYGON _ID	SPP	Age	Age Cls	Ht	Ht Cls	Vol	Area	NVAF Sample
80	092P088	21944289	BL	52	3	9.0	1	19.014	37.278	
89	092P080	80709987	BL	52	3	14.6	2	89.103	35.369	
82	092P080	34222166	BL	62	4	12.5	2	25.376	8.263	
90	092P080	53987040	BL	67	4	18.7	2	126.381	25.965	
91	092P070	55206347	BL	67	4	16.3	2	109.450	70.147	
103	092P069	90305258	BL	72	4	18.5	2	175.368	51.509	NVAF
83	092P079	61019260	BL	83	5	14.3	2	32.614	24.867	
81	092P080	48308252	BL	102	6	12.3	2	17.534	1.715	
92	092P089	84934914	BL	102	6	18.3	2	111.346	9.418	
132	092P070	60385674	FD	69	4	26.3	3	365.993	37.582	
119	092P090	47559043	PL	72	4	18.3	2	185.175	5.426	
120	092P090	34903931	PL	92	5	20.2	3	195.967	11.924	
131	092P070	93737125	PL	92	5	23.2	3	417.157	5.100	NVAF
122	092P079	97439291	PL	117	6	24.1	3	269.824	10.094	

129	092P069	38312819	PL	117	6	23.1	3	337.663	8.320	
56	092P078	16116144	SX	72	4	16.5	2	24.392	1.152	
58	092P080	53103355	SX	82	5	14.2	2	43.784	3.538	
42	092P090	45656975	SX	93	5	24.8	3	319.525	13.441	
70	092P089	13158673	SX	98	5	24.5	3	199.235	21.734	
57	092P078	96087602	SX	102	6	26.3	3	82.711	9.691	NVAF

K=20/3 = 7
Random no =6

List For NVAF Selection -121+

Sample	MAP_ID	POLYGON_ID	SPP	Age	Age Cls	Area	NVAF Selected
112	092P068	31634701	PL	122	7	9.828	NVAF
133	092P090	44659070	PL	122	7	8.962	
130	092P078	21597369	PL	142	8	45.529	
118	092P078	33350148	PL	162	8	39.007	NVAF
113	092P079	121551	PL	202	8	5.892	
121	092P079	99721149	PL	202	8	6.283	
56	092P078	16116144	SX	72	4	1.152	NVAF
58	092P080	53103355	SX	82	5	3.538	
42	092P090	45656975	SX	93	5	13.441	
70	092P089	13158673	SX	98	5	21.734	NVAF
57	092P078	96087602	SX	102	6	9.691	
60	092P089	87308059	SX	127	7	10.232	
66	092P078	42708327	SX	142	8	20.610	NVAF
69	092P079	93649557	SX	142	8	80.213	
41	092P078	10280057	SX	152	8	28.398	
43	092P079	78701350	SX	152	8	22.222	NVAF
47	092P089	48134471	SX	152	8	8.324	
72	092P089	50273093	SX	162	8	9.904	
65	092P078	29060489	SX	164	8	53.233	NVAF
67	092P090	30628781	SX	177	8	26.985	
45	092P089	66948033	SX	202	8	11.321	
68	092P079	33727219	SX	227	8	7.534	NVAF
59	092P079	11457810	SX	242	8	7.041	
71	092P089	82418206	SX	256	9	13.373	
46	092P089	69863575	SX	262	9	10.672	NVAF
44	092P089	18125079	SX	307	9	67.592	

k=(26/9)=3
Random no=1

The Following tables show the VRI samples chosen for NVAF sampling.

List of NVAF Samples for 51-120 Year Age Group

Sample	MAP_ID	POLYGON_ID	SPP	Age Cls	Area	NVAF Sample
103	092P069	90305258	BL	4	51.509	NVAF
131	092P070	93737125	PL	5	5.100	NVAF
57	092P078	96087602	SX	6	9.691	NVAF

List For NVAF Selection -121+

Sample	MAP_ID	POLYGON_ID	SPP	Age Cls	Area	NVAF Selected
112	092P068	31634701	PL	7	9.828	NVAF
118	092P078	33350148	PL	8	39.007	NVAF
56	092P078	16116144	SX	4	1.152	NVAF
70	092P089	13158673	SX	5	21.734	NVAF
66	092P078	42708327	SX	8	20.610	NVAF
43	092P079	78701350	SX	8	22.222	NVAF
65	092P078	29060489	SX	8	53.233	NVAF
68	092P079	33727219	SX	8	7.534	NVAF
46	092P089	69863575	SX	9	10.672	NVAF

Appendix E

NVAF – BEC summary for Sample Population, Age 51+

TFL 18 NVAF-BEC Summary For 51-120

BEC	Area
ESSFdc 3	1564
ESSFwc 2	7400
ESSF wcw	134
ICH dw 3	275
ICHmk 2	1240
ICHmw	2145
SBSdw1	185
SBSmm	3377
TOTAL	**16320**

TFL 18 NVAF-BEC Summary For 121+

BEC	Area
ESSFdc 3	6093
ESSFwc 2	10273
ESSFwcw	1606
ICHdw 3	35
ICHnk 2	1785
ICHmw 3	2191
SBSdw1	249
SBSmm	8698
TOTAL	**30930**

All Mature **47250**